DOI: http://dx.doi.org/10.22122/arya.v15i3.1588 Published by Vesnu Publications

The effect of educational and encouragement interventions on anthropometric characteristics, obestatin and adiponectin levels

Firoozeh Sajjadi[1], Noushin Mohammadifard[2], Maryam Maghroun[3], Fatemeh Shirani[4], Simin Karimi[5], Marzie Taheri[3], Nizal Sarrafzadegan[6]

Original Article

Abstract

BACKGROUND: Lifestyle modification is the most important strategy for control of obesity and overweight. Obestatin and adiponectin are the biomarkers of obesity. Thus, this study was performed to examine the effect of educational and encouragement interventions and lifestyle modifications on obesity anthropometric as well as obestatin and adiponectin levels.

METHODS: This semi-experimental study was conducted on a subsample of TABASSOM study. Participants were 41 overweight and obese children and adolescents aged 6-18 years old and 45 overweight and obese adults aged 19-65 years old. Anthropometric characteristics including height, weight, waist and hip circumferences, and body fat percentage (BFP) were measured at the first and after one year at the end of study. We implemented some educational and encouragement interventions regarding dietary modification and physical activity during the study. Obestatin and adiponectin levels were measured at the first and end of study by enzyme-linked immunosorbent assay (ELISA) method.

RESULTS: The study did not show significant effect on anthropometric characteristics such as body mass index (BMI) and waist circumference (WC). BFP decreased significantly in boys, total children and adolescent group, and waist-to-hip ratio (WHR) decreased significantly only in adolescent boys after 1 year ($P < 0.050$).

CONCLUSION: Educational and encouraging interventions and lifestyle modifications could lead to decrease of body WHR and BFP in adolescent boys. This is helpful in controlling the increasing rate of obesity.

Keywords: Obesity, Overweight, Adults, Children, Adolescents, Obestatin, Adiponectin

Date of submission: 21 Feb. 2018, ***Date of acceptance:*** 30 Jan. 2019

Introduction

Obesity is a major cause of non-communicable diseases (NCDs). Studies have shown that weight gain contributes to the incidence of several different diseases, including hypertension (HTN), diabetes, cardiovascular diseases (CVDs), and cancer.[1,2] In Iran, the prevalence of overweight and obesity is 50.5% in men, 60.4% in women, 18.6% in boys, and 21.4% in girls.[3,4] The World Health Organization (WHO) is seeking through its plans to stop the increasing trend of obesity and overweight in the world by 2025.[5]

Prevention and treatment are mainly focused on lifestyle modification, including the modification of nutrition and increasing physical exercise.[5] Making changes in the living environment and developing guidelines for a healthy lifestyle are major strategies for the treatment of obesity and overweight.[6]

How to cite this article: Sajjadi F, Mohammadifard N, Maghroun M, Shirani F, Karimi S, Taheri M, et al. **The effect of educational and encouragement interventions on anthropometric characteristics, obestatin and adiponectin levels.** ARYA Atheroscler 2019; 15(3): 123-29.

1- Heart Failure Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran
2- Assistant Professor, Hypertension Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran
3- Interventional Cardiology Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran
4- Food Security Research Center, Isfahan University of Medical Sciences, Isfahan, Iran
5- Cardiac Rehabilitation Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran
6- Professor, Isfahan Cardiovascular Research Center, Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran
Correspondence to: Nizal Sarrafzadegan, Email: nsarrafzadegan@gmail.com

Regaining weight and behavioral change after interventions also comprise a major challenge in the treatment of obesity. Methods need to be devised that help control weight for a longer time and permanently, if possible.

The interventions performed within the Isfahan Healthy Heart Program (IHHP), which is a community-based interventional program conducted in Isfahan, Iran,[7,8] were found to have helped modify certain lifestyle-related factors to an extent.[9,10]

Various biological and psychological factors contribute to gaining back weight after weight loss.[11] Evidence suggests that some treatments for obesity fail in the long term due to the compensatory decrease in metabolism and thus lead to further weight gain.[12] The hormones affecting hunger and satiety play an influential role in this phenomenon.[13] Obestatin is a gastric hormone that affects the stimulation of appetite and thereby energy balances in the body.[14] This hormone stimulates the appetite, regulates weight, and opposes ghrelin.[15] Adiponectin, which is secreted from fat tissues, also affects blood glucose regulation and fatty acid catabolism, such that it improves the body's response to insulin by increasing metabolism.[16] In a study to determine the relationship between obestatin and serum insulin levels, body mass index (BMI), waist circumference (WC), and obesity ratios were significantly higher in obese children, while the obestatin level was significantly lower in these subjects.[17]

Different methods of weight loss are effective in the treatment of obesity, including diet, physical exercise, and surgery, and studies have demonstrated the separate effects of these methods on ghrelin, leptin, adiponectin, resistin, and insulin both in adults and children.[18] Few studies have examined that how training individuals to choose their preferred method of weight loss affects their weight goals and what long-term consequences ensue these interventions.[19,20] This study seeks to answer the question of whether or not giving training to individuals about the different methods of weight loss and allowing them to freely choose their preferred method help modify these biomarkers and whether the changes in these biomarkers correlate with long-term weight loss or further weight gain. This study was conducted to examine the effect of educational and encouragement interventions on obesity indicators and biomarkers including adiponectin and obestatin levels in overweight and obese subjects.

Materials and Methods

This quasi-experimental study was conducted on February 2012 until March 2013 with a before-after design on a subgroup of people who had participated in the TABASSOM study. In TABASSOM study, overweight and obese volunteers willing to participate in the "lose weight and win" competition were invited through a public announcement through the Islamic Republic of Iran Broadcasting (IRIB) and in the schools.[11] The participants included 86 persons that were divided into two groups: 41 children and adolescents (aged 6-18 years) and 45 adults (aged 19-65 years). The inclusion criteria consisted of residing in Isfahan City and having a BMI of 25 or higher for the adults and 85th percentile or higher for the children and adolescents.[21] Participants should have no systemic illness, liver and renal disease, and endocrine and mental disorders. Those who did not practice other methods of weight loss, including pharmacotherapy and surgery, were also allocated. We excluded non-compliant subjects from the study. Only 4 children were excluded due to unwillingness to continue. The study was approved by the Ethics Committee of Isfahan Cardiovascular Research Institute (ICRI). Written informed consents were obtained from all participants. Trained health professionals carried out detailed interviews at study baseline to obtain information about participants' socioeconomic and demographic characteristics.[22]

In order to implement a comprehensive interventional program, educational and encouraging interventions were applied in the course of one year.

Educational interventions: Educational materials (e.g., pamphlets, CDs, and multimedia programs) were used to explain weight control strategies and inappropriate weight loss methods (e.g., particular medical treatments and their side effects). The participants were also provided with a pamphlet about healthy diet, a CD about physical activity, and follow-up cards. They were asked to keep the cards during the follow-up sessions (6 and 12 months later). Furthermore, after coordination with the Culture Department of Isfahan Municipality, extensive community-based interventions regarding obesity and obesity prevention were provided in 17 cultural centers. Five educational pamphlets were also distributed in schools of Isfahan with the help of Isfahan Municipality's Committee for Citizenship Culture. Several educational posters were also prepared and installed on billboards in crowded areas of the city.

Encouraging interventions: After six months, the participants with at least 10% weight loss were included in a competition. They were reevaluated after another six months. Twenty individuals who showed weight loss or no weight gain after the second period were randomly rewarded. The anthropometric indices, obestatin and adiponectin levels, were re-evaluated after one year.

Participants' weight and height were measured with no shoes on and in light clothing using a seca scale with a precision of 0.5 kg and a plastic meter with a precision of 0.5 cm. The BMI was calculated using the equation 'weight in kilograms divided by the square of the height in meters'. The waist and hip circumferences were measured over light clothing at a standing position using a plastic meter, and the WC was measured at the center of the lower rib and the top of the hip, and the hip circumference at the femur.[21] The waist-to-hip ratio (WHR) was also calculated. The body fat percentage (BFP) was measured with a body composition analyzer (Ironman InnerScan Body Composition Monitor from Tanita).

Participants' adiponectin and obestatin levels were measured using the enzyme-linked immunosorbent assay (ELISA) method and with a buffer kit and an Eastbiopharm elisa kit (Hangzhou Eastbiopharm Co., USA) at baseline and at the end of the project, i.e., one year later.[23]

All the information collected from the questionnaires and the initial demographic information obtained from the candidates were entered into a computer using Epi Info software. Once thoroughly analyzed and managed, the data were reported as mean and standard deviation (SD), and the non-normally distributed data were reported as median and interquartile range, and all this data were then tabulated.

The paired sample t-test was used to compare the data before and after the intervention, and Wilcoxon's nonparametric test (the Wilcoxon signed-rank test) was used to compare the non-normally distributed data. The independent sample t-test was used to examine the percentage of changes between the two genders, and Mann-Whitney's nonparametric U test was used for the non-normally distributed data. Data were analyzed in SPSS software (version 15, SPSS Inc., Chicago, IL, USA). The level of statistical significance was set at $P < 0.050$.

Results

Table 1 indicates the mean demographic and anthropometric data of adults and children and adolescents based on gender. The mean weight, BMI, WHR, and BFP differed significantly between the two genders in adults and WHR in children and adolescents ($P < 0.050$).

Comparison of the median obestatin level before and after the intervention in the adults and children and adolescents by gender has been shown in table 2. Although the obestatin level increased among the women and decreased among the men, the difference observed was not statistically significant ($P > 0.050$). There was no significant obestatin reduction in children and adolescents ($P > 0.050$).

The level of adiponectin had a non-significant change in adults and children and adolescents ($P > 0.050$) (Table 3).

Table 4 shows the mean of BMI, WC, WHR, and BFP before and after the intervention in adults and children and adolescents by gender. A significant difference was shown between mean of WHR and BFP in boys ($P = 0.040$ and $P = 0.008$, respectively) and BFP in total children and adolescents ($P = 0.006$), but no significant difference was observed in adults. The other indices did not show significant differences before and after the intervention in either of the age groups ($P > 0.050$).

Table 1. Basic characteristics of study participants

Characteristics	Adults				Children and adolescents			
	Women	Men	P	Total	Girls	Boys	P	Total
Number	22	23		45	18	23		41
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	Mean ± SD		Mean ± SD
Age (year)	40.60 ± 9.80	45.20 ± 10.80	0.160	43.05 ± 10.50	12.50 ± 3.30	12.60 ± 2.90	0.870	12.56 ± 3.06
Weight (kg)	79.10 ± 11.80	86.60 ± 9.50	0.030	82.90 ± 11.20	60.81 ± 16.52	64.29 ± 20.02	0.550	62.76 ± 18.43
BMI (kg/m^2)	31.63 ± 4.30	28.84 ± 2.46	0.010	30.20 ± 3.72	26.30 ± 4.24	26.89 ± 4.59	0.670	26.63 ± 4.40
WC (cm)	96.07 ± 9.78	99.60 ± 15.00	0.140	97.88 ± 7.83	81.28 ± 8.71	86.96 ± 11.52	0.090	84.46 ± 10.65
WHR	0.89 ± 0.08	0.95 ± 0.04	0.001	0.92 ± 0.07	0.84 ± 0.06	0.91 ± 0.04	< 0.001	0.88 ± 0.06
BFP	35.95 ± 5.14	26.40 ± 4.23	< 0.001	31.07 ± 6.70	34.95 ± 4.56	30.34 ± 7.83	0.050	32.20 ± 6.86

BMI: Body mass index; WC: Waist circumference; WHR: Waist-to-hip ratio; BFP: Body fat percentage; SD: Standard deviation

Table 2. Comparing the median of obestatin level before and after the intervention in two groups of adults and children and adolescents based on sex

Obestatin (ng/ml)	Before intervention	After intervention	P
	Median (25^{th}-75^{th})	Median (25^{th}-75^{th})	
Adults			
Women	6.03 (5.24-6.20)	6.12 (5.43-6.86)	0.350
Men	5.58 (4.76-6.44)	5.43 (5.01-5.88)	0.130
Total	5.93 (5.03-6.24)	5.76 (5.11-6.62)	0.200
Children and adolescents			
Girls	0.91 (0.75-1.08)	0.93 (0.80-1.00)	0.570
Boys	3.77 (2.51-8.29)	3.85 (3.08-6.20)	0.320
Total	2.13 (0.94-4.08)	2.86 (2.67-4.52)	0.130

Discussion

The results showed that the education and encouragement interventions did not have a significant effect on anthropometric factors in either of the age groups; however, they did lead to a significant reduction in the WHR and BFP in the boy participants; furthermore, no changes were observed in adiponectin and obestatin levels in either age group.

It has been suggested that adiponectin, which is a peptide derived from fat tissues, is inversely correlated with obesity;[24,25] so that the reduced changes in serum adiponectin largely contribute to obesity-related complications and problems.[26,27] Studies also show that when adiponectin decreases, the body reserves fat in risky regions, such as the muscular tissues, and the fat percentage then increases in these regions.[28] However, no significant reductions were observed in anthropometric indicators in this study, and adiponectin also did not change significantly.

Evidence suggests that when the adiponectin level is high, the body protects itself from the shortage of energy through reserving fat in the fat cells. This fat tissue is first added to the layer beneath the skin, and when adiponectin decreases, the body continues to reserve more fat in certain critical regions, which can lead to inflammation and increased risk of heart disease.[29,30]

Few studies have examined the obestatin peptide and produced contradictory results about plasma obestatin level. A study conducted in 2008 on overweight children and adolescents showed a significantly higher plasma obestatin level in the overweight group compared to the study group with normal weight. That study found that weight loss increased obestatin in the overweight group.[19] Ghanbari-Niaki et al. reported similar findings, only with this difference that the level of obestatin increased significantly after weight loss in their study; while, before their weight loss, the overweight children had lower levels of obestatin compared to the group of children with normal weight.[31]

The present study found that obestatin levels did not change significantly in the adults or children and adolescents; however, the WHR and BFP changed significantly in the boy participants. Obesity and overweight were found to decrease the obestatin level.[32] In a study by Beasley et al., overweight and obese people had lower levels of obestatin compared to people with normal weight.[32]

Table 3. Comparing the mean of adiponectin level before and after the intervention in two groups of adults and children and adolescents based on sex

Adiponectin (ng/ml)	Before intervention	After intervention	P
	Mean ± SD	Mean ± SD	
Adults			
Women	33.10 ± 19.65	31.62 ± 18.11	0.340
Men	29.73 ± 21.60	26.23 ± 19.28	0.280
Total	31.40 ± 20.50	28.88 ± 18.86	0.240
Children and adolescents			
Girls	24.65 ± 12.81	22.22 ± 11.52	0.310
Boys	25.85 ± 13.92	29.73 ± 14.39	0.240
Total	25.32 ± 13.30	25.85 ± 13.11	0.760

SD: Standard deviation

Table 4. Comparing the mean anthropometric characteristics before and after the intervention in two groups of adults and children and adolescents based on sex

Variable	Before intervention	After intervention	P
	Mean ± SD	Mean ± SD	
Adults			
BMI (kg/m^2)			
Women	31.63 ± 4.30	31.43 ± 3.69	0.410
Men	28.84 ± 2.46	28.43 ± 3.29	0.330
Total	30.20 ± 3.72	29.95 ± 3.71	0.180
WC (cm)			
Women	96.07 ± 9.78	96.09 ± 8.97	0.820
Men	99.61 ± 5.00	99.49 ± 8.60	0.630
Total	97.88 ± 7.83	97.75 ± 3.71	0.520
WHR			
Women	0.89 ± 0.08	0.88 ± 0.08	0.730
Men	0.95 ± 0.04	0.96 ± 0.04	0.710
Total	0.92 ± 0.07	0.92 ± 0.07	0.600
BFP			
Women	35.95 ± 5.14	35.77 ± 4.74	0.580
Men	26.40 ± 4.23	26.68 ± 7.84	0.500
Total	31.07 ± 6.70	31.06 ± 8.54	0.840
Children and adolescent			
BMI (kg/m^2)			
Girls	26.30 ± 4.24	26.21 ± 3.90	0.740
Boys	26.89 ± 4.59	26.74 ± 5.03	0.620
Total	26.63 ± 4.40	26.55 ± 4.56	0.540
WC (cm)			
Girls	81.28 ± 8.71	81.16 ± 8.71	0.580
Boys	86.96 ± 11.52	86.43 ± 14.7	0.310
Total	84.46 ± 10.65	84.38 ± 12.60	0.380
WHR			
Girls	0.84 ± 0.06	0.85 ± 0.06	0.530
Boys	0.91 ± 0.04	0.89 ± 0.06	0.040
Total	0.88 ± 0.06	0.87 ± 0.06	0.210
BFP			
Girls	34.59 ± 4.56	33.83 ± 4.99	0.330
Boys	30.34 ± 7.83	26.87 ± 9.07	0.008
Total	32.20 ± 6.16	29.93 ± 8.25	0.006

BMI: Body mass index; WC: Waist circumference; WHR: Waist-to-hip ratio; BFP: Body fat percentage; SD: Standard deviation

In the study by Lippl et al., no significant differences were observed in the obestatin level between the overweight and the thin children; however, the level of obestatin increased significantly in the group of overweight children after their weight loss with diet, but the change was not significant in overweight children who did not lose much weight.[33] Overall, obestatin appears to inhibit overeating and is associated with proven appetite-suppressing effects and thus, plays a key role in weight control.[33] Obestatin and adiponectin can be used as markers of the success of interventions and also to monitor treatments.[34] Obesity is an independent risk factor in adulthood that is closely related to health factors.[35,36] Interventions are necessary for the control, reduction, or at least stabilization of obesity. The results of this study revealed that instructional and incentive interventions cannot reduce overweight and obesity, but can prevent weight gain and control its progressive trend, especially in children and adolescents, who are a more sensitive age group, since the modification of their weight ultimately leads to lower rates of obesity in the society. In a study conducted by Sahota et al. in the United Kingdom for examining the effects of an intervention program on the obesity, the subjects' BMI did not change significantly after the intervention (which is in line with the present findings), but some of their dietary habits were

slightly modified.[37] Studies show that exercise can probably affect obestatin levels.[38] The intervention performed in this study targeted increased physical activity and improved diets through educational materials, CDs, and offering prizes; however, the results showed that even these strategies could not really increase the frequency of physical activity.

Conclusion

The interventions performed did not significantly affect the anthropometric factors in either age group examined in the study; however, they did lead to a significant reduction in the WHR and BFP in boy participants. Moreover, these interventions did not significantly affect serum adiponectin and obestatin levels. Although the instructional and incentive interventions given did not significantly reduce obesity, they are still regarded as helpful due to their inhibitory effect on the increasing trend of obesity. Further long-term comprehensive interventions performed with better facilities are suggested for achieving a maintenance lifestyle modification to decrease obesity indices and increase adiponectin and obestatin levels.

Acknowledgments

Here it is necessary to thank the management of the development of research, evaluation of research, and coordination of research centers that approved the implementation of research project (number 191124) in Isfahan University of Medical Sciences.

Conflict of Interests

Authors have no conflict of interests.

References

1. Calza S, Decarli A, Ferraroni M. Obesity and prevalence of chronic diseases in the 1999-2000 Italian National Health Survey. BMC Public Health 2008; 8: 140.
2. Guh DP, Zhang W, Bansback N, Amarsi Z, Birmingham CL, Anis AH. The incidence of co-morbidities related to obesity and overweight: A systematic review and meta-analysis. BMC Public Health 2009; 9: 88.
3. Sarrafzadegan N, Kelishadi R, Sadri G, Malekafzali H, Pourmoghaddas M, Heidari K, et al. Outcomes of a comprehensive healthy lifestyle program on cardiometabolic risk factors in a developing country: the Isfahan Healthy Heart Program. Arch Iran Med 2013; 16(1): 4-11.
4. Kelishadi R, Mohammadifard N, Sarrazadegan N, Nouri F, Pashmi R, Bahonar A, et al. The effects of a comprehensive community trial on cardiometabolic risk factors in adolescents: Isfahan Healthy Heart Program. ARYA Atheroscler 2012; 7(4): 184-90.
5. World Health Organization. Commission on Ending Childhood Obesity [Online]. [cited 2017]; Available from: URL; https://www.who.int/end-childhood-obesity/en
6. Gao Y, Griffiths S, Chan EY. Community-based interventions to reduce overweight and obesity in China: A systematic review of the Chinese and English literature. J Public Health (Oxf) 2008; 30(4): 436-48.
7. Sarrafzadegan N, Kelishadi R, Siadat ZD, Esmaillzadeh A, Solhpour A, Shirani S, et al. Obesity and cardiometabolic risk factors in a representative population of Iranian adolescents and adults in comparison to a Western population: The Isfahan Healthy Heart Programme. Public Health Nutr 2010; 13(3): 314-23.
8. Sarraf-Zadegan N, Sadri G, Malek Afzali H, Baghaei M, Mohammadi Fard N, Shahrokhi S, et al. Isfahan Healthy Heart Programme: A comprehensive integrated community-based programme for cardiovascular disease prevention and control. Design, methods and initial experience. Acta Cardiol 2003; 58(4): 309-20.
9. Sarrafzadegan N, Kelishadi R, Esmaillzadeh A, Mohammadifard N, Rabiei K, Roohafza H, et al. Do lifestyle interventions work in developing countries? Findings from the Isfahan Healthy Heart Program in the Islamic Republic of Iran. Bull World Health Organ 2009; 87(1): 39-50.
10. Mohammadifard N, Kelishadi R, Safavi M, Sarrafzadegan N, Sajadi F, Sadri GH, et al. Effect of a community-based intervention on nutritional behaviour in a developing country setting: The Isfahan Healthy Heart Programme. Public Health Nutr 2009; 12(9): 1422-30.
11. Abolhassani S, Irani MD, Sarrafzadegan N, Rabiei K, Shahrokhi S, Pourmoghaddas Z, et al. Barriers and facilitators of weight management in overweight and obese people: Qualitative findings of TABASSOM project. Iran J Nurs Midwifery Res 2012; 17(3): 205-10.
12. Abete I, Parra D, Crujeiras AB, Goyenechea E, Martinez JA. Specific insulin sensitivity and leptin responses to a nutritional treatment of obesity via a combination of energy restriction and fatty fish intake. J Hum Nutr Diet 2008; 21(6): 591-600.
13. Seoane LM, Al-Massadi O, Caminos JE, Tovar SA, Dieguez C, Casanueva FF. Sensory stimuli directly acting at the central nervous system regulate gastric ghrelin secretion. An ex vivo organ culture study. Endocrinology 2007; 148(8): 3998-4006.
14. Lee MJ, Fried SK. Integration of hormonal and nutrient signals that regulate leptin synthesis and

secretion. Am J Physiol Endocrinol Metab 2009; 296(6): E1230-E1238.
15. Zhang JV, Ren PG, Avsian-Kretchmer O, Luo CW, Rauch R, Klein C, et al. Obestatin, a peptide encoded by the ghrelin gene, opposes ghrelin's effects on food intake. Science 2005; 310(5750): 996-9.
16. Meier U, Gressner AM. Endocrine regulation of energy metabolism: Review of pathobiochemical and clinical chemical aspects of leptin, ghrelin, adiponectin, and resistin. Clin Chem 2004; 50(9): 1511-25.
17. Zhang MY, Li F, Wang JP. Correlation analysis of serum obestatin expression with insulin resistance in childhood obesity. Genet Mol Res 2017; 16(2).
18. Goodson JM, Kantarci A, Hartman ML, Denis GV, Stephens D, Hasturk H, et al. Metabolic disease risk in children by salivary biomarker analysis. PLoS One 2014; 9(6): e98799.
19. Reinehr T, de Sousa G, Roth CL. Obestatin and ghrelin levels in obese children and adolescents before and after reduction of overweight. Clin Endocrinol (Oxf) 2008; 68(2): 304-10.
20. Zou CC, Liang L, Wang CL, Fu JF, Zhao ZY. The change in ghrelin and obestatin levels in obese children after weight reduction. Acta Paediatr 2009; 98(1): 159-65.
21. NHLBI Obesity Education Initiative. The Practical Guide Identification, Evaluation, and Treatment of Overweight and Obesity in Adults [Online]. [cited 2000]; Available from: URL: https://www.nhlbi.nih.gov/files/docs/guidelines/prctgd_c.pdf
22. Golshiri P, Yarmohammadi P, Sarrafzadegan N, Shahrokhi S, Yazadani M, Pourmoghaddas M. Developing and validating questionnaires to assess knowledge, attitude, and performance toward obesity among Iranian adults and adolescents: Tabassom study. ARYA Atheroscler 2012; 7(Special Issue): S119-S124.
23. World Health Organization, Pan American Health Organization. Maintenance manual for laboratory equipment. 2nd ed. Geneva, Switzerland: World Health Organization; 2008.
24. Kishida K, Funahashi T, Shimomura I. Adiponectin as a routine clinical biomarker. Best Pract Res Clin Endocrinol Metab 2014; 28(1): 119-30.
25. Kishida K, Funahashi T, Matsuzawa Y, Shimomura I. Visceral adiposity as a target for the management of the metabolic syndrome. Ann Med 2012; 44(3): 233-41.
26. Goldstein BJ, Scalia R. Adiponectin: A novel adipokine linking adipocytes and vascular function. J Clin Endocrinol Metab 2004; 89(6): 2563-8.
27. Smith J, Al-Amri M, Sniderman A, Cianflone K. Leptin and adiponectin in relation to body fat percentage, waist to hip ratio and the apoB/apoA1 ratio in Asian Indian and Caucasian men and women. Nutr Metab (Lond) 2006; 3: 18.
28. Kamada Y, Matsumoto H, Tamura S, Fukushima J, Kiso S, Fukui K, et al. Hypoadiponectinemia accelerates hepatic tumor formation in a nonalcoholic steatohepatitis mouse model. J Hepatol 2007; 47(4): 556-64.
29. Esposito K, Pontillo A, Di Palo C, Giugliano G, Masella M, Marfella R, et al. Effect of weight loss and lifestyle changes on vascular inflammatory markers in obese women: A randomized trial. JAMA 2003; 289(14): 1799-804.
30. Coughlin CC, Finck BN, Eagon JC, Halpin VJ, Magkos F, Mohammed BS, et al. Effect of marked weight loss on adiponectin gene expression and plasma concentrations. Obesity (Silver Spring) 2007; 15(3): 640-5.
31. Ghanbari-Niaki A, Saghebjoo M, Rahbarizadeh F, Hedayati M, Rajabi H. A single circuit-resistance exercise has no effect on plasma obestatin levels in female college students. Peptides 2008; 29(3): 487-90.
32. Beasley JM, Ange BA, Anderson CA, Miller Iii ER, Holbrook JT, Appel LJ. Characteristics associated with fasting appetite hormones (obestatin, ghrelin, and leptin). Obesity (Silver Spring) 2009; 17(2): 349-54.
33. Lippl F, Erdmann J, Lichter N, Tholl S, Wagenpfeil S, Adam O, et al. Relation of plasma obestatin levels to bmi, gender, age and insulin. Horm Metab Res 2008; 40(11): 806-12.
34. Hirose H, Yamamoto Y, Seino-Yoshihara Y, Kawabe H, Saito I. Serum high-molecular-weight adiponectin as a marker for the evaluation and care of subjects with metabolic syndrome and related disorders. J Atheroscler Thromb 2010; 17(12): 1201-11.
35. Salmon J, Ball K, Crawford D, Booth M, Telford A, Hume C, et al. Reducing sedentary behaviour and increasing physical activity among 10-year-old children: Overview and process evaluation of the 'Switch-Play' intervention. Health Promot Int 2005; 20(1): 7-17.
36. Sarrafzadegan N, Rabiei K, Nouri F, Mohammadifard N, Moattar F, Roohafza H, et al. Parental perceptions of weight status of their children. ARYA Atheroscler 2013; 9(1): 61-9.
37. Sahota P, Rudolf MC, Dixey R, Hill AJ, Barth JH, Cade J. Randomised controlled trial of primary school based intervention to reduce risk factors for obesity. BMJ 2001; 323(7320): 1029-32.
38. United States, Department of Health and Human Services. Healthy People 2010: Understanding and Improving Health. Burlington, MA: Jones and Bartlett Publishers; 2000.