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Original / *Obesidad*

Effect of a weight loss program in obese adolescents; a long-term follow-up

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Abstract

Objectives: **Obesity during adolescence is an increasing health problem in industrial countries. The co-morbidities associated with obesity include important metabolic diseases.**

Methods: **To analyze the effect of a weight-loss program, we recruited 12 obese, male adolescents before entering this program. We determined body weight measures at baseline, 6-week and 36-month follow-up. Also, the long-term changes of blood pressure, HbA1c, and CRP were evaluated. Twenty healthy age-matched adolescents served as controls.**

Results: **Within the intervention group ((body mass index [BMI, kg/m²] > 95th percentile for age and sex, age 13-17 years) the BMI and BMI-standard deviation score [SDS] were significantly reduced in the 6-week follow-up after completing the weight loss program. However, the significant weight-reduction effect was not persistent until the 36-month follow-up.**

Conclusion: **The 6-week weight-loss program had beneficial short-term effects on body weight, BMI, and BMI-SDS in obese adolescents, but these effects could not be maintained until the 36-month follow-up.**

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Key words: *Adolescent. Long-term effects. Obesity. Weight loss. Weight reduction programs.*

EFECTO DE UN PROGRAMA DE PÉRDIDA DE PESO EN ADOLESCENTES OBESOS; SEGUIMIENTO A LARGO PLAZO

Resumen

Objetivos: **La obesidad durante la adolescencia es un problema de salud creciente en los países industriales. Las co-morbilidades asociadas a la obesidad conllevan importantes enfermedades metabólicas.**

Métodos: **Para analizar el efecto de un programa de pérdida de peso, seleccionamos a 12 adolescentes varones obesos antes de entrar en este programa. Determinamos las mediciones de peso corporal al inicio del programa y en los seguimientos a las 6 semanas y a los 36 meses. También se evaluaron los cambios a largo plazo de tensión arterial, HbA1c y PCR. Igualmente se seleccionó a veinte adolescentes sanos de la misma edad que sirvieron como grupo de control.**

Resultados: **Dentro del grupo de intervención ((índice de masa corporal [IMC, kg/m²] > percentil 95 para edad y sexo, 13-17 años) el IMC y la puntuación de la desviación estándar sobre el IMC [SDS] se vieron significativamente reducidos en el seguimiento de 6 semanas tras completar el programa de pérdida de peso. Sin embargo, el efecto de reducción de peso significativa no fue persistente hasta el seguimiento a los 36 meses.**

Conclusión: **El programa de pérdida de peso de 6 semanas tuvo efectos beneficiosos a corto plazo en el peso corporal, IMC y en el IMC-SDS en adolescentes obesos, pero estos efectos no se pudieron mantener hasta el seguimiento a los 36 meses.**

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Palabras clave: *Adolescente. Efectos a largo plazo. Obesidad. Pérdida de peso. Programas de pérdida de peso.*

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Abbreviations:

Ao: Aorta.
BMI: Body mass index.
BMI-SDS: Body mass standard deviation score.
BP: Blood pressure.
CHD: Coronary heart disease.
CKD: Chronic kidney disease.
CRP: C-reactive protein.
EF: Ejection fraction.
FS: Fractional shortening.
FU: Follow-up.
HDL: High-density lipoprotein.
IVS: Intraventricular septum.
LAD: Left atrium diameter.
LDL: Low-density lipoprotein.
LP(a): Lipoprotein a.
LVD: Left ventricular diameter.
LVPW: Left ventricular posterial wall.

Introduction

Over the past years, pediatric and adolescent obesity has reached epidemic proportions in industrial countries throughout the whole world. The National Health and Nutrition Examination Study (NHANES) showed that in the USA almost 17% of children and adolescents are considered obese and 32% overweight or obese.[1] In Germany, data obtained from 2003-2006 showed that 15% of 3-17 years-olds are overweight, and 6,3% are obese.[2] This is an increase in the prevalence of overweight and obesity by 50% with respect to the 1980s and 1990s. The study also demonstrated that the percentage of overweight persons increased from < 1% of the 3-6 years-olds to 15% of the 7-10 years-olds to 17% of the 14-17 years-olds. According to the WHO classification, overweight is defined as a body mass index (BMI) > 25 kg/m^2 and obesity as a BMI > 30 kg/m^2 for adults (> 19 years of age), and for children aged 2 to 19 years, overweight is defined as a BMI between the 85th and 95th percentile, while obesity is defined as a BMI at or above the 95th percentile for children of the same age and sex.[3]

Chronic obesity in adolescence persisting to adulthood causes —besides social consequences like social discrimination, and low self-esteem— an increased risk to develop diseases that involve different apparatuses, for example sleep apnea, asthma, steatohepatitis, and musculoskeletal diseases like slipped capital femoral epiphysis, and blount's disease. It also increases cardiovascular risk factors[4] and causes metabolic diseases like hypertension, type 2 diabetes mellitus, and dyslipidemia.[5] For diabetes it is shown that the risk to develop this metabolic disease is particularly high in individuals who were obese as adolescents compared to those with adult-onset obesity.[6] This increased risk to develop metabolic diseases associated with obesity might be one of the reasons for a correlation of the BMI of persons between 7 and < 18 years and the risk to develop coronary heart disease (CHD).[7,8]

Besides its consequences for the individual, obesity raises enormous costs for the health system of developed countries. A recent study in the USA showed that childhood obesity causes besides hospitalization for comorbidities of obesity[9] also increased expenditures for additional outpatient/emergency room visits or prescription drug expenditures. Data from the Medical Expenditure Panel Survey from 2002-2005 demonstrated that elevated BMI in childhood was associated with 14.1 billion additional USD only for non-hospitalization expenditures. Furthermore, it has been shown that adolescent obesity is strongly associated with persistent adulthood obesity[10] which represents ongoing health risks – and ongoing health costs. For all these mentioned reasons it is particularly important to act against obesity in childhood and adolescence. Besides putting effort in health education of the child or adolescent itself, it is also fundamental to include the children's environment, especially raise their parents' or caregivers' awareness for proper nutrition and healthy habits.[11]

In Germany, it is possible for obese children and adolescents to take part in outpatient or inpatient weight loss programs financed by the national health system. In the year 2001, 5950 weight loss programs were financed by the German government for children and adolescents up to 19 years.[12] Considering these enormous health costs, it is important to have a proven long-term effectiveness of these programs. While different lifestyle intervention programs addressing adults have been evaluated, so far there are only few studies targeting children and adolescents. Whereas for adolescents there are different studies showing significant weight-reduction effects of intervention programs in short-term follow-ups,[13] there are only few studies about the long-term effects. A recent study was published by Lloyd-Richardson et al.[14] who provide 24-month follow-up data from a randomized trial of two 6 month group-based behavioral weight loss programs for obese adolescents in the USA. It has been demonstrated that these programs were effective at reaching and maintaining weight reductions in 13-16 years-old adolescents through a 24-month follow-up. In a 4-years follow-up, Kubicky et al.[15] presented a significant, but slight reduction in BMI-SDS from 2.49 to 2.33.

Despite different results showing some long-term effects of weight intervention programs, the effectiveness of these programs needs to be further investigated because of a lack of quality management for inpatient weight loss programs resulting in similar program structures. Thus, the aim of the present study was to examine the long-term outcome (36 months) of a 6-week inpatient weight loss program for adolescents.

Methods

In this observational study 12 obese adolescents (intervention group, median weight 96 kg; 82-111 CI) and 20 adolescents with normal BMI (control group, median weight 64 kg; 60-68 CI) were included. Participants were aged 13 to 17 years, male, and Caucasian. The adolescents of the obese group had a BMI above the 95th percentile (mean BMI-SDS 2.4; 2.1-2.7 CI) at time of study enrollment. They were recruited from a specialized local rehabilitation hospital. As a control group, voluntary, obviously healthy adolescents from schools of the same geographic area (Jena, Germany), were recruited. Written informed consent was obtained from the adolescent and at least one parent. The study protocol was approved by the ethics committee of the University of Jena and is in accordance with the Helsinki Declaration II. For all participants the following characteristics were recorded at study inclusion: age, height, weight, BMI, waist circumference, hip circumference, hip/waist-ratio, heart rate, blood pressure, sports habits, and family history. Exclusion criteria were any sign of disease or medications that potentially influence body weight.

In the 6-week weight loss program the obese participants attended, importance was attached to nutritional education, physical activity, and behavior modification. At admission, adolescents had to absolve a fitness test. According to the fitness test results, patients had to attend obesity-sports and swimming activities: swimming (2x/week), bicycle ergometer (2-3x/week), sports in a gym or outdoor (3x/week), 1x adolescents' favorite sports, in summary at least 6 h/week. These activities were supervised by a sports teacher. Also, every day before breakfast the participants had to do 15 minutes morning sports. Additionally, there were leisure activities like hiking attended by pedagogues. As possible, heart rate was measured to determine the sports intensity. Nutritional intervention and nutritional education was based on the food guide pyramid. Adolescents were taught how much the recommended intake for each food group according to their age is. Therefore, they had to weigh everything they ate during this 6-week program. Nutritional education was presented by a dietitian. Participants attended 90-minutes nutrition classes each week and additionally informal meetings discussing the eaten food once a week. During these classes adolescents were taught to shop and cook in a healthy manner, and learned how to estimate the calories of different foods properly. Medical ward rounds were held by a medical doctor for endocrinology. If necessary, psychologists were available to support adolescents' progress. In addition to this support provided for the adolescents themselves, the clinic offered educational training in physical exercise, nutrition, and behavioral habits for parents.

Data achievement

Data of 12 obese adolescents were obtained at the time of inclusion and at a 6-week follow-up. In addition all participants were invited to a 36-month follow-up and contacted via telephone. Five adolescents refused to take part in the long-term follow up resulting in data of 7 obese adolescents at 36 months. Data of adolescents with normal weight were obtained as control group data at the time of inclusion. Basic clinic data were collected from adolescents and parents including age, sex, weight, and height. Participants' weight and height were measured by the study team. The height (in meters) was determined without shoes using a standiometer calibrated in 0.1-cm intervals. Participants' weight (in kilograms) was measured without shoes wearing a light gown using a medical weight scale, calibrated before each weight. Weight and height were used to calculate BMI (kg/m^2). BMI-standard deviation score (BMI-SDS) was calculated according to current guidelines using German charts (16). Briefly, the formula BMI-SDS = ([BMI/M(t)] L(t)—1)/L(t)*S(t) was used. M(t) is the age- and sex-specific BMI median. L(t) and S(t) are age- and sex-specific calculation variables available in charts. Blood pressure was measured three times by a single trained observer using a conventional blood pressure analyzer after participants sat still for at least 5 minutes. Blood samples for routine laboratory were obtained after a 8-hour overnight fast for measurement of serum glucose, total cholesterol (mmol/l), HDL cholesterol (mmol/l), LDL cholesterol (mmol/l), and triclycerides (mmol/l), lipoprotein (a) (mg/l), high sensitive CRP (CRP) (mg/l), and white blood count differential in the Department for Clinical chemistry of the University Hospital Jena.

Statistical analysis

Analyses at baseline included all participants (n = 32), at the end of the 6-week weight loss program data were also obtained from all obese adolescents. 58% (n = 7) of the obese group consented to take part in the follow-up examination 36 months after completing the weight loss program. Statistical analysis was performed by using Sigma Plot Version 12.0 (Systat Software Inc.). Paired t-tests, One Way ANOVA of repeated measurements, Fisher Exact Test, and correlation (Spearman's rank correlation coefficient) were used to evaluate changes in body weight across the time (baseline, 6 weeks, 36 months), and the differences between the two groups. Normal distribution was tested with the Shapiro Wilk Test. Not normally distributed continuous variables were compared by the Signed Rank Test. Statistical significance was assigned at the 0.05 level of probability.

Results

The baseline parameters of 32 adolescents enrolled in the present study are summarized in table I. As expected, adolescents in the obese group had a significantly higher body weight (1.5-fold), BMI, and BMI-SDS (all: $p < 0.001$). The obese group also had higher waist (1.4-fold) and hip (1.3-fold) circumferences compared to the control group. Interestingly, the waist-to-hip ratio was almost equal in both groups. The waist index was significantly, 1.4-fold higher in the obese

Table I
Characteristics of the study groups at baseline. Data presented as mean (±SEM) oe id Normality Test (Shapiro Wilk-Test) failed as median (25-75% CI).

	Control group (n = 20)		*Obesity group (n = 12)*		*p value*
	Median	*25-75% CI*	*Median*	*25-75% CI*	
Age (y)	15.0	15.0-16.0	15.0	14.0-16.5	n.s.
Body Weight (kg)	64.5	58.3-68.0	97.0	85.3-107.8	< 0.001
BMI (kg/m²)	20.1	18.9-21.9	31.7	28.3-34.7	< 0.001
BMI-SDS	-0.08	± 0.69	2.43	± 0.49	< 0.001
Waist circumference (cm)	73.0	68.3-74.8	102.0	91.3-107.8	< 0.001
Hip circumference (cm)	82.5	78.3-84.8	109.0	102.0-119.0	< 0.001
Waist-to-hip-ratio	0.88	± 0.04	0.90	± 0.05	n.s.
Waist index	41.0	39.0-42.2	59.1	52.6-63.1	< 0.001
Heart rate (/min.)	80	± 14	79	± 12	n.s.
BP sys (mmHg)	120	120-130	134	123-143	n.s. (p = 0.07)
BP dias (mmHg)	70	60-80	71	63-78	n.s.
Total cholesterol	4.1	± 0.92	4.0	± 0.92	n.s.
HDL (mmol/l)	1.2	1.1-1.5	1.1	0.9-1.2	0.01
LDL (mmol/l)	2.2	1.9-2.9	2.6	2.0-3.1	n.s.
LDL/HDL	1.8	1.3-2.5	2.5	2.2-3.1	0.03
Lp(a) (mg/l)	60	30-126	193	124-314	0.02
TG (mmol/l)	0.9	0.8-1.2	0.8	0.6-1.1	n.s.
HbA1c (%)	5.1	4.9-5.2	5.2	5.2-5.3	0.03
CRP (mg/l)	0.1	0.1-0.1	1.5	0.7-7.3	< 0.001

BP: blood pressure, HDL: high density lipoprotein, LDL: low density lipoprotein, LP(a) Lipoprotein a. n.s.: not significant.

group with respect to the control group. Also, they had a slightly but significantly elevated HbA1c. There was a trend to a higher systolic blood pressure in the obese group (p = 0.07). Besides that, they presented an altered cholesterol profile: The high-density lipoprotein (HDL) was significantly lower than in the control group and this led to a significantly altered HDL/LDL ratio. The HDL/LDL ratio was 1.8 in the control group and 2.5 in the obese group. The lipoprotein A was significantly, 3.2 -fold higher in obese adolescents. Moreover, an elevated, 15-fold higher CRP in the obese group compared to the control group was detectible suggesting a higher pro-inflammatory status.

Analyzing exercise habits (table II), significantly more participants (2.1-fold) of the control group did sports. The control group also spent significantly more time doing sports (50-fold). Analyzing nutritional habits, there was no significant difference in the number of warm meals/week and the adolescents' impression of their parents paying attention for regular meals. Looking at the participants' families, the participants' mothers had a significantly higher BMI in the obese group. The BMI of the adolescents' mothers was 23.1 kg/m² in the control group and 29.0 kg/m², in the obese group, showing that the mothers of participants with normal weight are also of normal weight and mothers of obese participants are often also overweight. Also, the parents of the treatment group are significantly younger than the parents of the control group. In addition, there was a higher emergence of cardiovascular diseases in the participants' relatives of first or second degree: They had significantly more often diabetes mellitus, hypertension, gout, and a trend to a higher emergence of hyperlipidemia. Concerning the academic education of the participants' parents, there was a higher educational level of the mother visible in the control group than the obese group. The mothers in the control group had absolved more often university studies. However, this did not reach significance. Interestingly, adolescents of the obese group had significantly better school grades (average school grade 2.8 ± 0,5 in the obese group, 2.2 ± 0,7 in the control group, p = 0.04). There was no difference visible in the use of television or computer during their free time in both groups.

In correlation analyses, we were able to show significant correlations between CRP and BMI-SDS (r = 0.7, p < 0.001, fig. 1) or BMI (r = 0.7, p < 0.001). This reflects a higher inflammatory state in obesity. Interestingly, in the performed correlation analyses, a correlation between systolic blood pressure and BMI-SDS (r = 0.6, p = 0.009) or BMI (r = 0.6, p = 0.004) could be noticed, which demonstrates a correlation between different cardiovascular risk factors.

Echocardiographic parameters

Additionally, echocardiographic data were obtained (table IV). The intraventricular septum thickness (diastolic) (IVSd) was significantly higher in the obesity group than in the control group. Also, the diameter of

Table II
Behavioural habits of the study groups. Data presented as mean (± SEM) or if Normality Test (Shapiro-Wilk-Test) failed as median (25-75% CI).

	Control group		*Obesity group*		*p value*
	Median	*25-75% CI*	*Median*	*25-75% CI*	
Smoking	15%		8%		n.s.
Sports	90%		42%		0.006
Sports (hours/week)	5	1.5-9.0	0.1	0.1-1.8	0.04
School bread/week	4	0-5	5	0-5	n.s.
Warm meal/week	7	4-7	7	2-7	n.s.
Parents attention for nutrition	70%		92%		n.s.
BMI mother (kg/m²)	23.1	21.6-27.3	29.0	24.2-36.2	0.04
BMI father (kg/m²)	25.3	24.5-28.5	25.9	23.5-30.5	n.s.
Age mother (y)	42.5	± 4.2	36.7	± 3.5	0.004
Age father (y)	44.7	± 4.2	40.4	± 4.3	0.03
Father university studies	10%		8%		n.s.
Mother university studies	40%		8%		n.s.
Father unemployed	5%		0%		n.s.
Mother unemployed	10%		25%		n.s.
Siblings	1	1-1	1	0-1	n.s.

BMI: Body mass index. n.s.: not significant.

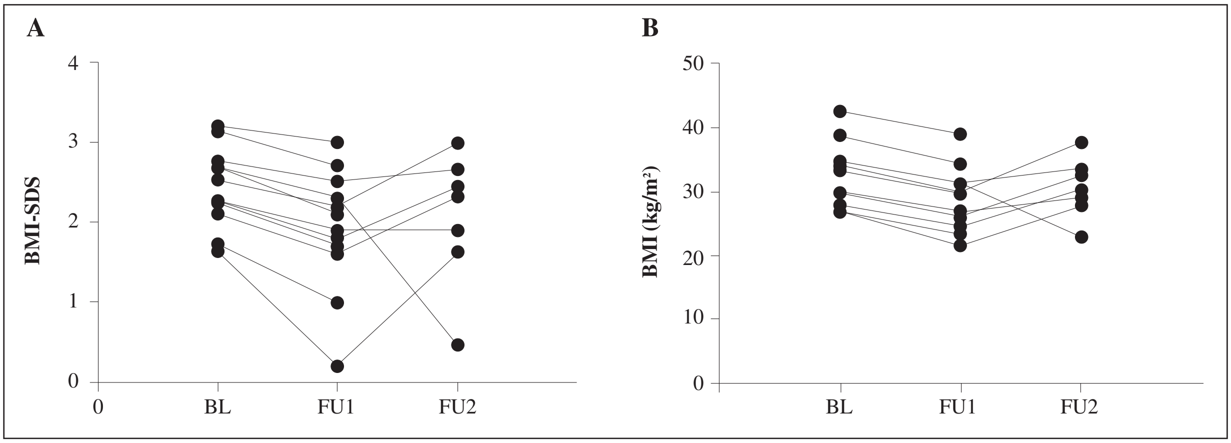

Fig. 1.—BMI-SDS (A) and BMI (B) follow-up of the participants in the obesity group at baseline (BL), the 6-week wollow-up (FU1), and 36-month follow-up (FU2).

Table III
Family history. Emergence of diseases in the participants' relatives of first or second degree

	Control group	*Obesity group*	*p-value*
Hypertension	25%	75%	0.01
Diabetes mellitus	5%	67%	< 0.001
Hyperlipidemia	1%	25%	n.s. (0 = 0.07)
Gout	5%	42%	0.02
CKD	10%	25%	n.s.
CHD	15%	25%	n.s.

CKD: chronic kidney disease; CHD: coronary heart disease; n.s.: not significant.

the left atrium (systolic) (LADs) was significantly higher in obese adolescents. These differences reflect first changes in the heart structure that reflect beginning left ventricular hypertrophy.

Effect of a weight loss program

The 12 recruited obese adolescents took part in a weight loss program (median duration time 5.8 weeks) and all of them completed it. 7 obese adolescents (58%) of the obese group attended the 36-month follow-up. The adolescents that dropped out of the study had similar anthropometric data compared to those who completed the follow-up.

Table IV
Echocardiographic parameters of the two study groups

	Control group		Obesity group		p value
	Median	25-75% CI	Median	25-75% CI	
Ao (mm)	29.4	± 2.5	30.7	± 3.6	n.s.
LADs (mm)	33.2	± 4.0	39.2	± 3.7	0.005
IVSd (mm)	9.3	± 1.3	10.6	± 1.6	0.034
LVPWd (mm)	10	90-11.0	9.0	9.0-11.3	n.s.
IVSs (mm)	12.2	± 1.5	12.8	± 1.2	n.s.
LVPWs (mm)	15.0	13.0-16.0	16.5	13.0-17.0	n.s.
LVDd (mm)	47.7	± 4.2	49.5	± 4.4	n.s.
LVDs (mm)	29.9	± 4.9	32.0	± 3.6	n.s.
FS	0.4	± 0.06	0.4	± 0.06	n.s.
EF	0.68	± 0.07	0.65	± 0.07	n.s.

Ao: Aorta; LADs: left atrium diameter systolic; IVSd: intraventricular septum diastolic; LVPWd: left ventricular posterial wall diastolic; IVSs intraventricular septum systolic; LVPWs: left ventricular posterial wall systolic; LVDd: left ventricular diameter diastolic; LVDs: left ventricular diameter systolic; FS: fractional shortening; EF: ejection fraction; n.s.: not significant.

Short-term weight changes

After completion of the 6-week weight loss program, a significant decrease in all parameters reflecting weight status could be detected. There was a reduction in median weight from 97 kg to 87.5 kg ($p < 0.001$, table V) and a significant decrease in BMI from 31.7 to 28.4 ($p < 0.05$) from baseline to follow-up. BMI-SDS decreased from median 2.4 to 2.0 ($p < 0.001$) after the 6-week program.

Long-term weight changes

7 adolescents of the obese group attended the 36-month follow-up. In the obese group, 36-month follow-up data reflecting body weight changes revealed a relevant increase in body weight, BMI, and BMI-SDS compared to the 6-week follow-up. Anyway, there was a relevant increase in BMI-SDS from 2.0 after completion of the weight loss program to 2.3 at the 36-month follow-up. This change did not reach the level of significance because of the reduced number of obese adolescents attending the long-term follow-up. Comparing the BMI-SDS as the most reliable parameter reflecting body weight status over time and growth process, the BMI-SDS almost remained the same at baseline and 36 months after completion of the weight loss program (2.3 at 36-month follow-up, 2.4 at baseline). This shows that the relevant weight-reducing short-term effect of the weight loss program could not be maintained to the long-term follow-up. The BMI increased significantly again comparing the 6-week follow-up and the 36-month follow-up (from median 28.4 to 30.6, $p < 0.05$). Also, in the 36-month follow-up, different cardiovascular risk factors (blood pressure, lipid profile, HbA1c, CRP) did not differ significantly from those at the time of inclusion.

Discussion

In summary, significant differences in baseline characteristics were found for obese and non-obese adolescents, including an altered lipid profile, an increased CRP reflecting a higher inflammatory state, and higher

Table V
Changes in parameters reflecting body weight status in the obesity group

	Baseline (BL)		6-week FU (FU1)		p-value FU1: BL	36-month FU (FU2)		p-value FU2: FU1	p-value FU2: BL
	Median	25-75% CI	Median	25-75% CI		Median	25-75% CI		
N	12		12			7			
Age (y)	15.0	14.0-16.5	15.0	14.0-16.5	n.s.	18	16-18		
Body weight (kg)	97.0	85.3-107.8	87.5	69.8-97.8	< 0.001	105.4	92.3-117.0	n.s.	n.s.
BMI (kg/m^2)	31.7	28.3-34.7	28.4	25.1-31.3	< 0.05	30.6	27.8-33.6	< 0.05	n.s.
BMI-SDS	2.4	2.1-2.7	2.0	1.6-2.5	< 0.001	2.3	1.6-2.7	n.s.	n.s.

BMI: body mass index; BMI-SDS: body mass index standard deviation score; n.s.: not significant.

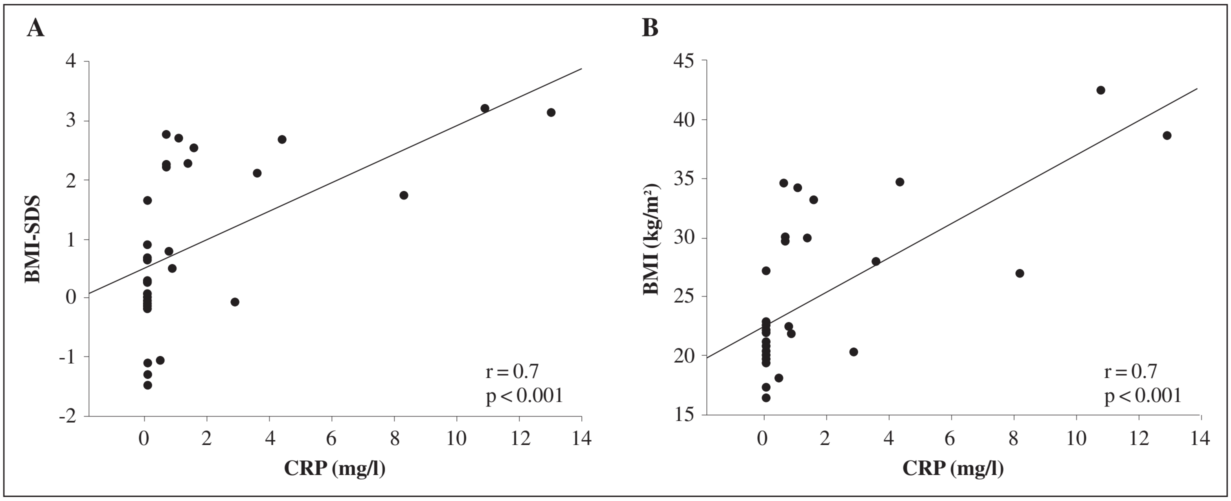

Fig. 2.—Correlations between BMI-SDS (A) and BMI (B) with CRP. r correlation coefficient, p: level of propability.

values for HbA1c and blood pressure. This confirms earlier studies published.[17-22] The data obtained reflect a higher cardiovascular risk factor profile in obese adolescents and might explain partially why already childhood BMI is positively correlated with coronary heart disease, and stroke in later life.[7,23] This is further supported by the obtained echocardiographic parameters indicating early structural changes caused by obesity. A higher intraventricular septum thickness and a larger left atrium are findings typical for left ventricular (LV) hypertrophy. This observation is in concordance with former studies that showed that the thickness of the LV correlates with BMI, and LV hypertrophy has been shown to occur more often in obesity.[24,25] As expected, participants of the control group spent significantly more time doing sports than the obese group. This finding supports the theory that one of the main reasons why obesity is an increasing problem of the presence is a decrease in physical activity and an increase in sedentary habits.[26] Other predisposing factors for obesity is a low parental level of education, and a low parental income.[27] This is reflected in the results of the current study which show a higher number of absolved university studies of the participants' mothers in the control group than in the treatment group. Considering all these findings long-lasting weight loss effects are of central importance to ameliorate the consequences of obesity in early life.

However, our small observational, non-randomized study shows that attendance at the 6-week weight loss program did not lead to a significant long-term reduction of body weight of the included adolescents. A significant weight loss could be noted directly after attendance of this program, but as the adolescents leave the clinic, they gain weight again. Due to the limited number of subjects our study results have to be interpreted with some limitations. Although one can assume that the adolescents that dropped out the study show similar developments in their weight, the poor retention rate reduces the power of our thesis that questions the long-term effectiveness of weight loss programs. On the other hand, the obtained data clearly shows that there was no long-term detectable after three years.

Former studies investigating the effectiveness of weight management programs showed conflicting results, some presenting significant reductions in body weight and body fat,[14,15,28] others demonstrating that the weight reduction could not be maintained in long-term follow-up.[29,30] It is important to find the reasons for this contradiction. Analyzing the methodic part of the publications, it is not possible to get a comprehensive view about the weight loss programs investigated. In the future, different programs with different methodic approaches should be compared and further evaluated, possibly using randomization comparing different protocols.

It is also important to evaluate the weight-reducing effect of intervention programs with respect to different patients' ages. For example, a former study showed differences in the long-term maintenance (3 years) of weight-reducing effects for an outpatient intervention. There were significant reductions in BMI-SDS observed for severely obese children , but not adolescents.[31]

Moreover, integration of the participants' families, especially their mothers, seems to be extraordinary important to give rise to long-term success.[32] A former study showed that the mother's characteristics are more important than those of the father in children's obesity and weight loss.[33] This theory is supported by the observation of the current study that overweight of mothers is associated with higher emergence of obesity in adolescents.

Obviously, a quality management for weight loss programs resulting in homogeneous standards is indispensable to guarantee similar effects for different programs. In the future, through a more detailed examination of current weight loss concepts standardized programs should be created to achieve long-term success. Generating effective weight loss programs for adolescents is critical to leading to health improvement in the adulthood because there is simply a lack of alternatives. For example, current existent medical treatment for obesity is limited. Orlistat is the only drug available for long-term use for weight-reduction. It leads only to a very slight reduction of weight, some studies do not find a significant reduction of weight at al.[34] Also surgical interventions are left for severe obesity because of their surgical risks and adverse effects. For these reasons, conservative treatment of obesity gains enormous importance and needs to be put in the focus of health questions.

In conclusion, existing weight loss programs should be critically analyzed in the future to develop a similar standard with proven long-term success within different intervention programs to fight the growing health threat of obesity, especially in early life.

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