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The effect of educational and encouraging interventions on anthropometric characteristics and perilipin-1 levels: TABASSOM Study

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Original Article

Abstract

BACKGROUND: Perilipin protein located in lipid droplets is involved in formation and storage of lipid in adipocytes; thus, it is considered as one of the obesity biomarkers. This study was performed to examine the effect of educational and encouragement interventions and lifestyle modifications on anthropometric characteristics and perilipin-1 level.

METHODS: This quasi-experimental study was conducted on subsample of TABASSOM Study. Participants were 42 overweight and obese children and adolescents aged 6-18 years old and 80 overweight and obese adults aged 19-65 years old. Anthropometric characteristics including weight, height, waist circumference (WC), body fat percentage (BFP), and perilipin-1 level were measured at the first and the end of study (after one year).

RESULTS: After intervention, the mean of perilipin-1 decreased significantly in total children and adolescents (before vs. after: 26.79 ± 13.17 vs. 22.57 ± 8.03; P = 0.006) and girls (27.75 ± 10.51 vs. 22.00 ± 8.15; P = 0.001), but decreasing was not significant in boys. In adults, perilipin-1 levels were significantly reduced in total subjects (before vs. after: 16.19 ± 13.42 vs. 15.34 ± 11.25; P = 0.029) and men (18.02 ± 15.78 vs. 15.44 ± 10.61; P = 0.003). There was no significant difference in mean of body mass index (BMI), WC, and BFP in both groups after 12 months.

CONCLUSION: Educational and encouraging interventions and lifestyle modifications could lead to decreasing perilipin-1 level in adults, children, and adolescents.

Keywords: Obesity; Overweight; Adult; Child; Adolescent; Perilipin-1; Anthropometry

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Introduction

Obesity is a main cause of non-communicable diseases (NCDs), such as hypertension (HTN), diabetes, cardiovascular diseases (CVDs), and different types of cancer.[1] The rapid increase of overweight and obesity is a major health problem not only for adults, but also for children all around the world. According to the World Health Organization (WHO) report, 75 million children will suffer from obesity by 2025. Therefore, obesity reduction is one of WHO global targets by 2025.[2] The prevalence of overweight and obesity in Iran is 50.5% in men, 60.4% in women, 18.6% in boys, and 21.4% in girls.[3] Obesity is caused by a combination of environmental factors including increased energy intake, physical inactivity, hormonal factors consisting of ghrelin, leptin, and obestatin, and genetic factors such as perilipin levels.[4] Increased energy intake and physical inactivity can result in the accumulation of energy as adipose tissue and cause

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obesity.[5] Energy storage as fat and energy consumption through lipolysis have complex mechanisms.[6] Perilipin is one of the most important proteins covering fat cells and protecting them against lipase. Following phosphorylation, perilipin leaves fat particles unprotected. Lipase then breaks down triglyceride into glycerol and fatty acids.[6,7] Perilipin-1 is one of the perilipin family of genes that is associated with obesity risk.[5] Many studies have shown the effects of different methods, including diet, physical activity, and medicines for weight loss, and also the effect of weight loss on the above-mentioned hormones and proteins in both adults and children in short-term.[8-11] Several biological and psychological factors are involved in weight regain.[12] Nevertheless, the major challenge is long-term weight loss maintenance and prevention of weight regain.[13] One of the cost-effective approaches for prevention of obesity is community-based interventional program.[14]

Isfahan Healthy Heart Program (IHHP) is a comprehensive community-based interventional program conducted in Iran.[3] Some studies show the effect of educational intervention on anthropometric and biochemical indices in short-term;[15] however, little is known about the long-term effects of educational interventions on the biological and anthropometric indices. Therefore, this study aimed to evaluate the effects of educational and encouraging interventions on anthropometric indices and biological factors involved in obesity such as perilipin-1 levels.

Materials and Methods

Design and subjects: The current study was carried out on subsample of TABASSOM Study. The TABBASSOM study was a quasi-experimental study based on educational and encouraging interventional programs.[16] The target population consisted of overweight and obese people who volunteered to participate in that study.[17] The samples included 60 children and adolescents (6-18 years old) and 80 adults (18-65 years old) of obese and overweight volunteers. The inclusion criteria were volunteer subjects with body mass index (BMI) ≥ 25 kg/m^2 in adults and BMI ≥ 85 percentile in children and adolescents. Subjects with any systemic or endocrine diseases (e.g., thyroid, liver, and kidney diseases) and psychological disorders, pregnant women, and individuals using hormonal drugs or receiving weight loss treatments including diet, medical treatments, and surgical procedure and those not willing to continue the study were excluded from study. 18 children and adolescents were not willing to continue the study. Thus, our samples in this analysis included 42 children and adolescents and 80 adults.

After providing written informed consent, the participants were interviewed and their demographic characteristics were obtained. The anthropometric and perilipin-1 level measurements were performed at baseline and one year after the interventions at the end of the study. The participants were examined in follow-up sessions after 6 and 12 months. The study was approved by the Ethical Committee of Isfahan Cardiovascular Research Institute and Research Council of Isfahan University of Medical Sciences, Isfahan, Iran.

Anthropometric measurements

Weight and height were measured with the participants wearing light clothing and no shoes. Weight was measured using a conventional Seca scale with an accuracy of 0.5 kg. A plastic tape with an accuracy of 0.5 cm was used for height and waist circumference (WC) measurements. WC was measured over light clothing while the participants were in a standing position. It was measured at the midpoint between the top of the iliac crest and the lower edge of the last palpable rib in the mid axillary line. BMI was calculated as weight (kg) divided by height squared (m^2). The body fat percentage (BFP) was determined by a body composition monitor (Inner Scan, Iron Man, Tanita®).

Perilipin-1 measurement: Perilipin-1 levels were measured at baseline and one year after the interventions. Serum perilipin-1 levels were measured by means of enzyme-linked immunosorbent assay (ELISA) (Hangzhou Eastbiopharm Co., Ltd.); serum samples, the standard, and reagents were prepared and 50 µl of the standard samples (with concentrations of 0, 2, 4, 8, 16, 32, 64 ng/ml) were transferred to wells. Since the standard included biotin, no additional antibodies were needed. Moreover, 40 µl of serum samples plus 10 µl of antibody were poured into wells. In the next stage, 50 µl of streptavidin-horseradish peroxidase (HRP) was added to all samples and the wells were incubated at 37 °C for 60 minutes. The wells were then rinsed with the solution, added with 60 µl of chromogenic A and 50 µl of chromogenic B, and mixed for 10 minutes. The mixture was then incubated at 37 °C. Finally, 50 µl of step solution was added to the whole well and the absorption values were read in the ELISA reader device at a wavelength of 450 nm. The

concentrations of the samples were then calculated by comparing the results with the standard curve.

Interventions

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

Educational interventions: Educational materials consisting pamphlets, CDs, and multimedia programs were used to explain importance of obesity, its role in NCDs, proper weight loss approaches, and inappropriate weight loss methods such as particular medical treatments and their side effects. Our approaches for weight reduction were life style modification including healthy dietary intake, energy restriction, regular physical activity, and stress management. The participants were also provided with follow-up cards. They were asked to hold the cards during the follow-up sessions (6 and 12 months later) and to keep them for the final contest. We asked participants to plan their weight reduction program according to our advices, considering their possibilities. 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 in Isfahan City. Two educational pamphlets were also distributed in schools of Isfahan with the help of Isfahan Municipality's Committee for Citizenship Culture. Four 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 re-evaluated after another six months. Twenty individuals who showed weight loss or no weight gain after the second period were randomly rewarded. The anthropometric indices and perilipin-1 levels were re-evaluated after one year.

Statistical analysis: Data were shown as mean ± standard deviation (SD) for quantitative variables. Kolmogorov-Smirnov test was applied to check the normality of data. In order to compare normal and non-normal data before and after the study, paired samples t-test and Wilcoxon signed-rank test were used, respectively. Independent t-test and Mann-Whitney test were respectively conducted to assess the percentage of differences in normal and non-normal data between genders. Data were analyzed using SPSS software (version 15.0, SPSS Inc., Chicago, IL, USA) and P-value less than 0.05 was considered significant.

Results

This study was carried out on 80 adults (40 women and 40 men) and 42 children and adolescents (20 girls and 22 boys). Table 1 shows the demographic and anthropometric characteristics at baseline in adults, children, and adolescents. Men had a significant higher body weight ($P = 0.040$) and WC ($P = 0.044$) and less BMI ($P < 0.001$) and BFP ($P < 0.001$) than women. In children and adolescents, the mean of fat percentage was significantly higher in girls than boys ($P < 0.001$).

The mean of anthropometric indices and perilipin-1 levels before and after the interventions in adults, children, and adolescents are presented in tables 2 and 3, respectively. In adults, perilipin-1 levels were reduced significantly in total subjects (before vs. after: 16.19 ± 13.42 vs. 15.34 ± 11.25; $P = 0.029$) and men (18.42 ± 15.78 vs. 15.04 ± 10.61; $P = 0.003$), but this change was not significant in women (Table 2). Perilipin-1 levels were significantly decreased in total children and adolescents (before vs. after: 26.79 ± 13.17 vs. 22.57 ± 8.03; $P = 0.016$) and girls (27.75 ± 10.51 vs. 22.00 ± 8.15; $P = 0.001$), but decreasing was not significant in boys (Table 3). No significant changes in BMI, WC, and BFP were seen in either adults or children and adolescents after the interventions (Tables 2 and 3).

Discussion

Present study did not show any significant effect of intervention on anthropometric characteristics such as BMI, WC, and BFP in both adults and children and adolescents groups. Perilipin-1 levels were significantly reduced in total adults, children, and adolescents after the interventions. Many interventional studies show decreasing effect on BMI and WC.[15,18,19] A comprehensive healthy lifestyle program (IHHP) showed a significant decrease in WC but not in BMI in adults.[3] In IHHP study, the prevalence of overweight and obesity decreased significantly in girls and increased in boys.[20] In one study conducted in United Kingdom (UK), there was no significant change in BMI.[21] Based on the available evidence, metabolic compensatory mechanism affected by hunger and satiety hormones (including ghrelin and obestatin) along with other hormones and proteins is engaged in lipid metabolism such as perilipin that has role in both regulations of lipolysis and lipid store.[6,22,23] Previous studies have confirmed a relationship between different phenotypes of perilipin and obesity indices like BMI.[6,24]

Table 1. Basic characteristic of study subjects

Variable	Adults			Children and adolescents				
	Women (n = 40)	Men (n = 40)	P	Total (n = 80)	Girl (n = 20)	Boy (n = 22)	P	Total (n = 42)
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	Mean ± SD		Mean ± SD
Age (year)	42.89 ± 10.91	46.80 ± 10.21	0.109	44.92 ± 10.62	13.00 ± 2.91	12.45 ± 3.35	0.588	12.72 ± 3.11
Weight (kg)	79.39 ± 12.47	85.85 ± 9.27	0.040	82.66 ± 11.37	66.08 ± 16.75	61.56 ± 21.48	0.455	63.71 ± 19.28
BMI (kg/m^2)	32.05 ± 4.13	29.10 ± 2.57	< 0.001	30.56 ± 3.72	27.76 ± 4.99	25.76 ± 4.11	0.158	26.71 ± 4.61
WC (cm)	95.73 ± 9.40	99.39 ± 6.02	0.044	97.58 ± 8.03	86.13 ± 12.81	83.93 ± 13.00	0.571	84.98 ± 12.80
BFP (%)	37.21 ± 5.23	26.47 ± 4.01	< 0.001	31.77 ± 7.11	38.09 ± 11.65	28.78 ± 5.75	< 0.001	33.21 ± 17.80
Perilipin (ng/ml)	14.37 ± 10.44	18.02 ± 15.78	0.126	16.19 ± 13.42	27.75 ± 10.51	25.92 ± 15.39	0.658	26.79 ± 13.17

SD: Standard deviation; BMI: Body mass index; WC: Waist circumference; BFP: Body fat percentage

Table 2. The mean of anthropometric characteristics and perilipin levels before and after the intervention in adults

Variable	Before (mean ± SD)	After (mean ± SD)	P*
BMI (kg/m^2)			
Women	32.05 ± 4.13	31.16 ± 3.86	0.531
Men	29.10 ± 2.57	28.80 ± 3.03	0.686
Total	30.56 ± 3.72	29.93 ± 3.75	0.496
WC (cm)			
Women	95.73 ± 9.40	95.15 ± 19.55	0.616
Men	99.39 ± 6.02	99.35 ± 7.49	0.860
Total	97.58 ± 8.03	97.26 ± 8.09	0.365
BFP (%)			
Women	37.21 ± 5.23	37.12 ± 5.15	0.805
Men	26.47 ± 4.01	26.33 ± 5.97	0.883
Total	31.77 ± 7.11	31.65 ± 7.54	0.812
Perilipin (ng/ml)			
Women	14.37 ± 10.44	15.25 ± 11.99	0.824
Men	18.42 ± 15.78	15.04 ± 10.61	0.003
Total	16.19 ± 13.42	15.34 ± 11.25	0.029

* Paired samples t-test was used except for perilipin that Wilcoxon signed-rank test was used
SD: Standard deviation; BMI: Body mass index; WC: Waist circumference; BFP: Body fat percentage

Table 3. The mean of anthropometric characteristics and perilipin levels before and after the intervention in children and adolescents

Variable	Before (mean ± SD)	After (mean ± SD)	P
BMI (kg/m^2)			
Girl	27.76 ± 4.99	27.30 ± 5.31	0.951
Boy	25.76 ± 4.11	25.38 ± 4.19	0.897
Total	26.71 ± 4.61	26.35 ± 4.55	0.626
WC (cm)			
Girl	86.13 ± 12.81	86.61 ± 11.12	0.741
Boy	83.93 ± 13.00	84.18 ± 13.62	0.816
Total	84.98 ± 12.80	85.32 ± 12.37	0.653
BFP (%)			
Girl	38.09 ± 11.65	35.65 ± 6.68	0.587
Boy	28.78 ± 5.75	26.72 ± 8.17	0.145
Total	33.21 ± 17.80	30.86 ± 8.69	0.061
Perilipin (ng/ml)			
Girl	27.75 ± 10.51	22.00 ± 8.15	0.001
Boy	25.92 ± 15.39	23.09 ± 8.07	0.350
Total	26.79 ± 13.17	22.57 ± 8.03	0.016

Paired samples t-test was used except for perilipin that Wilcoxon signed-rank test was used
SD: Standard deviation; BMI: Body mass index; WC: Waist circumference; BFP: Body fat percentage

In fact, due to higher amounts of accumulated fat, obese people have higher levels of perilipin.[25] Several studies have reported that the absence of perilipin in rats promoted lipolysis and made the animals more muscular despite high energy intake.[6] In our study, after the interventions, the perilipin-1 levels reduced significantly in total adults, children, and adolescents; in addition, fat percentage reduced just in children and adolescents but not significantly. Perilipin-1 decreasing can be used as an indicator of obesity reduction programs. Inconsistent to our study, Kern et al. showed a significant positive relationship between perilipin levels and fat percentage, as well as BMI. They justified this finding by the fact that increased BFP increased gene expression to produce more perilipin.[25] Results of other interventional studies also indicated a significant relationship between diet and genetic factors. Weight loss following decreased energy intake was associated with reduced perilipin levels.[26-28] A study by Soenen et al. revealed that following a low-calorie diet and weight reduction was accompanied by decreased anthropometric indices and perilipin-1 levels in both men and women.[26] As in our study, perilipin-1 may have been reduced due to people following a low-calorie diet. Although our results showed no significant differences between pre- and post-intervention anthropometric indices, an interventional study in Kermanshah, Iran, found that weight, BMI, WC, and BFP decreased after intervention.[29] However, a little reduction in fat percentage (but not significant) was shown in children and adolescents in our study. No changing in BMI despite a little reduction in fat percentage could be because of increasing in muscle mass which ultimately cause weight gain. Meanwhile, the simultaneous growth in height and weight during the childhood and adolescence might have been responsible for the absence of significant differences between the pre- and post-intervention BMI. Several short- and long-term studies with 1-12-month follow-up indicated the effect of educational intervention on anthropometric and biochemical indices.[6,15,18,19,21,29] In this study, the obesity trend has not only increased but also remained stable that is in line with WHO goals.

Some limitations should be considered in this study. Due to the financial limitation, we could not measure other factors associated with obesity, including insulin resistance and we had insufficient sample size to obtain a significant finding in obesity indicators improvement in adults. Pre- and post-intervention design and lack of control group were other limitations of the present study.

Conclusion

No differences between the pre- and post-intervention BMI, WC, and BFP were seen in any of the study groups. However, perilipin-1 levels were generally decreased in total adults, children, and adolescents. The significant reduction in perilipin-1 levels after the intervention shows that although the interventions could not effectively decrease obesity indices, they diluted the increasing trend of obesity. This can be considered as a positive outcome for comprehensive educational

program for obesity control. Accordingly, it seems that educating people about appropriate diet and adequate physical activity can prevent the accumulation of fat. Further well-designed and long-term studies are suggested to examine the effects of diet and physical activity on biological indicators of obesity.

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Conflict of Interests

Authors have no conflict of interests.

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