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ORIGINAL ARTICLE

Can a Trial of Motivational Lifestyle Counseling be Effective for Controlling Childhood Obesity and the Associated Cardiometabolic Risk Factors?

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Objectives: This study was conducted to assess the effectiveness of a simple office-based program for encouraging healthy lifestyle on controlling childhood obesity and associated cardiometabolic risk factors.
Methods: This non-randomized 24-week lifestyle modification trial was conducted among 457 obese children and adolescents, aged 2–18 years, who had at least one cardiometabolic risk factor in addition to obesity. This trial included three components of exercise, diet education and behavior modification, with all recommendations provided by a pediatrician, two general physicians and a nurse. Instead of strict inhibitory recommendations, healthier lifestyle was encouraged.
Results: Overall 448 (98.04%) of enrolled children completed the trial with a mean age of 9.6 ± 2.9 years. After the trial, the mean of anthropometric measures and cardiometabolic risk factors decreased significantly, the mean high-density lipoprotein cholesterol (HDL-C) increased significantly, and the prevalence of the metabolic syndrome decreased from 20.8%

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to 1.8%. Triglycerides, LDL-C, diastolic blood pressure and WC had the highest decrease in all age groups, with the most prominent changes in the 14—18-year age group. By each -1SD decline in BMI and WC, risk factors had significant improvement.
Conclusion: Motivational office-based counseling can be effective in treatment of childhood obesity and its associated cardio-metabolic risk factors. Such approach can be implemented in the primary health care system; and can be of special concern in low- and middle-income countries with limited human and financial resources. We suggest that expanding the roles of non-physician clinicians such as nurse practitioners can help to increase the amount of time available for such services.

1. Introduction

The escalating trend of childhood obesity has tremendous implications for the risk of chronic diseases later in life. The clustering of cardiometabolic risk factors in obese children and adolescents is an important contributor to the increased risk of prediabetes, type 2 diabetes and cardiovascular diseases.[1] Metabolic syndrome (MetS), a common pathophysiological condition with implications in the development of chronic diseases, is becoming a public health problem even in children and adolescents of developing countries.[2] It is therefore extremely important that childhood obesity is prevented and treated by simple and feasible methods. Healthy lifestyle remains the mainstay of weight control and is recommended as the first-line intervention for controlling excess weight and MetS among children and adolescents.[3]

The two most important modifiable determinants of body weight are healthy diet and physical activity, which can influence excess weight and some of its cardiometabolic consequences.[3,4] This association has been documented in different ethnic groups.[5,6]

Results of residential programs[7,8] and trials including supervised physical exercise[9] have been satisfactory in controlling weight and related cardiometabolic risk factors among youths; however such programs might be not accessible for children and adolescents with various economic and socio-cultural backgrounds in different community settings. Furthermore, given that the common forms of childhood obesity seem to result from a predisposition that primarily favors obesogenic behaviors in an obesogenic environment,[10] no program can be sustainable without involvement of families in the process of controlling childhood overweight.

It is suggested that office-based comprehensive multidisciplinary intervention, even of low intensity, can be effective in motivating and promoting health to obese children and families.[11] Such experience is limited in most developing countries, and to the best of our knowledge, no previous similar study has been conducted in the Eastern Mediterranean region. We aimed to assess the effectiveness of a simple office-based program, feasible for integration into a primary healthcare system, for encouraging healthy lifestyle on controlling excess weight and associated cardiometabolic risk factors among obese children and adolescents in Isfahan, Iran.

2. Methods

2.1. Study population

This nonrandomized trial was conducted among 457 obese children and adolescents, i.e., with a body mass index (BMI) equal to or greater than the 95th percentile, who were aged 2—18 years, and had at least one cardiometabolic risk factor in addition to obesity. Participants were consecutively recruited from among 725 obese children and adolescents who were referred from October 2007 to June 2008 to the Obesity and Metabolic Syndrome Research Clinic of the Pediatric Preventive Cardiology Department, Isfahan Cardiovascular Research Center (ICRC), a World Health Organization (WHO) collaborating center. They were referred from schools and healthcare centers, as well as public and private offices of all parts of the city with different socio-demographic characteristics. Those individuals with syndromal obesity, mental retardation, signs or symptoms of endocrine disorders, presence of any physical disability, and/or history of chronic medication use were not included in the survey.

The study was approved by the Ethics Committee of ICRC (NIH Code: FWA 0000t8578). All parents of included children gave written informed consent after receiving information about the trial, and oral assent was obtained from participants.

2.2. Physical examination

All measurements were made by the same trained team of general physicians and nurses under the supervision of the same pediatrician, by using calibrated instruments and following standard protocols.

The age of participants was recorded according to their birth date. Height (Ht) and weight (Wt) were measured twice to $\pm$0.2 cm and to $\pm$0.2 kg, respectively, with subjects being barefoot and lightly dressed; the averages of these measurements were recorded. BMI (weight in kilograms divided by the square of height in meters) was calculated. Waist circumference (WC) was measured with a nonelastic tape at a point midway between the lower border of the rib cage and the iliac crest at the end of normal expiration.

Blood pressure (BP) was measured using mercury sphygmomanometers after 5 minutes of rest in the sitting

position. The subjects were seated with the heart, cuff and zero-indicator on the manometer at the level of the observer's eye. All readings were taken in duplicate in the right arm. Appropriate size cuffs were used with cuff-width 40% of mid-arm circumference, and cuff bladders covering 80% to 100% of the arm circumference and approximately two-thirds of the length of the upper arm without overlapping. The procedure was explained to the children and the cuff inflated and deflated once, the first BP measured was not used in the analysis of this study. The readings at the first and the fifth Korotkoff phase were taken as systolic and diastolic BP (SBP and DBP), respectively. The average of the two BP measurements was recorded and included in the analysis.[12]

2.3. Biochemical analysis

The children were instructed to fast for 12 hours before the screening; compliance with fasting was determined by interview on the morning of examination. Each child was accompanied by one of their parents while blood samples were taken from the antecubital vein between 8:00 AM and 9:30 AM.

All laboratory measurements were performed in ICRC central laboratory with adherence to external national and international quality control. The blood samples were centrifuged for 10 minutes at 3000 rpm within 30 minutes of venipuncture. Fasting blood sugar (FBS), total cholesterol (TC), low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C) and triglycerides (TG) were measured enzymatically by auto-analyzer (Hitachi, Tokyo, Japan). HDL-C was determined after dextran sulfate-magnesium chloride precipitation of non-HDL-C.[13]

2.4. Definition of cardiometabolic risk factors

Abnormal serum lipids were defined as a TC, LDL-C and or TG higher than the level corresponding to the age- and gender-specific 95th percentile, as well as HDL-C lower than age- and gender-specific fifth percentile.[14] MetS was defined based on criteria analogous to Adult Treatment Panel III (ATP III) modified for children and adolescents[15] as three or more of the following: fasting TG $\geq$ 100 mg/dL, HDL-C $<$ 50 mg/dL (except in boys aged 15–18 years, in whom the cut-off was $<$/45 mg/dL), WC $>$ 75th percentile for age and gender in the population studied[16]; SBP and/or DBP $>$/90th percentile for gender, age and height from the National Heart, Lung and Blood Institute's recommended cut-off point[12] and FBS $\geq$/100 mg/dL. It should be noted that the modified ATP III definition[15] used the cut-off of FBS $\geq$/110 mg/dL, but similar to our previous national study,[6] we used the last recommendation of the American Diabetes Association.[17]

2.5. Intervention

This 24-week lifestyle modification trial, which was carried out with the same method for all participants, included three components of exercise, diet education and behavior modification.

To be feasible for integration into a primary healthcare system, all recommendations were provided by a team consisting of a pediatrician, two general physicians and a nurse. Instead of strict inhibitory recommendations sometimes provided for controlling overweight, we tried to encourage children and families to follow a healthier lifestyle. We used face-to-face education for each participant and their accompanying parent, who was usually the mother. First, simple rules of controlling overweight were advised to children and parents simultaneously, and it was emphasized that as in adults, there is no quick and easy way for children and adolescents to lose weight, and that healthy lifestyle is the mainstay of weight loss. For further encouragement of participants, this fact was accentuated that contrary to adults, children and adolescents are growing and by getting taller, they can reach ideal body weight much easier than adults can. The first realistic goal was described as to stop gaining weight, but given that participants had cardiometabolic disorder, the optimal goal was defined as gradual weight loss to achieve a healthier BMI. Then, the importance of following a combination of decreasing the amount of energy intake and energy expenditure was explained. Given that our national study revealed that the main problems in families' dietary habits were overconsumption of carbohydrates (mostly white bread, rice and potato), frequent use of deep-fried foods, using hydrogenated solid fats rich in trans fatty acids, frequent use of sweet/salty/fat snacks,[6,18] we focused our recommendations to improve these unhealthy habits.

Parents were asked not to sensitize their children by talking to them too much about reducing the calorie intake, and instead, offer a healthy diet without skipping the three main meals (especially breakfast) and with healthy snacks, and allowing occasional treats. For dietary recommendations to children, we used the term "eat" for healthy foods, instead of using "don't eat" for unhealthy choices. For instance we recommended: "eat breakfast", "eat vegetables", "eat salads", "eat nonfried foods", "eat beans", "eat fruits instead of potato chips" etc. In addition we trained children to increase their physical activity on the occasions they used high-calorie foods such as sweets, fast foods, soft drinks etc.

For increasing daily physical activity, first we asked participants to reduce their sedentary habits notably limiting the time spent on watching television and playing computer and video games to less than 2 hours a day. Then we encouraged them to take regular daily exercise and physical activities they enjoyed, beginning with low-intensity activities of short duration and gradually increasing the intensity and duration. We asked parents to join in with their children's physical activities as much as possible.

We also tried to help participants improve their self-esteem by giving examples of those children referred to our clinic who have succeeded in achieving healthier weight and could overcome their negative self-perception, which contributed to feelings of loneliness and negative self-regard. We trained participants to use a 'stimulus control' method to break the chain of events that might lead to overeating; we suggested that they drink glasses of water and/or take ten slow, deep breaths to control the stress that would lead to overfeeding without feeling satiety.

In addition, we informed participants that we would organize a festival to celebrate and reward children who have been successful in weight loss, while encouraging other overweight children and families.[19]

The first face-to-face education for each participant lasted for about 15 minutes; thereafter families and children participated voluntarily in group discussions to share their experiences on weight control. All participants and their parents were followed up by monthly telephone call for 6 months, and were invited to the clinic every 2 months. During the follow-up visits, participants and their parents were encouraged to follow the healthy lifestyle recommendations, and any related questions that they had were answered. Anthropometric measurements were repeated, and the results including positive or negative changes were provided to participants. Those who had a raised BMI were encouraged to intensify their healthy habits, and were reassured that by following the recommended simple rules, they could achieve a healthier BMI. After 6 months, all participants were recalled to the clinic to repeat the physical and biochemical examinations.

2.6. Statistical analysis

Data were analyzed by SPSS version 16.0 (SPSS Inc., Chicago, USA). Descriptive data were expressed as mean values ± standard deviations (SD) for continuous variables. Paired Student *t* test and Chi-square tests were used to compare variables before and after the trial. Regression analysis was conducted for the change in cardiometabolic risk factors per one SD decline in BMI and WC according to gender and age groups.

3. Results

Overall 448 (98.04%) of enrolled children and adolescents completed the trial, consisting of 261 (58.3%) girls and 187 (41.7%) boys. The mean age of participants was 9.6 ± 2.9 years without difference in terms of gender. Participants consisted of 34 (22 girls, 12 boys) in the 2—5.9-year age group, 198 (118 girls, 80 boys) in the 6—9.9-year age group, 166 (93 girls, 73 boys) in the 10—13.9-year age group and 50 (28 girls, 22 boys) in the 14—18-year age group.

After the trial, the mean of all anthropometric measures and cardiometabolic risk factors decreased significantly, and the mean HDL-C had a significant increase (Table 1). The percentage changes in variables studied according to the age groups of participants are presented in Figure 1. It shows that TG, LDL-C, DBP and WC had the highest decrease in all age groups, with the most prominent changes in the 14—18-year age group.

After the trial, the prevalence of MetS decreased from 20.8% to 1.8%. The prevalence of cardiometabolic risk factors before and after the trial decreased significantly in those participants with and without MetS (Table 2).

Table 3 presents the changes in cardiometabolic risk factors by one SD decline in the BMI and WC according to gender and age groups, and shows improvement of risk factors by decline in both anthropometric measures.

4. Discussion

Our findings show that small reductions of excess weight through simple changes in lifestyle can be effective in significant improvement of cardiometabolic risk factors among different age groups of obese children and adolescents. We suggest that motivating obese children and their families by encouraging healthy lifestyle through simple office-based multidisciplinary counseling are effective, and can be implemented as an integrated part of primary healthcare programs. Our simple and practical recommendations targeted the obesogenic habits of children and encouraged them to overcome these unhealthy habits. Our program aimed to help obese children and adolescents to become more motivated by getting actively involved in the process of eating healthier and exercising regularly; instead of making them feeling guilty and shameful for their neglect of healthy lifestyles. As it is suggested that pleasure works better than guilt as a motivator, and a weight-loss program should use the joy that comes from feeling and looking better, not fear of dying,[20] we tried to support children and families who needed encouragement to keep up a weight-loss program. Although it is well documented that lifestyle change through organized protocols including supervised physical activity of vigorous intensity[9,21] and residential programs[7,8] are effective in reducing excess

Table 1 Characteristics of participants before and after the trial.

	Post-intervention*	Pre-intervention*	95% confidence interval of the difference	*t*	*p*
Body mass index (kg/m^2)	23.68 (3.82)	22.61 (3.67)	1.07—1.45	21.95	<0.0001
Waist circumference (cm)	83.98 (17.42)	79.93 (11.19)	1.07—7.98	2.02	0.04
Total cholesterol (mg/dL)	185.00 (35.73)	152.37 (16.10)	29.34—35.91	19.52	<0.0001
LDL cholesterol (mg/dL)	115.12 (33.74)	91.09 (12.35)	20.91—27.34	14.24	<0.0001
HDL cholesterol (mg/dL)	45.95 (19.42)	49.30 (3.94)	−5.20 — −1.50	−3.57	<0.0001
Triglycerides (mg/dL)	127.92 (24.21)	112.48 (27.04)	8.82—22.05	4.58	<0.0001
Fasting blood glucose (mg/dL)	88.70 (12.43)	75.67 (3.44)	11.84—14.22	21.38	<0.0001
Systolic blood pressure (mmHg)	101.05 (12.94)	91.37(8.30)	8.35—11.01	14.29	<0.0001
Diastolic blood pressure (mmHg)	61.93 (11.96)	51.58(5.85)	9.15—11.53	17.06	<0.0001

LDL = low-density lipoprotein; HDL = high-density lipoprotein.
* Mean (SD).

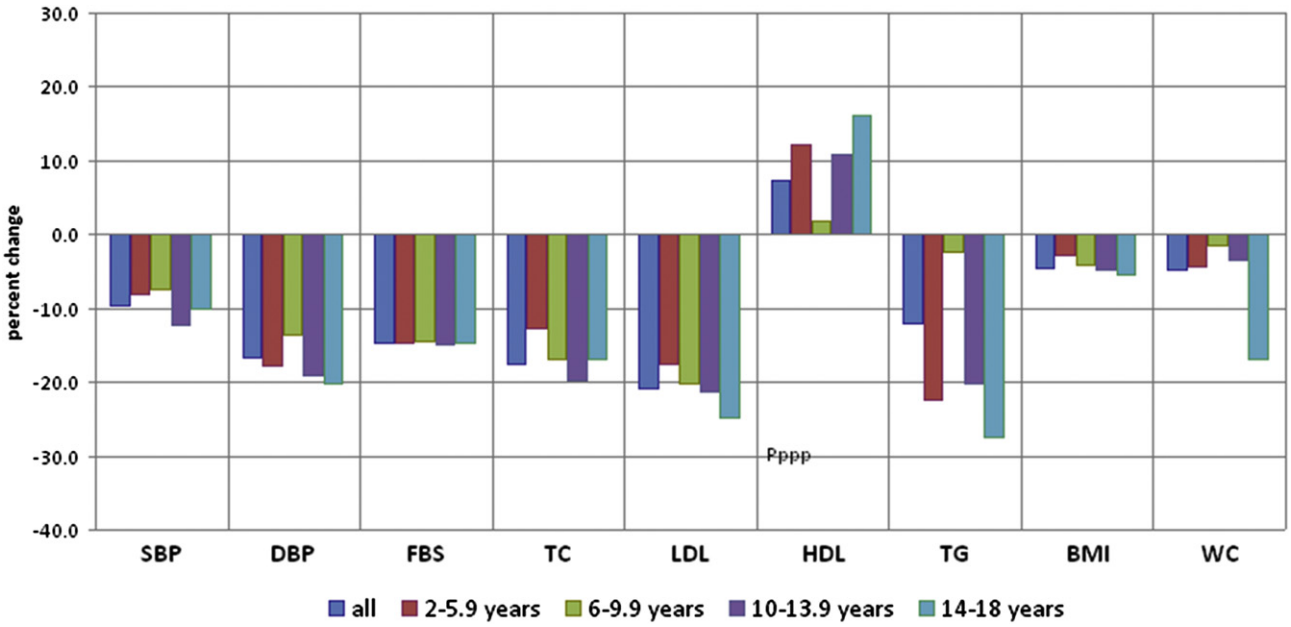

Figure 1 Percentage change in cardiometabolic risk factors after the trial according to the age group. $*p < 0.05$ in comparison between age groups: HDL-C in 6—9.9 years versus other age groups; TG in 6—9.9 years versus other age groups; WC in 14—18 years versus other age groups. BMI = body mass index; DBP = diastolic blood pressure; FBS = fasting blood sugar; HDL = high-density lipoprotein; LDL = low-density lipoprotein; SBP = systolic blood pressure; TC = total cholesterol; TG = triglycerides; WC = waist circumference.

weight and some cardiometabolic risk factors among obese adolescents, limited experience exists on the efficacy of uncomplicated programs with lower intensity. Although, as expected, the current low-intensity trial achieved smaller changes in cardiometabolic risk factors than did the abovementioned studies, its uncomplicated, comprehensive and motivating counseling style was effective, and we suggest it is more feasible than residential and high-intensity programs. Family-centered programs have been successful in improving lifestyle behaviors of households,[22] as well as in reducing anthropometric and metabolic measures of obese children and adolescents.[23] In the current trial, we have motivated children and adolescents and in turn controlled their weight gain and cardiometabolic risk factors. The high compliance of participants and their families and the negligible drop-out rate of this trial is evidence for its practicability, and the favorable changes in cardiometabolic risk factors shows the efficacy of motivational counseling by physicians and nurses without need for a structured program with collaboration of different specialists who are not easily reached in different community settings. A hospital-based, family-centered intervention has been shown to reduce weight gain in overweight children and adolescents,[24] and our findings are consistent with this. Such experience is scarce from developing countries; our findings are confirmation of the role of health professionals in promoting preventive measures and encouraging positive lifestyle behaviors, as well as identifying and treating obesity-related comorbidities.[25]

Our findings about the improvement in cardiometabolic risk factors, including the components of MetS, through low-intensity interventions are in agreement with some previous randomized control trials of at least 8 weeks.

Table 2 Changes in the number (%) of participants with different cardiometabolic risk factors among the whole study population and those with metabolic syndrome.

	All participants		Participants with metabolic syndrome	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
FBS $\geq$ 100 mg/dL	62 (14%)	0	30 (32%)	0
TG $>$ 95th percentile	111 (24.9%)	18 (4%)	66 (71%)	8 (100%)
HDL-C $<$ fifth percentile	151 (34%)	19 (4.3%)	72 (78%)	7 (87.5%)
LDL-C $>$ 95th percentile	135 (30.4%)	4 (0.9%)	32 (34.8)	0
SBP and/or DBP $>$90th percentile	38 (8.7%)	4 (0.9%)	26 (28.3%)	1 (12.5%)

DBP = diastolic blood pressure; FBS = fasting blood sugar; HDL = high-density lipoprotein; LDL = low-density lipoprotein; SBP = systolic blood pressure; TG = triglycerides.

Table 3 Changes in cardiometabolic risk factors by one standard deviation decline in the body mass index and waist circumference according to gender and age groups.

Age group (y)	1 SD decline in body mass index		1 SD decline in waist circumference	
	Boys	Girls	Boys	Girls
Systolic blood pressure (mmHg)				
2–5.9	−6.91	−7.57	−5.71	−5.51
6–9.9	−6.79	−6.43	−6.21	−5.44
10–13.9	−8.74	−9.38	−7.24	−8.21
14–18	−7.02	−8.66	−6.25	−7.62
Diastolic blood pressure (mmHg)				
2–5.9	−6.08	−5.92	−4.72	−6.08
6–9.9	−6.88	−6.73	−5.47	−5.17
10–13.9	−7.56	−6.41	−7.11	−6.56
14–18	−8.51	−7.35	−6.55	−7.54
Fasting blood sugar (mg/dL)				
2–5.9	−2.65	−2.91	−2.58	−2.79
6–9.9	−2.45	−2.17	−2.75	−2.07
10–13.9	−8.71	−7.05	−8.51	−7.25
14–18	−7.81	−6.25	−7.41	−6.65
Total cholesterol (mg/dL)				
2–5.9	−29.58	−26.45	−27.12	−26.34
6–9.9	−27.14	−28.00	−26.18	−27.20
10–13.9	−31.51	−32.38	−32.55	−30.45
14–18	−35.08	−36.97	−34.81	−35.87
LDL cholesterol (mg/dL)				
2–5.9	−29.15	−28.96	−27.25	−26.14
6–9.9	−30.54	−31.34	−28.81	−30.37
10–13.9	−30.52	−31.32	−30.52	−29.12
14–18	−34.29	−32.10	−34.29	−33.14
HDL cholesterol (mg/dL)				
2–5.9	1.63	1.97	2.78	1.95
6–9.9	2.48	1.17	2.14	1.57
10–13.9	1.71	2.06	1.95	2.17
14–18	3.15	3.20	3.75	3.48
Triglycerides (mg/dL)				
2–5.9	−21.48	−21.53	−22.17	−22.56
6–9.9	−17.19	−15.14	−21.11	−20.15
10–13.9	−27.76	−27.71	−29.25	−30.08
14–18	−31.40	−31.35	−35.49	−34.54

These studies showed that aerobic exercise training and healthy diet are effective in lowering plasma concentration of LDL-C and TG[26–28] and increasing HDL-C,[28,29] as well as reducing SBP and DBP.[26,30] The better results in the 14–18-year age group than in other age groups might be because compared to younger age groups, notably those aged less than 10 years, they pay more attention to their body image and might have better compliance for lifestyle change. Given that interventional programs have been effective in increasing insulin sensitivity,[9,29,31,32] the beneficial effects documented in the current study might be attributed to improvement in insulin sensitivity. In addition, some factors such as decreased sympathetic nervous system activity, decreased extracellular fluid volume and normalization of the renin–angiotensin–aldosterone system are proposed as underlying mechanisms of lowering blood pressure after calorie restriction and exercise.[32] Our findings might suggest that low-intensity interventions for lifestyle modification of obese children and adolescents can be beneficial for decreasing insulin resistance even without reaching ideal body weight.

In addition to its clinical implication on the favorable changes in cardiometabolic risk factors, the simple office-based counseling used in the current study might have impact on public health programs for primordial/primary prevention of chronic diseases.

Childhood obesity is largely underdiagnosed and undertreated; the role of the primary care providers in its timely assessment and management is underscored.[33,34]

A review of published articles confirmed the efficacy of office-based promotion of physical activity for treatment and prevention of childhood obesity.[35] Although a non-randomized trial has shown that motivational interviewing by pediatricians and dietitians can be a promising office-based strategy for prevention and control of childhood obesity,[36] the role of pediatricians in controlling the emerging epidemic of childhood obesity is generally focused on screening and prevention of childhood overweight and associated morbidities,[37–39] and less attention is paid to their role in treatment options. Results of qualitative research in the USA showed that pediatricians follow many of the obesity prevention guidelines[40]; meanwhile in the same community, 10–18-year-old youths reported infrequently receiving counseling on specific overweight prevention topics during routine primary care visits.[41]

According to the Expert Committee on childhood obesity, the use of patient-centered counseling techniques such as motivational interviewing for prevention of childhood obesity can be useful for prevention of childhood obesity. Whereas for treatment, the recommendations propose four stages of obesity care: the first is brief counseling that can be delivered in a healthcare office, and subsequent stages require more time and resources according to the patient's age and degree of excess weight.[42] MetS is not a single entity and consists of several distinct but interrelated entities[43]; healthy lifestyle may be the core for prevention and control of these entities.

4.1. Study limitations

We acknowledge that this study was a nonrandomized trial without control, and various confounders might have influenced the findings. However the large sample size, and inclusion of children and adolescents with diverse socio-demographic backgrounds, reduces the effect of confounders.

5. Conclusion

Our findings suggest that motivational office-based counseling can be effective in treatment of obesity and its associated cardiometabolic risk factors. Such an approach can be implemented in the primary healthcare system, especially in low- and middle-income countries with limited human and financial resources.

Increasing the delivery of obesity prevention and management services requires a change in approach.

Instead of focusing on disease and making sick children well, we must focus on health promotion and spend more time on counseling and preventive efforts. Apparently, the restoration of health is an approach superior to the treatment of disease and its accompanying symptoms, notably in the pediatric age group. We suggest that intensifying the roles of nonphysician clinicians such as nurse practitioners can help to increase the amount of time available for such services.

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References

1. Cali AM, Caprio S. Prediabetes and type 2 diabetes in youth: an emerging epidemic disease? *Curr Opin Endocrinol Diabetes Obes* 2008;**15**:123—7.
2. Kelishadi R. Childhood overweight, obesity, and the metabolic syndrome in developing countries. *Epidemiol Rev* 2007;**29**: 62—76.
3. Steinberger J, Daniels SR, Eckel RH, et al. Progress and challenges in metabolic syndrome in children and adolescents. A scientific statement from the American Heart Association Atherosclerosis, Hypertension, and Obesity in the Young Committee of the Council on cardiovascular disease in the young; Council on cardiovascular nursing; and Council on nutrition, physical activity, and metabolism. *Circulation* 2009; **119**:628—47.
4. Pan Y, Pratt CA. Metabolic syndrome and its association with diet and physical activity in US adolescents. *J Am Diet Assoc* 2008;**108**:276—86.
5. Casazza K, Dulin-Keita A, Gower B, Fernandez JR. Differential influence of diet and physical activity on components of metabolic syndrome in a multiethnic sample of children. *J Am Diet Assoc* 2009;**109**:236—44.
6. Kelishadi R, Gouya MM, Adeli K, et al. 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.
7. Roberts CK, Chen AK, Barnard RJ. Effect of a short-term diet and exercise intervention in youth on atherosclerotic risk factors. *Atherosclerosis* 2007;**191**:98—106.
8. Chen AK, Roberts CK, Barnard RJ. Effect of a short-term diet and exercise intervention on metabolic syndrome in overweight children. *Metabolism* 2006;**55**:871—8.
9. Kelishadi R, Hashemi M, Mohammadifard N, Asgary S, Khavarian N. Association of changes in oxidative and proinflammatory states with changes in vascular function after a lifestyle modification trial among obese children. *Clin Chem* 2008;**54**:147—53.
10. Bouchard C. Childhood obesity: are genetic differences involved? *Am J Clin Nutr* 2009;**89**:S1494—501.
11. Spear BA, Barlow SE, Ervin C, et al. Recommendations for treatment of child and adolescent overweight and obesity. *Pediatrics* 2007;**120**:S254—88.
12. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics* 2004;**114**:555—76.
13. Warnick GR, Benderson J, Albers JJ. Dextran sulfate-magnesium precipitation procedure for quantitation of high-density lipoprotein cholesterol. *Clin Chem* 1982;**28**: 1379—82.
14. Lipid Research Clinics Population Studies Data Book. NIH Publication No. 80—1527. *The Prevalence Study*, vol. 1. Washington (DC): National Institutes of Health; 1980.
15. De Ferranti SD, Gauvreau K, Ludwig DS, Neufeld EJ, Newberger JW, Rifai N. Prevalence of the metabolic syndrome in American adolescents: findings from the Third National Health and Nutrition Examination Survey. *Circulation* 2004; **110**:2494—7.
16. 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. Genuth S, Alberti KG, Bennett P, et al. Follow-up report on the diagnosis of diabetes mellitus. *Diabetes Care* 2003;**26**: 3160—3.
18. Kelishadi R, Ardalan G, Gheiratmand R, et al. Association of physical activity and dietary behaviours in relation to the body mass index in a national sample of Iranian children and adolescents: CASPIAN Study. *Bull World Health Org* 2007;**85**: 19—26. CASPIAN Study Group.
19. Kelishadi R. Case for Prevention: Health promotion festival onchildhood overweight, Isfahan, Iran. 16 Dec, 2008. Available at: http://www.procor.org/globaldialogue/globaldialogue_show.htm?doc_id=753671 [Date accessed: April 17, 2010].
20. Ornish D. *The spectrum. How to customize a way of eating and living just right for you and your family. Random House*. New York: Ballantine Books; 2007.
21. Kang HS, Gutin B, Barbeau P, et al. Physical training improves insulin resistance syndrome markers in obese adolescents. *Med Sci Sports Exerc* 2002;**34**:1920—7.
22. Anand SS, Davis AD, Ahmed R, et al. SHARE-AP. ACTION Investigators. A family-based intervention to promote healthy lifestyles in an aboriginal community in Canada. *Can J Public Health* 2007;**98**:447—52.
23. Monzavi R, Dreimane D, Geffner ME, et al. Improvement in risk factors for metabolic syndrome and insulin resistance in overweight youth who are treated with lifestyle intervention. *Pediatrics* 2006;**117**:e1111—8.
24. Dreimane D, Safani D, MacKenzie M, et al. Feasibility of a hospital-based, family-centered intervention to reduce weight gain in overweight children and adolescents. *Diabetes Res Clin Pract* 2007;**75**:159—68.
25. Lyznicki JM, Young DC, Riggs JA, Davis RM. Council on scientific affairs, American medical association. Obesity: assessment and management in primary care. *Am Fam Physician* 2001;**63**: 2185—96.
26. Lakka TA, Laaksonen DE. Physical activity in prevention and treatment of the metabolic syndrome. *Appl Physiol Nutr Metab* 2007;**32**:76—88.
27. Kranus WE, Houmard JA, Duscha BD, et al. Effects of amount and intensity of exercise on plasma lipoproteins. *New Eng J Med* 2002;**374**:1483—92.
28. Leon AS, Sanchez OA. Response of blood lipids to exercise training alone or combined with dietary intervention. *Med Sci Sports Exerc* 2001;**33**:S502—15.
29. Thompson PD, Crouse SF, Goodpaster B, Kelley D, Moyna N, Pescattello L. The acute versus chronic response to exercise. *Med Sci Sports Exerc* 2001;**33**:438—53.
30. Kirk S, Zeller M, Claytor R, Santangelo M, Khoury PR, Daniels SR. The relationship of health outcomes to improvement in BMI in children and adolescents. *Obes Res* 2005;**13**:876—82.
31. Kelishadi R, Hashemipour M, Mohammadifard N, Alikhassy H, Adeli K. Short- and long-term relationships of serum ghrelin with changes in body composition and the metabolic

syndrome in prepubescent obese children following two different weight loss programmes. *Clin Endocrinol (Oxf)* 2008; **69**:721—9.
32. Mertens IL, Vangaal LF. Overweight, obesity, and blood pressure: the effects of modest weight reduction. *Obes Res* 2000;**8**: 270—8.
33. Nichols MR, Livingston D. Preventing pediatric obesity: assessment and management in the primary care setting. *J Am Acad Nurse Pract* 2002;**14**:55—62.
34. Shephard RJ. Role of the physician in childhood obesity. *Clin J Sport Med* 2004;**14**:161—8.
35. Floriani V, Kennedy C. Promotion of physical activity in primary care for obesity treatment/prevention in children. *Curr Opin Pediatr* 2007;**19**:99—103.
36. Schwartz RP, Hamre R, Dietz WH, et al. Office-based motivational interviewing to prevent childhood obesity: a feasibility study. *Arch Pediatr Adolesc Med* 2007;**161**:495—501.
37. Perrin EM, Finkle JP, Benjamin JT. Obesity prevention and the primary care pediatrician's office. *Curr Opin Pediatr* 2007;**19**: 354—61.
38. Dennison BA, Boyer PS. Risk evaluation in pediatric practice aids in prevention of childhood overweight. *Pediatr Ann* 2004; **33**:25—30.
39. Bowman SA. Pediatrician's office: a solution in the prevention of childhood obesity. *Acta Paediatr* 2005;**94**:652—4.
40. Gilbert MJ, Fleming ME. Pediatricians' approach to obesity prevention counseling with their patients. *Wisconsin Med J* 2006;**105**:26—31.
41. Taveras EM, Sobol AM, Hannon C, Finkelstein D, Wiecha J, Gortmaker SL. Youths' perceptions of overweight-related prevention counseling at a primary care visit. *Obes (Silver Spring)* 2007;**15**:831—6.
42. Barlow SE, Expert Committee. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics* 2007;**120**:S164—92.
43. Kelishadi R, Ardalan G, Adeli K, et al. CASPIAN Study Group. Factor analysis of cardiovascular risk clustering in pediatric metabolic syndrome: CASPIAN study. *Ann Nutr Metab* 2007;**51**: 208—15.