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Three-year follow-up of 3-year-old to 5-year-old children after participation in a multidisciplinary or a usual-care obesity treatment program


Department of Pediatrics, Beatrix Children's Hospital, University Medical Center Groningen, University of Groningen, P.O. Box 30.001, 9700 BB Groningen, The Netherlands

Department of Epidemiology, University Medical Center Groningen, University of Groningen, P.O. Box 30.001, 9700 BB Groningen, The Netherlands

1. Introduction

In the Netherlands, the prevalence of childhood obesity has increased by two to three times between 1980 and 2009. In 2009, the prevalence of overweight in Dutch boys between the ages of 3–5 years was 7.8–12.8% and in Dutch girls 12.8–18.1%. For obesity, the prevalence in Dutch boys and girls aged 3–5 years was 0.8–2.0% and 1.6–3.3%, respectively. For comparison, in 2010 the prevalence of obesity in the same age category of children from the United States was 12.4% in boys and 10.0% in girls. In obese children, a decreased insulin sensitivity and dyslipidemia have been described at a young age. Childhood obesity may persist into adulthood, potentially leading to the development of cardiovascular disease (CVD) and type 2 diabetes (T2D).

Prevention of childhood obesity should have a high priority. When efforts to prevent the development of obesity have failed, it is important to intervene. A Cochrane review has shown that family-based, multidisciplinary lifestyle intervention programs for children under the age of 12 years with overweight or obesity can be successful in reducing weight. Literature reporting on long-term effects of lifestyle intervention programs is limited. These long-term effects are important since maintenance of beneficial effects of obesity intervention programs would indicate the persistence of a reduced life-time risk on CVD and T2D.

At present, the longest follow-up period of obesity treatment programs was published in 1994. Epstein and colleagues reported 10-year outcomes of 4 randomized studies in 185 children aged 6–
12 years. The authors concluded that the results obtained in the first 5 years of treatment were predictive for the outcome at 10 years. The importance of positive results during the intervention period on maintaining these effects on the long-term was also emphasized by an obesity intervention study in 663 children with a mean age of 10.6 years. A 5-year follow-up study in 31 obese children with a mean age of 8.4 years, in which eight follow-up visits were included, showed a persistent decrease in BMI-SDS and WC, together with improved family habits towards a healthy lifestyle and decreased total energy intake.

Little is known about the long-term outcome of obesity intervention programs in preschool-aged children. The aim of this study was to evaluate the long-term effects of a multidisciplinary intervention program in overweight or obese children aged 3–5 years and in children receiving usual-care. Primary outcome measures were the changes in body fat percentage (BF%), visceral fat (VF) and abdominal subcutaneous fat (SCF), WC z score (WC-z), hip circumference z score (HC-z), and fat-free mass (FFM).

2. Materials and methods

Details of the programs and effects until 12 months after the start of both programs have been described previously. In short, children and parents participated in a randomized, controlled clinical trial at the “Groningen Expert Center for Kids with Obesity (GECKO)–Outpatient Clinic”. Children aged 3–5 years were referred to the outpatient clinic if they had a BMI-z > 1.1. After exclusion of medical causes for obesity, eating disorders, mental retardation and behavioral problems, children were randomly assigned to the multidisciplinary lifestyle intervention or usual-care programs. Enrollment took place from October 2006 to March 2008. A total of 75 children started with the study. They all were Dutch, except for five children from former Dutch colonies (two Suriname and three Dutch Antillean children) and one child from Morocco. Children lived in rural as well as in urban regions.

The multidisciplinary lifestyle intervention program included dietary advice for children and parents (6 sessions of 30 min each), physical activity sessions for children (12 sessions of 60 min each) and psychological counselling for parents only (6 sessions of 120 min each). Dietary advice was given by a dietician and aimed at improving eating behavior by using personal goals. Physical activity sessions under guidance by a physiotherapist mimicked elementary school exercise. For example, children were supervised on dancing to music and ball playing, aiming at developing motor skills and having fun during exercise. Furthermore, the parents were asked to stimulate the physical activity of their child at home, for at least 60 min per day, according to the Dutch Standard of Healthy Activities. Psychological counselling sessions were given by a psychologist who taught the parents how to be a healthy role model to their child. In the usual-care group, children and parents were followed up by a pediatrician (3 sessions of 30–60 min each) who advised on healthy eating and an active lifestyle. Both programs lasted 16 weeks. Written informed consent was obtained from the parents or legal caretakers. The study was approved by the Medical Ethics Committee of the University Medical Center Groningen.

Between the anthropometric measurements and assessment of body composition at 12 months after the start of the intervention and visits at 18 and 36 months from baseline, no follow-up visits or interventions were done. Height and weight were measured in duplo using standard calibrated stadiometers and scales. BMI was calculated and age- and gender-specific z scores were determined using the web-based program Growth Analyser 3 (http://www.growthanalyser.org). WC and HC were measured in duplo using a standard measuring tape. WC-z and HC-z were calculated as described for BMI. Bio-impedance analysis (BIA-101, Akern S.r.l./RJL Systems) was used to assess BF% and FFM, and ultrasound (Sonosite Titan, Sonosite, Inc) to measure VF and SCF. Pedometers (Yamax Digi-Walker SW-200, Yamax USA, Inc) were used to assess the children’s physical activity and were worn, at a minimum, three weekdays and one weekend-day. The average number of steps was calculated. During two weekdays and two weekend-days, specially developed diaries were used to document the type and amount of food consumed. The diaries were analyzed by a dietician using a validated computer program (Vodisys Medical Software, IP Health Solutions) containing the 2006 Dutch food composition database, and the intake of nutrients was calculated.

Statistical analysis was done using PASW Statistics version 18.0. Distribution of normality was tested using the 1-sample Kolmogorov–Smirnov test. The statistical analysis for testing a treatment effect, implemented a population-averaged linear mixed model on the repeated measurements after intervention for each end point separately. Follow-up time was treated as a categorical variable to avoid a specific and possibly unrealistic parametric time profile per individual. The analysis was corrected for its baseline value to eliminate possible random differences in the response at baseline. The intervention was implemented as a main effect and as an interaction effect with time, to be able to investigate a possible effect of the intervention at different time points. The effect size per time point and an overall or average effect size over time are provided accompanied with a 95% confidence interval. An unstructured correlation matrix was selected to describe the dependency among the repeated measurements after intervention. Restricted maximum likelihood was applied to estimate the population-averaged model to be able to address the missing data appropriately. The significance level of all tests was $P < .05$.

Due to loss to follow-up, data on anthropometry and body composition from 48 (64.0%) children were available 18 months after the start of the intervention, 25 of 40 (62.5%) children from the multidisciplinary intervention group and 23 of 35 (65.7%) children from the usual-care group. At 36 months after starting the intervention, anthropometric data and data on body composition from 29 (38.7%) children were available, 17 of 40 (42.5%) children from the multidisciplinary intervention group and 12 of 35 (34.3%) children from the usual-care group. Not all children and parents used the pedometers and diaries to assess physical activity and food consumption. At 18 and 36 months from baseline respectively, in children from the multidisciplinary intervention group, data from 12 and 12 pedometers and 16 and 14 diaries were available respectively. In children from the usual-care group, this was 10 and 5 and 8 and 6, at 18 and 36 months from baseline.

3. Results

Table 1 shows the descriptive and anthropometric characteristics of the study population at baseline. Figure 1 provides details about inclusion and dropout from the study. Mean (SD) age of the children in the multidisciplinary intervention group 18 months after the start of the intervention was 6.0 (0.8) years and 7.3 (1.1) years at 36 months. In the usual-care group, mean (SD) ages at 18 and 36 months from baseline were 6.2 (0.9) years and 7.4 (1.3) years, respectively. Table 2 shows the estimated effect sizes and their 95% confidence intervals of the multidisciplinary intervention program, compared with the usual-care program, on the anthropometric parameters of obesity and body composition at the different follow-up moments. It should be noted that none of the outcome variables demonstrated a significant interaction effect between the
multidisciplinary intervention and the time course of the study at the level of significance of 0.10. This may imply that a possible treatment effect attained at 16 weeks does not change anymore until the end of the follow-up. This means that we may ignore an interaction effect of the multidisciplinary intervention program with the time course and estimate the constant treatment effect over all follow-up times. A significant overall treatment effect of the multidisciplinary intervention program would then be demonstrated for BMI-z (0.28, 95% CI 0.03–0.54) and abdominal SCF (0.23, 95% CI 0.01–0.45), but not for any of the other outcome variables at the significance level of 0.05.

As there were no statistically significant differences between the groups over time, other than for BMI-z and SCF, we combined the data from both groups to assess whether there were any effects of the obesity treatment programs on WC-z or BF% at 36 months of follow-up. Mean (SD) decrease in WC-z was 0.4% (0.7), 95% CI 0.1–0.7 (P = 0.01). For BF%, mean (SD) increase at 36 months follow-up was 3.5% (5.5), 95% CI 1.4–5.6 (P = 0.002). At 18 months follow-up, there was no statistically significant difference in BF%, compared to baseline (mean (SD) –1.4% (5.7), 95% CI –3.0–0.3 (P = 0.11)).

Table 3 shows the estimated effect sizes and their 95% confidence intervals of the multidisciplinary intervention program, compared with the usual-care program, on physical activity and energy intake at the different follow-up moments. Overall, there were no statistically significant differences between the groups during the 36-month follow-up period.

4. Discussion

The aim of this study was to assess the 3-year outcome of a multidisciplinary intervention program on anthropometric parameters of obesity in 3-year-old to 5-year-old children, compared with a usual-care program. At 12 months after the start of both programs, children in the multidisciplinary intervention group showed greater decreases in BMI-z and WC-z compared with children in the usual-care group.13 During the follow-up period of 36 months, a significant overall treatment effect on a reduction in BMI-z and abdominal SCF was present for the multidisciplinary intervention group. Combining the results from both groups, body fatness tended to increase again 18 months after the start of the intervention. This may be due to a natural increase in body fatness at ages 5–6 years.16 However, it may also indicate that measures of adiposity may provide useful information on when to intensify the caloric restriction to sustain normalization of BMI-z. There were no statistically significant differences between the groups with respect to energy intake and physical activity, during the 36-month follow-up period.

The multidisciplinary treatment program did not show markedly better long-term effects on parameters of obesity, compared with the usual-care program at 36 months of follow-up. Possible causes for the absence of an effect of the multidisciplinary treatment program at 36 months, could be the large number of children dropping out from the study. At 36 months of follow-up, only 42.5% and 34.3% of the children from the multidisciplinary treatment and usual-care groups were available for analysis, respectively. Also, the lack of a maintenance program after the multidisciplinary treatment program had ended, could have contributed to the absence of a better long-term effect of the multidisciplinary program, compared with the usual-care program. It may be hypothesized that the presence of a maintenance program during follow-up, could have shown a long-term difference between both treatment programs.

The addition of maintenance interventions to prevent weight regain after the end of obesity treatment programs has been studied by Willfey and colleagues.17 This randomized controlled trial studied the 2-year outcome of 2 different maintenance interventions after a 5-month weight loss program in 204 obese children, 7–12 years old. The authors concluded that maintenance-targeted programs improved short-term results of weight loss treatment but questioned whether this effect was caused by the content of the maintenance program, or by the increased frequency and duration of contact with parents and children. Unfortunately, this study also demonstrated that the positive effects waned off during follow-up. Our study did not provide maintenance sessions after the intervention period, nor were there contacts with parents and children between the follow-up moments. Nevertheless, during the 36-month follow-up period, a significant overall treatment effect on BMI-z and abdominal SCF was observed for the multidisciplinary intervention group in our study.

Our results show that a lifestyle intervention program to reduce overweight in 3- to 5-year-old children is not only feasible, but also has a positive effect. Positive long-term effects of lifestyle intervention programs have been described in studies with obese older children. Dietary data of overweight 5-year-old to 9-year-old children who participated in an intervention program showed a sustained decrease of the consumption of energy-dense, nutrient-poor foods and an increased consumption of core foods at 2 years follow-up.16 Persistent reductions of exposure to unhealthy foods with an improved eating style and reduction in sedentary behavior at 2-year follow-up have also been reported in 7-year-old to 13-year-old obese children.19 The positive long-term results on BMI-z from our study further support the finding that multidisciplinary intervention programs in young children with overweight or obesity are more effective in decreasing weight, compared with intervention programs in overweight or obese adolescents.20

Reducing childhood obesity is important as this may result in a decreased risk on the development of adult CVD.1 This hypothesis is supported by a study showing the tracking of cardiovascular risk factors from childhood to adolescence in obese children.21 Positive short-term effects of a reduction in BMI in obese prepubertal children have been shown to reduce insulin resistance.4 We also found in this cohort, at the end of the intervention program, a clear correlation between a decrease in BF% and an increase in insulin sensitivity.22 Moreover, sustained beneficial effects of obesity treatment programs on lipid profile and markers for insulin

### Table 1

<table>
<thead>
<tr>
<th>Descriptive and anthropometric characteristics of the study population at baseline. Mean (SD).13</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multidisciplinary intervention group n = 40</strong></td>
</tr>
<tr>
<td>Boys, No. (%)</td>
</tr>
<tr>
<td>Girls, No. (%)</td>
</tr>
<tr>
<td>Age, y</td>
</tr>
<tr>
<td>Overweight, No. (%)</td>
</tr>
<tr>
<td>Obese, No. (%)</td>
</tr>
<tr>
<td>Weight, kg</td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
</tr>
<tr>
<td>Body mass index z score</td>
</tr>
<tr>
<td>Waist circumference, cm</td>
</tr>
<tr>
<td>Waist circumference z score</td>
</tr>
<tr>
<td>Hip circumference, cm</td>
</tr>
<tr>
<td>Hip circumference z score</td>
</tr>
<tr>
<td>Upper arm circumference, cm</td>
</tr>
<tr>
<td>Body fat %</td>
</tr>
<tr>
<td>Fat-free mass, kg</td>
</tr>
<tr>
<td>Visceral fat, cm</td>
</tr>
<tr>
<td>Subcutaneous fat, cm</td>
</tr>
<tr>
<td>Steps, n/d</td>
</tr>
<tr>
<td>Energy intake, kcal/d</td>
</tr>
</tbody>
</table>

*4 Statistically significant lower number of steps compared with the multidisciplinary intervention group (independent t test, P<0.01).
sensitivity have been demonstrated in obese 8-year-old to 16-year-old children.\textsuperscript{23} Multidisciplinary lifestyle intervention programs for overweight and obese children aim at sustaining the positive effects of improved eating habits and increased physical activity. No previous studies have evaluated if a multidisciplinary program is more beneficial on the long term than only advices given by a paediatrician, what is considered usual-care in our country. In our study, at 3 years after the start of the intervention, there were no statistically significant differences over time between both groups regarding the number of steps and energy intake. It should be noted that the use of food diaries to document eating patterns has its limitations. In prepubertal

Fig. 1. Flow diagram of study group assignment and follow-up. T0 indicates baseline.
obese children, food intake using dietary records was shown to be underreported and not valid in assessing energy intake.24 Therefore, the use of food diaries to document diet can be considered as a weak point of our study. Another weak point of our study is the use of pedometers to assess physical activity. Pedometers only document the number of steps, in contrast to accelerometers which measure physical activity in more directions. It can be considered that accelerometers are more sensitive in documenting physical activity in preschool-aged children, as they move in more directions at the same time than older children do.25 However, literature on differences in the measurement of physical activity in preschool-aged children using different types of accelerometers is limited.26

Mechanisms leading to weight regain after obesity intervention programs are important to understand, as this may give the opportunity to prevent their occurrence. Children may show the tendency to relapse into unhealthy behavior, as was shown in a prospective, randomized study comparing two weight-reducing diets in obese 11-year-olds to 16-year-olds.27 In this study, energy intake increased and physical activity decreased between the first and second year after treatment, together with a regain in weight. The importance of maintaining a healthy lifestyle in preventing weight regain was also shown in a study in adolescents who during follow-up had lower total energy intake, more energy at breakfast and less snacking and television watching.28 A healthy lifestyle also implies healthy eating behavior. It has been demonstrated that eating behavior traits are stable between the ages 4–10 years,29 and that overweight pre-adolescent children show a strong parental link for eating in response to external food cues appealing to the senses.30 Therefore, it is important to involve the parents in attempts to change eating behavior, as this may affect the children’s eating patterns over a longer period of time. This is supported by the results of our study, where we found greater long-term effects on reductions in BMI-z and SCF in the multidisciplinary intervention group, in which changes in eating behavior was one of the key items.

In conclusion, our study shows that, during the follow-up period of 36 months, the multidisciplinary treatment program demonstrates a significant treatment effect on the reduction in BMI-z and abdominal SCF, compared to the usual-care program. If maintenance programs might have additional effects to prevent the relapse of positive lifestyle changes and regain in weight has to be studied further. It will be of interest to elucidate whether the content and/or the frequency of maintenance programs can lead to improvements in outcomes of future multidisciplinary intervention programs for children with overweight or obesity, thereby decreasing the risk of the development of CVD and T2D at a later age.

### Table 2
Estimated effect sizes and their 95% confidence intervals of the multidisciplinary intervention program on anthropometry and body composition per follow-up moment, with respect to the usual-care program.

<table>
<thead>
<tr>
<th></th>
<th>16 weeks</th>
<th>12 months</th>
<th>18 months</th>
<th>36 months</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body mass</td>
<td>0.207</td>
<td>0.267</td>
<td>0.267</td>
<td>0.394</td>
<td>0.284</td>
</tr>
<tr>
<td>index z score</td>
<td>[0.012; 0.400]</td>
<td>[−0.010; 0.544]</td>
<td>[−0.044; 0.579]</td>
<td>[−0.002; 0.790]</td>
<td>[0.031; 0.536]</td>
</tr>
<tr>
<td>Waist circumference</td>
<td>0.324</td>
<td>−0.030</td>
<td>0.104</td>
<td>−0.099</td>
<td>0.075</td>
</tr>
<tr>
<td>Hip circumference</td>
<td>0.041; 0.607</td>
<td>0.248</td>
<td>0.002</td>
<td>0.413</td>
<td>0.225</td>
</tr>
<tr>
<td>z score</td>
<td>0.222</td>
<td>0.264</td>
<td>0.002</td>
<td>0.413</td>
<td>0.225</td>
</tr>
<tr>
<td>Body fat %</td>
<td>1.177</td>
<td>1.687</td>
<td>2.744</td>
<td>1.976</td>
<td>1.896</td>
</tr>
<tr>
<td>Fat-free mass, kg</td>
<td>0.069</td>
<td>0.284</td>
<td>0.017</td>
<td>0.017</td>
<td>0.137</td>
</tr>
<tr>
<td>Visceral fat, cm</td>
<td>0.077</td>
<td>0.600</td>
<td>0.152</td>
<td>1.060</td>
<td>0.472</td>
</tr>
<tr>
<td>Subcutaneous fat, cm</td>
<td>[0.053; 0.207]</td>
<td>0.131</td>
<td>0.162</td>
<td>0.566</td>
<td>0.228</td>
</tr>
</tbody>
</table>

A positive effect size indicates that the multidisciplinary intervention reduces the outcome variable compared to care as usual. Bold means a statistically significant treatment effect of the multidisciplinary intervention program, compared with the usual-care program.
Sources of funding

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Statement of authorship

GB carried out the studies and data analyses and drafted the manuscript. EC and EH performed the statistical analysis and EC helped to draft the manuscript. PS and RS conceived of the study, and participated in its design and coordination and helped to draft the manuscript. All authors read and approved the final manuscript.

Conflict of interest

No honorarium, grant, or other form of payment was given to anyone to produce the manuscript. The authors have no competing interests.

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