ARTICLE

Results of a Multidisciplinary Treatment Program in 3-Year-Old to 5-Year-Old Overweight or Obese Children

A Randomized Controlled Clinical Trial

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Objective: To assess the effects of a multidisciplinary intervention program for 3-year-old to 5-year-old overweight and obese children compared with a usual-care program.

Design: Randomized controlled clinical trial conducted from October 2006 to March 2008.

Setting: Groningen Expert Center for Kids with Obesity at Beatrix Children's Hospital, University Medical Center Groningen.

Participants: Seventy-five children (29 overweight, 46 obese) aged 3 to 5 years.

Intervention: A multidisciplinary intervention program vs a usual-care program. Anthropometry was performed and body composition was determined by bioelectrical impedance analysis and ultrasonography at the start and end of the 16-week program and 12 months after starting the intervention.

Main Outcome Measures: The actual weight reduction, change in body mass index (BMI, calculated as weight in kilograms divided by height in meters squared), BMI *z* score, body fat percentage, and visceral fat in the multidisciplinary intervention group compared with a usual-care group.

Results: At the end of the treatment program, children in the multidisciplinary intervention group showed a greater decrease in BMI, BMI *z* score, and waist circumference *z* score compared with children in the usual-care group. At 12 months, children in the intervention group showed greater decreases in BMI, BMI *z* score, waist circumference, and waist circumference *z* score compared with children in the usual-care group. Visceral fat showed a trend toward a higher decrease.

Conclusions: A multidisciplinary intervention program in 3-year-old to 5-year-old overweight and obese children had beneficial effects on anthropometry and body composition. The positive effects were still present 12 months after the start of the intervention.

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IN THE NETHERLANDS, AS IS SEEN worldwide, the prevalence of childhood obesity has increased.[1] Between 1980 and 2003, the prevalence of obesity in boys and girls aged 4 to 16 years has increased, especially among those younger than the age of 8 years.[1] At present, the prevalence of excess weight among Dutch boys and girls aged 2 to 21 years is 13.3% and 14.9%, respectively, while the prevalence of obesity is 1.8% and 2.2%, respectively.[2] A sedentary lifestyle, a high-fat diet, and excess caloric intake are considered to be, at least partially, responsible for the epidemic rise in child obesity.[3] The influence of television viewing and lack of physical activity on body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) in preschool-aged children has been demonstrated.[4] Childhood obesity has extensive health risks including the development of metabolic syndrome (MS) at a later age.[5]

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Treatment of overweight and obese children is difficult. A recent meta-analysis on different treatment modalities for obesity in children aged 5 to 12 years showed that combined lifestyle interventions with a behavioral component could achieve an important weight reduction.[6] However, little is known about the results of lifestyle intervention programs in treating obesity in preschool-aged children. Treating obesity at a young age is especially important as the tracking of obesity exists.[7] Obese adolescents are clearly at risk for becoming obese adults.[8] Moreover, interventions preventing or reversing obesity in its early stage may be more successful than treating obesity that has been present for a longer period. Kindergarten-based interventions have proven to be useful in the prevention of overweight preschool-aged children.[9]

The aim of this study was to evaluate the effect of a multidisciplinary intervention program in overweight and obese children aged 3 to 5 years and their families when compared with usual care. Primary outcome measures were the actual weight reduction and changes in BMI, BMI *z* score (BMI-*z*), body fat percentage (BF%), and visceral fat (VF) in the intervention group compared with a usual-care group. Secondary outcome measures included changes in waist circumference (WC), WC *z* score (WC-*z*), hip circumference (HC), HC *z* score (HC-*z*), upper arm circumference, fat-free mass (FFM), and abdominal subcutaneous fat (SCF).

METHODS

STUDY DESIGN

Our study, a randomized controlled clinical trial called the GECKO–Outpatients Clinic Study, was performed in the Groningen Expert Center for Kids with Obesity (GECKO). Children and their families were randomly assigned to the multidisciplinary intervention program or to a usual-care program.

Inclusion took place between October 2006 and March 2008, and 78 children aged 3 to 5 years were assessed for eligibility for the study. Overweight or obese children, as defined by the International Obesity Task Force,[10] were referred to the Outpatient Clinic by youth health care physicians, general practitioners, or pediatricians. Children with mental retardation, severe behavioral problems, or other criteria interfering with participation were excluded. Also, children who were overweight or obese owing to known medical conditions or eating disorders, according to the Dutch Eating Behavior Questionnaire, were excluded from the study. Three children did not meet the inclusion criteria for the study because of a BMI-*z* of 1.1 or less, thus they were not overweight. In total, 75 children were included in the study.

Study participants were randomly assigned to the multidisciplinary intervention or usual-care groups by a computerized randomization procedure in groups of 20, matched by sex. Children and parents in the multidisciplinary intervention program received dietary advice, physical activity sessions and, for parents only, psychologic counseling. Dietary advice consisted of 6 sessions of 30 minutes each, guided by a dietician. During these sessions, a normocaloric diet was advised based on the required daily intake for this age group. In addition, education and advice to improve eating behavior was given. Parents and children were advised to have breakfast every morning, abstain from soft drinks, and have at most 3 snacks per day. Personal goals regarding the diet were set for parents and children. On consecutive sessions, feedback was given on these goals. The physical activity sessions consisted of 12 group sessions of 60 minutes each and were supervised by a physiotherapist. The exercise program focused on an active lifestyle and mimicked the type and intensity of habitual elementary school exercise (eg, ball playing and dancing to music). Motor skills were taught, and sessions were aimed at having fun during exercise, thereby improving the child's well being. Participants were advised to reduce sedentary activities. Every week, parents were asked to stimulate their child's physical activity to achieve daily physical activity of at least 60 minutes, according to the Dutch Standard of Healthy Activities. Behavioral therapy for parents comprised 6 group sessions of 120 minutes each that were guided by a psychologist. In these sessions, parents learned to be a healthy role model and work with feasible goals and healthy rewards. They also learned how to use sticker charts to motivate the children and keep track of their progress. Parents were taught to change family attitudes toward healthy eating and physical activity, learn practical ways to remove unhealthy food triggers, and know the difference between hunger and cravings. In total, the multidisciplinary intervention program consisted of 25 sessions, together approximately 30 hours in 16 weeks. Children and parents in the usual-care group were followed up by a pediatrician, also during a period of 16 weeks. In this period, they were seen 3 times for 30 to 60 minutes each time. Information on healthy eating behavior was provided, and they were advised to perform physical activity for 1 hour per day, according to the Dutch Standard of Healthy Activities. Furthermore, children were advised to play outside every day, walk or bike to school, and watch television or play with the computer at most 2 hours per day.

In both groups, physical activity was measured using a pedometer (Yamax Digi-Walker SW-200; Yamax USA Inc). The pedometer was worn at least 3 weekdays and 1 weekend day. After each day the pedometer was worn, parents documented the amount of steps in a diary. The average number of steps per day was calculated. To document eating patterns for both groups, special diaries were developed to document the type and amount of food that was consumed. The diaries were used during 4 consecutive days: 2 weekdays and 2 weekend days. Food records were checked by a dietician and the intake of nutrients was calculated with a validated computer program (Vodisys Medical Software; IP Health Solutions) using the Dutch food composition database (NEVO 2006). The study was approved by the medical ethics committee of the University Medical Center Groningen. Written informed consent from the parents or legal caretakers was obtained.

ANTHROPOMETRY AND ASSESSMENT OF BODY COMPOSITION, VF, AND SCF

Anthropometric measurements were performed at baseline, at the end of the treatment period (16 weeks), and at 12 months after the treatment started. All anthropometric measurements were done in duplo, with the children only wearing their underwear. The average of both measurements was calculated. Standard calibrated scales and stadiometers were used to determine height to the nearest 0.1 cm and weight to the nearest 0.05 kg. Height and weight were used to calculate BMI. Waist circumference was measured to the nearest 0.1 cm in orthostatic position at the midpoint between the lateral iliac crest and the lowest rib using a standard measuring tape. Hip circumference was measured to the nearest 0.1 cm at the level of the greater trochanter of both femurs, standing upright. Right upper arm circumference was measured to the nearest 0.1 cm at the middle of the upper arm. Body mass index–*z*, WC-*z*, and HC-*z* were calculated using the web-based program Growth Analyzer version 3 (http://www.growthanalyser.org/), which contains age-specific and sex-specific data from the Fourth Dutch Growth Study obtained in 1996 and 1997.[11]

Measurements for body composition, VF, and SCF were performed at baseline, 16 weeks, and 12 months using a 50-kHz

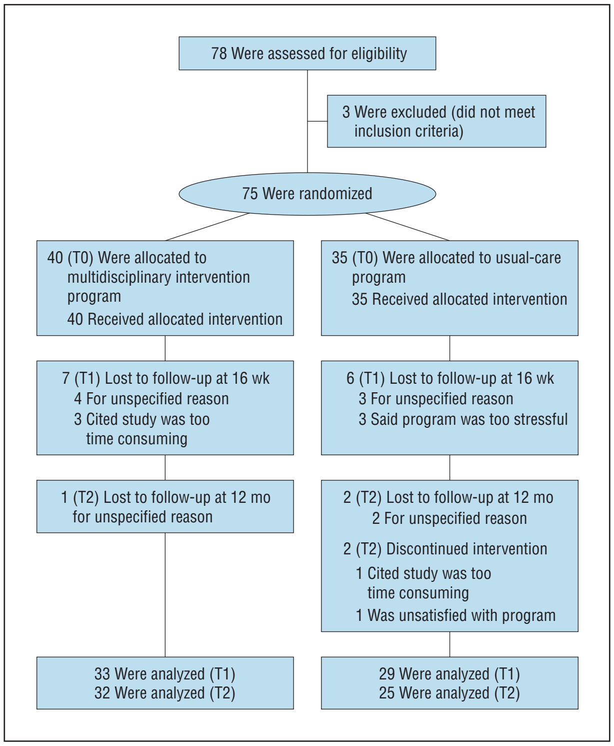

Figure 1. Flow diagram of study group assignment and follow-up. T0 indicates baseline; T1, 16 weeks; T2, 12 months.

fixed-frequency bioimpedance analyzer (BIA-101; Akern Srl/RJL Systems). Resistance and reactance values were collected, corresponding to total body water and extracellular water content, respectively. All measurements were performed 3 times, with the average being calculated. Fat-free mass and BF% were determined, as described by Horlick and colleagues.[12]

Abdominal SCF and VF were estimated based on distance measurements by standard protocol using a manual ultrasound device (SonoSite Titan; SonoSite Inc).[13,14] Measurements were performed at the middle of the imaginary line between both midpoints between the lateral iliac crest and lowest rib. All measurements were performed twice and to the nearest 0.01 cm. The average of both measurements was taken. Subcutaneous fat was measured at a depth of 4.7 cm with the transducer in a transverse position. The distance between the skin and abdominal muscles was measured on a frozen image after maximum decompression by lifting the transducer and after the child exhaled. Visceral fat was measured at a depth of 14 cm with the transducer in a longitudinal position. After the aorta and lumbar spine were visualized, the distance between the peritoneum and the lumbar spine was measured on a frozen image after maximal decompression and exhalation.

STATISTICAL METHODS AND DATA ANALYSIS

Statistical analysis was performed using PASW Statistics version 18.0. Distribution of normality was tested using the 1-sample Kolmogorov-Smirnov test. For within-group differences, a paired sample *t* test was used. For differences between groups, the independent *t* test was used. Repeated-measures analysis of variance, including baseline, 16 weeks, and 12 months, were used to determine the difference between groups at 12 months. The significance level of all tests was $P<.05$.

Seventy-five children should have been in the analysis (**Figure 1**). Owing to discontinuation of the intervention or loss to follow-up, data on 62 children (82.7%) were analyzed at the end of the treatment period. Dropouts at 16 weeks had a slightly lower BMI compared with children who continued the study, but that was not statistically significant. Data on 57 children (76.0%) were analyzed at 12 months after the start of the intervention (32 of 40 [80.0%] from the multidisciplinary intervention program and 25 of 35 [71.4%] from the usual-care group).

Table 1. Descriptive and Anthropometric Characteristics of the Study Population

	Mean (SD)	
	Multidisciplinary Intervention Group (n = 40)	Usual-Care Group (n = 35)
Boys, No. (%)	12 (30.0)	9 (25.7)
Girls, No. (%)	28 (70.0)	26 (74.3)
Age, y	4.6 (0.8)	4.7 (0.8)
Overweight, No. (%)	14 (35.0)	15 (42.9)
Obese, No. (%)	26 (65.0)	20 (57.1)
Weight, kg	28.4 (6.3)	28.1 (6.8)
Body mass index, kg/m^2	21.2 (2.9)	21.0 (2.7)
Body mass index *z* score	2.7 (1.0)	2.7 (1.0)
Waist circumference, cm	64.6 (7.1)	65.2 (8.0)
Waist circumference *z* score	2.7 (1.0)	2.7 (1.0)
Hip circumference, cm	69.0 (7.9)	68.6 (7.2)
Hip circumference *z* score	2.5 (1.3)	2.4 (1.1)
Upper arm circumference, cm	22.6 (2.3)	22.4 (2.4)
Body fat %	29.0 (7.8)	28.6 (6.3)
Fat-free mass, kg	19.7 (2.4)	19.7 (3.6)
Visceral fat, cm	4.4 (1.4)	4.3 (0.8)
Subcutaneous fat, cm	1.8 (0.7)	1.7 (0.7)
Steps, n/d	11 998 (3031)	9862 (2729)[a]
Energy intake, kcal/d	1434 (252)	1504 (316)

[a] Statistically significant lower number of steps compared with the multidisciplinary intervention group ($P<.01$).

RESULTS

Of the 75 children, with a mean age of 4.7 years, 29 were overweight and 46 were obese. For the whole group, BMI ranged from 17.2 to 32.5 and BMI-*z* from 1.11 to 6.30. **Table 1** shows the descriptive and anthropometric characteristics of the study population. The mean BMI for the intervention group and usual-care group were 21.2 and 21.0, respectively. The mean BMI-*z* for both the intervention and the usual-care groups was 2.7.

Figure 1 provides details about inclusion and dropout from the study. In the intervention group, 7 children (17.5%) were lost to follow-up or discontinued the program during the initial treatment period compared with 6 children (17.1%) in the usual-care group. During follow-up after the treatment period, 1 child (2.5%) in the intervention group and 4 children (11.4%) in the usual-care group were lost to follow-up or discontinued the program. The main known reasons for discontinua-

Table 2. Changes in Anthropometry and Body Composition Between Baseline and End of the 16-Week Treatment Program[a]

	Multidisciplinary Intervention Group (n = 33)		Usual-Care Group (n = 29)		Difference Between Groups	
	Mean (SD) Difference	95% CI	Mean (SD) Difference	95% CI	Mean (SD)	95% CI
Weight, kg	−0.2 (1.4)	−0.69 to 0.29	0.4 (1.4)	−0.15 to 0.93	0.6 (0.4)	−0.12 to 1.30
Body mass index, kg/m^2	−1.2 (1.0)	−1.50 to −0.81	−0.6 (1.1)	−1.04 to −0.19	0.5 (0.3)	0.01 to 1.07[b]
Body mass index *z* score	−0.5 (0.4)	−0.66 to −0.39	−0.3 (0.4)	−0.47 to −0.14	0.2 (0.1)	0.02 to 0.42[b]
Waist circumference, cm	−0.9 (3.2)	−2.05 to 0.25	0.9 (5.2)	−1.10 to 2.89	1.8 (1.1)	−0.39 to 3.98
Waist circumference *z* score	−0.3 (0.5)	−0.52 to −0.16	0.0 (0.6)	−0.24 to 0.21	0.3 (0.1)	0.04 to 0.60[b]
Hip circumference, cm	−2.2 (3.9)	−3.60 to −0.86	−0.8 (3.7)	−2.21 to 0.57	1.4 (1.0)	−0.50 to 3.33
Hip circumference *z* score	−0.6 (0.7)	−0.83 to −0.37	−0.3 (0.6)	−0.57 to −0.08	0.3 (0.2)	−0.06 to 0.60
Upper arm circumference, cm	−0.4 (0.9)	−0.70 to −0.02	0.0 (1.0)	−0.42 to 0.35	0.3 (0.2)	−0.17 to 0.82
Body fat %	−1.5 (3.4)	−2.73 to −0.29	−0.3 (4.0)	−1.81 to 1.26	1.2 (0.9)	−0.66 to 3.13
Fat-free mass, kg	0.3 (0.8)	0.02 to 0.56	0.4 (0.9)	0.01 to 0.73	0.1 (0.2)	−0.36 to 0.51
Visceral fat, cm	−0.5 (1.5)	−1.02 to 0.06	−0.2 (1.0)	−0.59 to 0.14	0.3 (0.3)	−0.41 to 0.91
Subcutaneous fat, cm	−0.2 (0.3)	−0.26 to −0.05	−0.1 (0.3)	−0.22 to 0.02	0.1 (0.1)	−0.10 to 0.21

[a] Positive numbers indicate an increase over time.
[b] Statistically significant higher decrease in the multidisciplinary intervention group compared with the usual-care group.

Table 3. Changes in Anthropometry and Body Composition From Baseline to 12 Months After the Start of the Intervention[a]

	Multidisciplinary Intervention Group (n = 32)		Usual-Care Group (n = 25)		Group × Time
	Mean (SD) Difference	95% CI	Mean (SD) Difference	95% CI	*P* Value[b]
Weight, kg	1.9 (2.6)	1.00 to 2.85	3.1 (2.2)	2.20 to 4.01	.12
Body mass index, kg/m^2	−1.0 (1.4)	−1.52 to −0.47	0.0 (1.6)	−0.67 to 0.62	.03[c]
Body mass index *z* score	−0.6 (0.5)	−0.82 to −0.44	−0.3 (0.5)	−0.49 to −0.05	.02[c]
Waist circumference, cm	0.9 (4.6)	−0.73 to 2.59	0.3 (5.0)	−1.73 to 2.37	.02[c]
Waist circumference *z* score	−0.4 (0.6)	−0.57 to −0.14	−0.3 (0.7)	−0.61 to −0.01	.01[c]
Hip circumference, cm	0.4 (4.5)	−1.20 to 2.07	2.3 (4.9)	0.29 to 4.37	.26
Hip circumference *z* score	−0.5 (0.7)	−0.78 to −0.25	−0.2 (0.9)	−0.52 to 0.20	.19
Upper arm circumference, cm	−0.3 (1.3)	−0.71 to 0.22	0.5 (1.5)	−0.16 to 1.10	.16
Body fat %	−1.7 (4.5)	−3.33 to −0.12	0.3 (4.9)	−1.75 to 2.27	.25
Fat-free mass, kg	1.8 (1.3)	1.33 to 2.25	2.1 (1.0)	1.69 to 2.55	.59
Visceral fat, cm	−0.7 (1.5)	−1.21 to −0.14	0.1 (1.2)	−0.40 to 0.62	.08
Subcutaneous fat, cm	−0.2 (0.4)	−0.30 to −0.02	0.0 (0.4)	−0.17 to 0.12	.40

[a] Positive numbers indicate an increase over time.
[b] *P* values are based on time × group effect from repeated-measures analysis of variance, including baseline, 16 weeks, and 12 months.
[c] Statistically significant higher decrease in the multidisciplinary intervention group compared with the usual-care group.

tion of the program were the time-consuming aspect and the stressfulness of the intervention.

To assess the direct effects of the 2 different treatment modalities, we determined the changes in anthropometry and body composition between baseline and 16 weeks for the intervention group and the usual-care group (**Table 2**). In the intervention group, significant decreases were observed for BMI, BMI-*z*, WC-*z*, HC, HC-*z*, upper arm circumference, BF%, and SCF. There was a significant increase in FFM. In the usual-care group during the treatment period, significant decreases were only observed for BMI, BMI-*z*, and HC-*z*. A significant increase in FFM was also found. Comparing the effect of the 2 treatment programs between baseline and 16 weeks, significantly greater decreases in BMI (mean [SD], 0.5 [0.3]; 95% CI, 0.01-1.07; *P* = .05), BMI-*z* (mean [SD], 0.2 [0.1]; 95% CI, 0.02-0.42; *P* = .03), and WC-*z* (mean [SD], 0.3 [0.1]; 95% CI, 0.04-0.60; *P* = .02) were demonstrated for the intervention group.

To assess the long-term effects of the 2 different treatment modalities, we determined the changes in anthropometry and body composition between baseline and 12 months for the intervention group and the usual-care group (**Table 3**). In the intervention group 12 months after the initial treatment had started, significant decreases were seen in BMI, BMI-*z*, WC-*z*, HC-*z*, BF%, VF, and SCF. Fat-free mass had increased significantly. In the usual-care group, significant decreases were only seen for BMI-*z*, WC-*z*, and HC. A significant increase in FFM had occurred. Comparing the effect of the 2 treatment modalities between baseline and 12 months, significantly greater decreases in BMI ($P = .03$), BMI-z ($P = .02$), WC ($P = .02$), and WC-z ($P = .01$) were shown for the multidisciplinary treatment program compared with the usual-care program (**Figure 2**). Visceral fat reached borderline significance ($P = .08$).

Table 4 shows the results of physical activity and energy intake. Between baseline and the end of the treatment program, a statistically significant increase in the daily number of steps was found for the usual-care group. For the multidisciplinary intervention group, there was a trend toward a statistically significant increase ($P = .09$). There was no difference between the groups. With regard to the nutrition data, in both groups a decrease in energy intake was observed. Only the change in daily intake of fiber between baseline and 16 weeks showed a statistically significant difference between both groups in favor of the multidisciplinary intervention group. Between baseline and 12 months after the start of the treatment program, neither group demonstrated a significant change over time in the daily number of steps and energy intake, despite the expected trends in nutrient intake, such as a decrease in the intake of monosaccharides and disaccharides, a small relative increase in energy percentage in total fat intake (owing to reduced saccharide intake), and an increase in fiber intake. There was no difference between the groups.

COMMENT

The aim of this study was to evaluate the effects of a multidisciplinary intervention program in overweight and obese children aged 3 to 5 years and their families. We showed that this multidisciplinary treatment program for overweight and obese preschool-aged children had better results on changes in anthropometry and body composition than a usual-care treatment program. The positive effect of the multidisciplinary treatment program was present directly after the intervention finished, and it was still present 12 months after the start of the treatment program. At the end of the intervention period, the children in the multidisciplinary treatment group showed greater decreases in BMI, BMI-z, and WC-z compared with the children in the usual-care group. Twelve months after the start of the intervention, greater reductions in BMI, BMI-z, WC, and WC-z were observed for the intervention group compared with the usual-care group. The reduction in VF showed a trend toward statistical significance.

With the exception of the daily intake of fiber, no significant differences in the daily number of steps and energy intake were found between both groups, either at the end of the treatment period or 12 months after the start of the intervention. It would be expected that these parameters had improved more in the multidisciplinary treatment group compared with the usual-care group, especially as the changes in anthropometry showed better results for the multidisciplinary treatment group. It can be hypothesized that the documentation or measurement of diet and physical activity has not been sensitive enough to detect differences, as has been described in literature.[15,16]

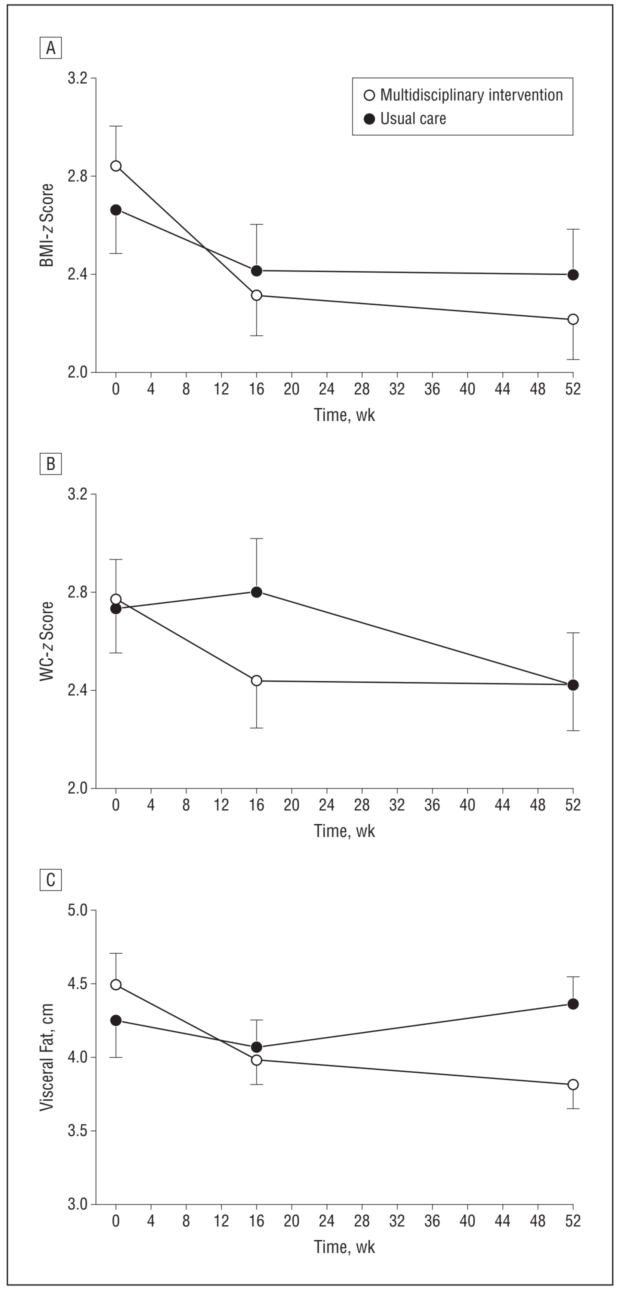

Figure 2. Body mass index (BMI) z score (A), waist circumference (WC) z score (B), and visceral fat (C) in the multidisciplinary intervention group and usual-care group from baseline to 12 months after the start of the intervention.

A successful treatment program for reversing excess weight and obesity in young children is important because the tracking of obesity has been demonstrated.[7] Consequently, an elevated BMI in adolescence is a clear risk factor for obesity-related disorders in midlife.[17] Besides possible health risks at a later age, obese and overweight children may have health problems at a young age. Metabolic syndrome has been described in childhood,[18] and complications of obesity in obese prepubertal children have been demonstrated.[19]

Long-lasting positive effects of treatment programs for overweight and obese children are difficult to realize. It has been demonstrated that younger children generally

Table 4. Changes in Physical Activity and Energy Intake From Baseline to the End of the 16-Week Treatment Program and to 12 Months After the Start of the Intervention

	Mean (SD)						Group × Time	
	Multidisciplinary Intervention Group			Usual-Care Group				
	Baseline	16 wk	12 mo	Baseline	16 wk	12 mo	P Value[a]	P Value[b]
Steps, n/d	11 998 (3031)	13 823 (2711)	12 455 (3185)	9862 (2729)	12 039 (2329)[c]	10 308 (2404)	.50	.39
Energy intake, kcal/d	1434 (252)	1323 (200)	1369 (244)	1504 (316)	1327 (220)	1429 (265)	.81	.87
Fat energy %	27.7 (3.9)	26.5 (5.0)	30.2 (6.2)	27.7 (3.8)	26.9 (4.1)	29.6 (4.0)	.59	.87
Saturated fat energy %	11.0 (2.2)	10.1 (2.2)	11.3 (2.7)	10.6 (1.7)	10.5 (1.7)	10.9 (1.6)	.22	.71
Unsaturated fat energy %	13.8 (2.0)	13.0 (3.0)	15.5 (3.2)	14.4 (2.5)	13.5 (2.8)	15.5 (2.7)	.98	.53
Carbohydrate energy %	57.3 (4.7)	57.1 (5.2)	53.8 (6.4)	58.6 (4.3)	58.1 (5.6)	54.8 (4.0)	.68	.92
Monosaccharide/ disaccharide energy %	32.8 (6.3)	31.6 (6.3)	28.4 (6.9)	35.1 (5.5)	33.0 (7.4)	29.1 (5.0)	.67	.69
Protein energy %	15.0 (2.6)	16.4 (2.6)	16.1 (2.7)	13.8 (2.0)	15.0 (2.8)	15.7 (1.9)	.89	.96
Fiber intake, g/d	13.3 (3.4)	14.7 (3.7)	14.9 (3.9)	14.4 (3.4)	13.1 (2.7)[d]	15.2 (2.5)	.02	.10

[a] *P* values are based on time × group effect from repeated-measures analysis of variance, including baseline and 16 weeks.
[b] *P* values are based on time × group effect from repeated-measures analysis of variance, including baseline, 16 weeks, and 12 months.
[c] Statistically significant increase compared with baseline ($P < .001$).
[d] Statistically significant decrease compared with baseline ($P < .05$).

achieve greater reductions in BMI-*z* in weight-management programs.[20] However, little is known about the effects of multidisciplinary intervention programs in overweight and obese preschool-aged children.[21] A randomized, controlled trial in 18 obese children aged 2 to 5 years showed a decrease in BMI-*z* in the intervention group compared with an increase in the control group posttreatment and at 12 months follow-up.[22] For children aged 5 to 12 years, the best results have been achieved in multidisciplinary programs aimed at changing lifestyle.[6] Hughes et al[23] demonstrated in 5-year-old to 11-year-old overweight children that family-centered counseling and behavioral strategies to modify diet, physical activity, and sedentary behavior had modest benefits on physical activity and sedentary behavior but did not have a significant effect on BMI-*z* compared with a standard-care program. A 12-month randomized, controlled trial in 6-year-old to 9-year-old overweight children involving parenting-skills training showed reductions in BMI-*z* and WC-*z*, particularly in boys.[24] Our study clearly showed that a combined lifestyle intervention program can result in important improvements in anthropometry and body composition in overweight and obese preschool-aged children. Furthermore, the results of this multidisciplinary treatment program were more pronounced when compared with the usual-care program. Still, it has to be proven whether this positive effect remains in the years after the treatment program has ended.

An important result of our study is the positive effect on the reduction of abdominal fat mass in the intervention group, shown by decreases in WC-*z* and VF. The reduction of WC-*z* is of importance, as this better demonstrates abdominal obesity than BMI.[25] One year after the start of the treatment program, reductions in WC-*z* and VF were shown for children in the intervention group, whereas children in the usual-care group only demonstrated a reduction in WC-*z*. Comparing both treatment modalities, the decreases in WC and WC-*z* were more distinct in the group that received the multidisciplinary treatment program. Visceral fat showed a trend toward a greater decrease in the children who received the multidisciplinary treatment program. Reduction of abdominal fat mass is important as visceral adipocytes are responsible for the production of adipokines. Adipokines can induce a state of low-grade inflammation,[26] oxidative stress,[27] and MS.[28] Furthermore, visceral obesity is responsible for the development of insulin resistance and eventually type 2 diabetes mellitus.[29] In addition to a reduction in VF, children in the multidisciplinary intervention group also had a reduction in abdominal SCF 16 weeks and 12 months after the start of the intervention. The importance of abdominal SCF in oxidative stress, insulin resistance, and MS has been demonstrated.[30]

In conclusion, we showed that a multidisciplinary intervention program for 3-year-old to 5-year-old overweight and obese children had beneficial effects on anthropometry and body composition when compared with a usual-care program. The positive effects of the intervention program remained 12 months after the start of the treatment. The effect on parameters for abdominal adipose tissue is especially important, as this may imply a decreased risk for the development of insulin resistance and MS at a later age. However, additional studies in overweight and obese preschool-aged children and long-term follow-up are needed to further elucidate whether the positive effects of multidisciplinary treatment programs remain during a longer period.

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