Treatment of Obese Children With and Without Their Mothers: Changes in Weight and Blood Pressure

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ABSTRACT. Weight and blood pressure changes were evaluated in a 16-month controlled trial comparing three methods of involving mothers in the treatment of their obese adolescents (aged 12 to 16 years). The treatments were: (1) Mother-Child Separately—children and mothers attended separate groups; (2) Mother-Child Together—the children and mothers met together in the same group; and (3) Child Alone—the children met in groups and mothers were not involved. The program consisted of behavior modification, social support, nutrition, and exercise. The Mother-Child Separately group lost more weight (8.4 kg) during treatment than did the other two groups (5.3 and 3.3 kg). Differences between the groups increased at the 1-year follow-up: compared to pretreatment weight, the Mother-Child Separately group lost 7.7 kg compared with gains of approximately 3 kg in the other two groups. Blood pressures of children with the highest initial pressures decreased by 16/9 mm Hg at the end of treatment and by 16/5 mm Hg at the 1-year follow-up. These results suggest that a program of behavior modification and parent involvement can lead to significant weight losses in obese children, and that the nature of parent involvement may be important. *Pediatrics* 1983;71:515–523; *obesity, blood pressure, behavior modification, exercise, nutrition.*

Obesity in children is a problem for three reasons. First, the obese child is at increased risk for carbohydrate intolerance, increased insulin secretion, hypercholesterolemia, hypertension, and decreased growth hormone release.[1-7] Second, obesity may have adverse social and psychological consequences.[8-11] Third, most children do not "grow out" of their obesity; 80% of children who are obese in the eighth grade become obese adults.[12,13]

Obesity has been one of the most refractory of all common disorders in children. Many approaches have been tried, but most have met with limited weight losses, high dropout rates, untoward emotional reactions, and high recidivism.[8,9,14-16] Behavior modification may offer new hope, but whereas this approach has been used extensively with adults,[17-19] comparatively few studies have been done with children. Early behavioral programs, based on a structured series of habit changes, were more successful than no treatment, dietary counseling, and several traditional approaches,[20-25] yet weight losses were modest. More recent studies using a broader combination of behavior modification, nutrition education, and exercise have shown greater effectiveness in both clinical and school settings.[26-32]

Parents may play an important role in both the development and treatment of obesity in their children.[9] Many writers have called for the training of parents to aid obese children,[8,15,16,24,27,28,32] yet there is only correlational evidence that parent involvement increases weight loss.[26-28] Furthermore, the nature of parent involvement may be important. Young children may need more supervision from their parents, whereas adolescents may require more independence.

This study was designed to test three methods of parent involvement in the treatment of obese adolescents aged 12 to 16 years. Short-term and long-term changes in weight and blood pressure were assessed at the end of a 16-week treatment period and at the end of a 1-year follow-up.

METHODS

Subjects

Subjects were 42 obese adolescents, aged 12 to 16

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years, from Williamsport, a city of 35,000 in north central Pennsylvania. All were white and from predominantly lower-middle class families. Subjects weighed at least 20% more than the average weight for their age, sex, and height[33]; they were free of medical conditions or medications that would influence body weight, were not involved in other formal weight loss programs, and were able to attend all sessions with their mothers. Mothers could be of any weight. Most subjects were enrolled by their parents, who learned of the program from a newspaper article. The remaining subjects were referred by physicians or school personnel. Each child entered treatment with his or her mother.

The children were an average of 55.7% overweight: 33 were girls, who averaged 47.2% overweight, and nine were boys, who averaged 86.9% overweight. For ages 12, 13, 14, 15, and 16, respectively, there were 10, 9, 8, 9, and 6 subjects. The mothers averaged 43.4% overweight[34]; 73% of the mothers were more than 20% overweight and 42% were more than 50% overweight.

Procedure

Children and mothers attended an orientation session prior to the program. Each parent deposited $15, $10 of which was refunded if both mother and child attended all sessions during the treatment phase. The remaining $5 was refunded for attendance at the follow-up meetings. In addition, the mothers paid a $3 fee before each meeting. As an incentive for the children, each child deposited $8 at the start of each month during treatment; $2 was returned to the child each week he or she lost 1 lb or more. The experimental nature of the program was explained and the participants were told that some children would attend sessions with their mothers and others would not.

All children received the same treatment, with the exception of parental involvement. The program was administered in weekly sessions of 45 to 60 minutes for a 16-week treatment phase. The children and mothers were weighed together prior to each session, and their records were reviewed by the group leader before formal group sessions began. Each group contained five to eight subjects. The group leader and the subjects discussed the week's didactic material and such matters as feelings about being overweight, family difficulties, and food preparation. After treatment ended, follow-up sessions were held every 2 months during the 1-year maintenance period. These sessions covered earlier material and focused on specific procedures for maintaining weight loss.

All subjects received a program of behavior modification, nutrition education, exercise instruction, and social support. The program was described in a 100-page treatment manual,[35] which was given to subjects in weekly installments. The behavioral component included sections on self-monitoring of food intake, physical activity, and behavior change; stimulus control and cue elimination; behavior chains and preplanning; attitude restructuring and cognitive control; and using alternatives to overeating. The nutrition education component included information on the basic food groups; maintaining a balanced diet low in sugar, salt, and fat; specific methods for buying, preparing, storing, and serving food; and misconceptions about diet and nutrition. Increasing physical activity was encouraged by discussions of the caloric expense of exercise; aerobic conditioning; programmed *v* life-style activity; and methods for gradually increasing energy expenditure.[36] One section of the manual concentrated on social support methods for enlisting the aid of family and friends. As discussed below, the issue of social support was a major factor distinguishing the three experimental conditions. Mothers who desired to lose weight were encouraged to do so, but were told from the beginning that they were under no obligation to lose weight.

The study was conducted with two cohorts of patients, the first from February to June and the second from December to April. Each cohort contained one group of subjects in each of the three treatment conditions. The group leader (J.H.K.) was a masters level psychologist with 3 years of experience in treating obesity. A male doctoral-level psychologist conducted the mothers' groups that met separately.

Experimental Conditions

The children were ranked according to percentage overweight and then assigned randomly from stratified blocks to one of three experimental conditions.

Mother-Child Separately. The mothers and children met concurrently in separate groups. The mothers were told that they were crucial to their child's success, and that separate meetings would help both mothers and children. The mothers and children were encouraged to discuss their feelings about obesity and dieting, to share their family experiences, and to work together in a spirit of cooperation.

Mother-Child Together. The children and mothers attended all treatment sessions and met together in the same group. They were told that this was a useful approach because the children and mothers would understand one another, would profit from hearing the others in the group, and would be able to practice the program components

together. Aside from the difference in parent involvement, children received the same treatment program as described above.

Child-Alone. The children met in groups, but the mothers did not take part in the formal treatment program. The children were told that they would do best if they could learn to control their eating on their own. They were encouraged to share the materials from the treatment manual with their parents. The basic treatment program was the same as that used for the other two groups.

Assessment and Statistical Analysis

Four measures were used to assess weight change: body weight; percentage above average weight; the body mass index (weight/height^2); and a new index which accounts for developmental growth. (Developmental growth does not occur consistently from child to child or even in the same child over time. Inasmuch as normal growth involves an increase in body weight, a child may gain weight and actually decrease in the degree of obesity if height has increased sufficiently. Similarly, two children of the same age and sex who lose the same amount of weight may differ if one has grown and the other has not. The Developmental Index is based on normative changes in height and weight,[37] and it calculates an adjusted weight change as a ratio of expected to actual changes in height. The adjusted weight is: actual weight change minus (actual height change)/(expected height change) multiplied by expected weight change. For example, during a 1-year period, a 14-year-old girl is expected to grow 1.4 in and gain 8.6 lb.[37] Using the index, a child who grows 0.7 in would be expected to gain only 4.3 lb. If the child actually gains 4.0 lb, the index would yield an adjusted weight change of −0.3 lb. This indicates that the child weighs 0.3 lb less than she would after accounting for growth.)

Multiple measures were used because changes in body weight in children are difficult to interpret. Children of different age, sex, and height are expected to weigh different amounts. The percentage overweight measure standardizes for differences between children in these three factors, whereas the body mass index standardizes for differences in height. The fourth measure, the new Developmental Index, was developed because of the importance of accounting for growth. Body fat measures were not taken because of problems with reliability and because the body mass index is strongly correlated with measures of body fat.[38]

Weights of children and mothers were measured with a balance-beam scale prior to each session. Height was measured before and after the program with the same scale. Measurements were taken in street clothes without shoes. At the 1-year follow-up, weight and height were obtained by phone from the mothers of the two children who had moved from the area. The blood pressure of all children was measured before (during the second visit to the clinic) and after the treatment phase and at the 1-year follow-up. The readings were taken by a nurse who had been certified in a blood pressure training program. Three measurements were taken on each occasion, following a five-minute period of sitting. One-minute intervals separated the readings, and the lowest reading was used for analysis. The measurements were taken prior to the treatment sessions, so the timing was consistent for each child.

Analyses of variance were used to evaluate changes in body weight. The analyses tested for the effects of cohort, experimental conditions, and their interactions. To provide a conservative estimate of the effects of each variable, the effects of the other variables were accounted for using analyses of covariance. Duncan's Multiple Range Test (using the .05 probability level) was used to compare the weight changes among the experimental conditions.

RESULTS

At treatment outset, there were 14, 15, and 13 children in the Mother-Child Separately, Mother-Child Together, and Child Alone groups, respectively. At 16 weeks and 1 year, the numbers of children remaining in each group were 13 and 12 for Mother-Child Separately, 13 and 12 for Mother-Child Together, and 12 and 12 for Child Alone. The attrition rate was 10% at 16 weeks and 14% at the 1-year follow-up.

The three groups within each cohort did not differ significantly in initial weight, percentage overweight, or body mass index. Similarly, the two cohorts did not differ significantly on these measures or in changes in any of the four measures of weight loss. In addition, no significant effects for cohort and no significant cohort-by-condition interactions were found when cohort was entered into analyses of variance comparing the three conditions. Therefore, the two cohorts were combined for the final analysis.

Analyses were conducted to determine whether boys and girls differed in their initial weight or weight losses. The boys weighed more initially (107.9 kg) than the girls (74.5 kg) (t, 41 = 3.7, $P <$ .004), and also had a higher percentage of overweight (86.9% v 47.2%) (t, 41 = 2.9, $P <$ .02). The boys had greater reductions in percentage overweight than did the girls (34% v 5.2%) (t, 37 = 2.8, $P <$ .04) and also lost more weight (11.3 v 4.7 kg), although the latter difference did not reach statistical significance. Similarly, at the 1-year follow-

up, there was a tendency for boys to have greater reductions in percentage overweight than girls (24.9% *v* 7.9%), and to have a greater net weight loss (3.3 *v* 0.5 kg), but these differences also did not reach statistical significance.

The limited number of boys in each experimental condition made it impossible to determine directly whether the boys and girls responded differently to treatment. Therefore, the most conservative test of treatment outcome was performed by first evaluating girls only. Data for the boys were then added to determine whether combining data from boys with those of girls would influence the results. Neither the pattern of results nor the statistical comparisons among experimental conditions changed when the boys were added. Accordingly, the results will be presented for boys and girls combined. This yielded the proportion of boys to girls reported in most treatment studies.

Initial Weight Loss

As shown in Fig 1, during treatment, the Mother-Child Separately group had a far greater decrease in percentage overweight (−17.1%) than did either the Mother-Child Together group (−7%) or the Child Alone group (−6.8%). A similar pattern for weight loss is shown in Fig 2: −8.4 kg for the Mother-Child Separately group compared with −5.3 kg and −3.3 kg for the Mother-Child Together and Child Alone groups.

The analyses of variance showed significant treatment effects for change in percentage overweight (F 2, 35 = 5.9, $P < .01$) and change in weight (F 2, 35 = 3.7, $P < .04$). The comparisons between groups using the Duncan's Multiple Range Test showed that the Mother-Child Separately group showed significantly greater changes in percentage

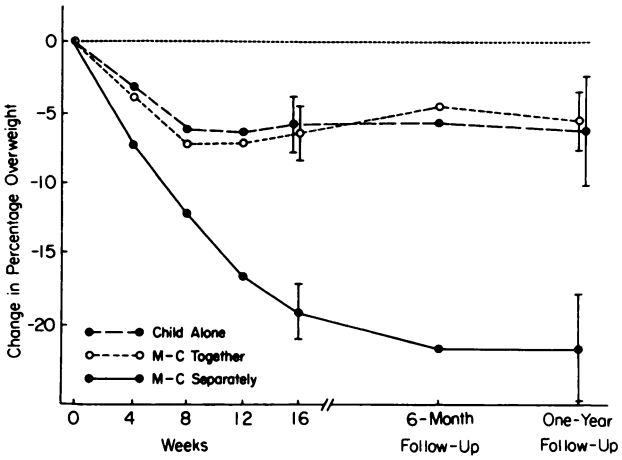

Fig 1. Mean changes (±SEM) in percentage overweight for three treatment conditions (Child Alone, Mother-Child Together, Mother-Child Separately) during treatment and 1-year maintenance period.

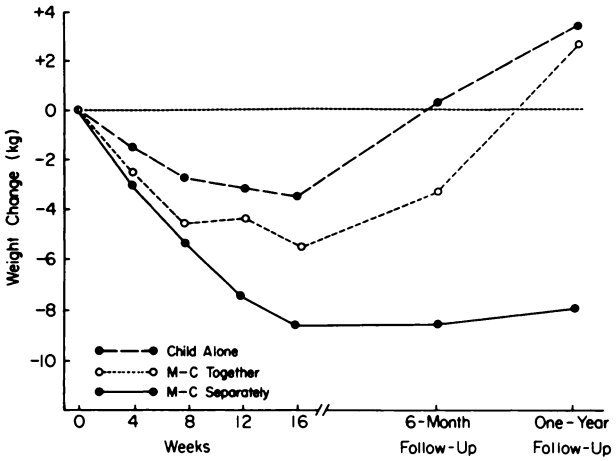

Fig 2. Mean changes in weight for three treatment conditions (Child Alone, Mother-Child Together, Mother-Child Separately) during treatment and 1-year maintenance period.

overweight than did the other two groups, which in turn did not differ from each other. The weight change for the Mother-Child Separately group was significantly greater than the loss for the Child Alone group. The Mother-Child Together group did not differ significantly from the other two groups. The Developmental Index and the body mass index revealed similar results. The Mother-Child Separately group lost significantly more than the Child Alone group, which did not differ from the Mother-Child Together group. The two groups that included mothers did not differ. The means and standard errors for the four measures of weight loss are presented in the Table.

Long-Term Weight Change

The differences between the Mother-Child Separately group and the other two groups increased in the year after treatment. As shown in Fig 1 the Mother-Child Together and Child Alone groups maintained their decreases in percentage overweight (−5.5% and −6%, respectively), whereas the Mother-Child Separately group had decreased even further(−20.5%). The Mother-Child Separately group had maintained a weight loss of 7.7 kg, while the other two groups had gained to approximately 3 kg above their base line weights (Fig 2). Because of increases in height, these latter two groups maintained their posttreatment degree of obesity despite the gains in weight. The analyses of variance showed significant treatment effects among the three groups for change in percentage overweight (F 2, 33 = 3.3, $P < .05$) and change in weight (F 2, 33 = 4.9, $P < .01$). The Mother-Child Separately group lost significantly more weight and showed greater reductions in percentage overweight than the Mother-Child Together and Child Alone

TABLE. Initial Values and Changes at Posttreatment and Follow-up for Each Measure of Weight Change*

	Weight (kg)			% Overweight			Body Mass Index			Developmental Index (kg)	
	Initial	16 wk	1 yr	Initial	16 wk	1 yr	Initial	16 wk	1 yr	16 wk	1 yr
Mother-child	83.6	−8.4	−7.7	59.9	−17.1	−20.5	45.5	−4.7	−4.6	8.9	9.4
separately	±4.5	±1.3	±4.1	±6.1	±2.4	±6.5	±1.9	±0.6	±1.9	±1.2	±3.7
Mother-child	80.5	−5.3	+2.9	50.4	−7.0	−5.5	42.4	−3.0	−0.1	5.9	0.6
together	±7.3	±1.6	±2.1	±9.9	±9.4	±3.5	±3.1	±0.9	±0.9	±1.7	±1.9
Child alone	81.1	−3.3	+3.2	57.4	−6.8	−6.0	42.0	−2.0	−0.1	3.7	0.4
	±5.2	±1.0	±1.7	±8.3	±2.0	±3.8	±1.8	±0.6	±1.0	±1.1	±1.7
Total sample	81.7	−5.7	−0.5	55.7	−10.3	−10.7	43.3	−3.3	−1.6	6.2	3.5
	±3.3	±0.8	±1.6	±4.7	±3.7	±7.4	±1.4	±0.4	±0.8	±0.9	±1.6

* Values are means ± standard error of mean.

groups, which in turn did not differ from each other. The results from the body mass index and the Developmental Index agreed with the data from the other measure, ie, there was a significant treatment effect among groups, and the Mother-Child Separately group was superior to the other two groups (Table).

Correlation analyses revealed that age and initial weight were related to weight loss. Older children lost more weight than younger children, both at 16 weeks ($r = .45$, $P < .005$) and at 1 year ($r = .54$, $P < .001$). Likewise, heavier children lost more weight than lighter children, at 16 weeks ($r = .62$, $P < .001$) and at 1 year ($r = .31$, $P < .07$). However, age and initial weight were highly correlated ($r = .37$, $P < .02$). These findings might suggest that older children lost more than younger children simply because they weighed more. However, independent associations of age and initial weight are possible because of their correlations with percentage overweight. Age was correlated significantly with change in percentage overweight at 1 year ($r = .35$, $P < .04$) but not at 16 weeks ($r = .21$, NS). Initial weight was also associated with decrease in percentage overweight, both at 16 weeks ($r = .57$, $P < .001$) and at 1 year ($r = .35$, $P < .04$). Older children and heavier children tended to have greatest reductions in their degree of obesity.

Changes in Mothers' Weight

Weight was obtained on mothers in the Mother-Child Separately and Mother-Child Together groups. The mothers in the two groups did not differ in initial weight, in initial percentage overweight, or in changes in these measures. Accordingly, their weights were grouped together.

Mothers lost 3.9 kg and decreased in their percentage overweight by 6.5%. The correlations between mother and child changes in weight and percentage overweight were not significant at the end of treatment or at follow-up. When changes in mothers' weight were entered as a covariate into the analyses for changes in children's weight, there were no significant effects for mothers' weight. Changes in mothers' weight accounted for little of the variance in changes in children's weight. These results might have been anticipated because not all mothers were obese and so could not be expected to lose weight.

The mothers were divided into those more than and less than 30% overweight. The former group averaged 63.7% overweight and the latter group averaged 15.4% overweight. There was a nonsignificant trend for the obese mothers (n = 14) to lose more weight (−4.5 kg) than the nonobese mothers (n = 12) (−2.9 kg), and to show greater reductions in percentage overweight (−7.9% *v* −4.7%). For the obese mothers and their children, there were no significant correlations between initial weights of mothers and children, or between changes in weight or percentage overweight for mothers and children at either 16 weeks or 1 year. Similar results were found for nonobese mothers and their children.

Correlations were also computed to evaluate whether weights for mother and child were related differently in the Mother-Child Separately and the Mother-Child Together groups. The correlations between initial weights and between weight changes for mothers and children were weak and nonsignificant in both groups, even though the involvement of the mothers led to far greater losses among the children in the Mother-Child Separately group.

Blood Pressure

Children in the three conditions did not differ in initial blood pressures. Because the experimental manipulation in this study (parent involvement) would not be expected to influence blood pressure aside from its effect on weight, the data for the three groups were combined to yield information from the total sample.

The most obese children had the highest blood pressures. Initial weight was correlated with initial systolic ($r = .64$, $P < .0001$) and diastolic ($r = .34$, $P < 0.03$) blood pressures. Similarly, initial per-

centage overweight was correlated significantly with initial systolic ($r = .64$, $P < .001$) and diastolic ($r = .41$, $P < .008$) blood pressures.

Blood pressure reductions during treatment were largest for children with the highest initial pressures (Figs 3 and 4). The children with the highest pressures initially had large reductions in pressure during treatment, and they were also successful in maintaining the losses. There were 12 children with initial systolic pressures greater than 130 mm Hg (mean = 145.8 mm Hg). At the end of treatment, the systolic pressures of these children decreased 16.1 mm Hg, and the pressures of 6/12 children were less than 130 mm Hg. The 1-year follow-up of 7/12 children showed a reduction 17.3 mm Hg in systolic pressure, and the pressure of four of these children was less than 130 mm Hg. Sixteen children had initial diastolic pressures greater than 80 mm Hg (mean = 85.3 mm Hg). The mean reduction at the end of treatment was 9.4 mm Hg, and 12/16 children had pressure less than 80 mm Hg. The 1 year follow-up of 11 of these children showed a mean decrease of 4.6 mm Hg, and 5/11 had pressure less than 80 mm Hg.

Blood pressures at the beginning and end of treatment for individual children in the entire sample (N = 37) are shown in Figs 3 and 4. Systolic blood pressure decreased in 30/37 (81%) of the children and diastolic pressure decreased in 26 (70%). At the end of treatment, systolic pressure had decreased by 10.8 mm Hg (t, 36 = 4.8, $P <$ .0001) and diastolic by 5.2 mm Hg (t, 36 = 7.4, $P <$ .0001). At the 1-year follow-up, the net changes from base line were −1.9/−1.2 mm Hg.

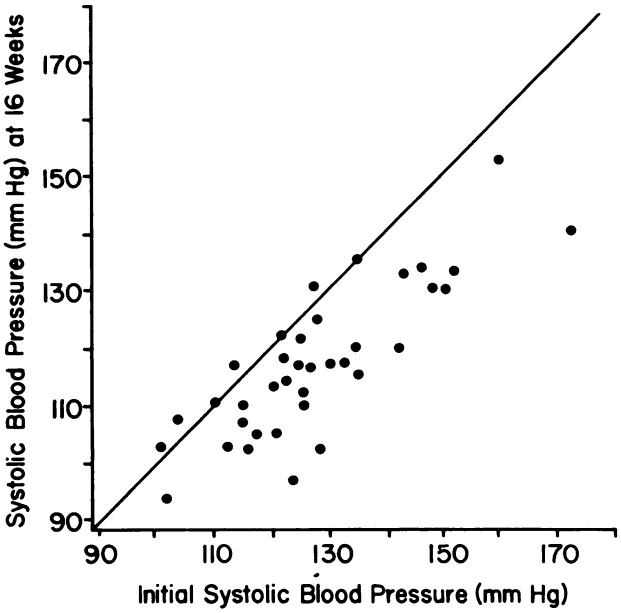

Fig 3. Initial systolic blood pressure plotted against systolic blood pressure after treatment for individual subjects. Points below diagonal line reflect decreases in blood pressure during treatment.

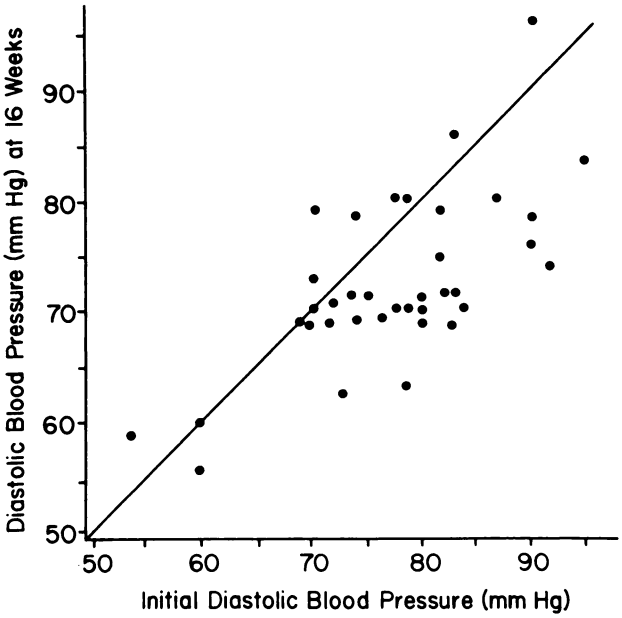

Fig 4. Initial diastolic blood pressure plotted against diastolic blood pressure after treatment for individual subjects. Points below diagonal line reflect decreases in blood pressure during treatment.

At both 16 weeks and 1 year, weight changes were related to systolic pressure but not to diastolic pressure. As the children lost weight, blood pressure tended to decline, and then as some of the children regained the lost weight, their pressures tended to increase. The correlations between change in weight and change in systolic pressure were .30 ($P < .07$) at 16 weeks and .42 ($P < .04$) at 1 year. The correlations between changes in percentage overweight and change in systolic pressure were similar. Decreases in diastolic pressure were not correlated significantly with changes in weight, even though systolic and diastolic pressures were correlated with each other ($r = .45$), $P < .004$).

DISCUSSION

There are four primary findings in this study: (1) the nature of parent involvement may be as important as its presence or absence; (2) a behavioral program with involvement of mothers can produce large weight losses and can sustain the losses for as long as 1 year after treatment; (3) weight changes in the children are not associated with weight changes in their mothers; and (4) weight losses in obese adolescents are associated with significant decreases in blood pressure, particularly in children with the highest initial blood pressures.

Children whose mothers were involved in treatment, but who attended sessions separately from their mothers, lost significantly more weight than

children who met in sessions with their mothers or children whose mothers were not involved in treatment. The advantage of the Mother-Child Separately condition began to occur during treatment, and increased during the 1-year follow-up. Children in the Mother-Child Separately condition lost 7.7 kg after 1 year with a 20.5% decrease in percentage overweight. In contrast, the weights of children in the Mother-Child Together and Child Alone groups were above their base line levels 1 year after treatment, and those groups showed no significant change in their degree of obesity.

There are several possible reasons for the greater weight losses in the Mother-Child Separately group. First, children in the Child Alone group did not give their full attention to the therapist and were prone to disruptive behavior. The mothers' involvement in the other two groups seemed to make the children more responsive to the therapist. Second, mothers and children in the Mother-Child Together group were reluctant to voice negative feelings about the problems of dealing with each other. The Mother-Child Separately group allowed both parties to discuss sensitive issues. These findings are consistent with the predictions one would make from developmental psychology. Adolescents face the difficult task of seeking independence from the parents upon whom they are financially and emotionally dependent.[39] Too much independence (Child Alone group) may create aggressive reactions because of the lack of structure, and too much parental involvement (Mother-Child Together group) may not give the child the necessary sense of responsibility. Third, separate meetings for the mother and child allowed for more teaching related to adolescence. Fourth, it is possible that differences in group leaders could have contributed to differences among groups. However, this did not appear to be the case. It appears, therefore, that treating mothers and children separately has the advantages of: (1) providing training for both parents and children; (2) allowing free discussion by both parents and children; and (3) making the children more responsible and better controlled than if the parents do not participate.

Obese children do not lose weight easily. Starvation, anorectic drugs, nutrition counseling, exercise programs, and psychotherapy have been of limited value.[8,14-16] Recent studies indicate that behavior modification with children is a promising approach with some showing significant weight losses and good maintenance,[26-29] even though others show limited losses and poor maintenance[8,15,16]. In the present study, children in the Mother-Child Separately group lost 8.4 kg during treatment and 7.7 kg 1 year later. These losses are perhaps the largest achieved in any controlled trial of outpatient treatment of obese children, and suggest that a comprehensive program of behavior modification, nutrition education, exercise instruction, and social support can be an effective treatment for childhood obesity.

Common to the successful programs for overweight children is the utilization of the social support that exists in the child's environment. Furthermore, it appears that the nature of social support, as well as its presence or absence, may be important for children as well as for adults.[40-43] Epstein et al.[27,28] used contracting procedures to encourage children and parents to work together, and Coates and Thoresen[26] included some family training in their program. Brownell and Kaye,[29] in a school program, encouraged social support from parents, teachers, peers, and various school personnel. In the present study, behavior modification did not produce long-term weight loss unless parent involvement was structured in a specific fashion.

Studies with obese adults and their spouses, and with obese children and their parents, generally show strong relationships between weight losses in the patients and their family members. Brownell and Stunkard[41] found that patients with obese spouses lost more weight than did patients with thin spouses, and that the obese spouses lost as much weight as the patients, even though the spouses did not enroll to lose weight. Epstein and colleagues[28] found a strong relationship between weight loss in children and loss in their mothers during initial treatment, but not during a follow-up. Another study by the same group[27] found such a relationship in a behavior modification condition but not a nutrition education group. It is surprising, therefore, that the present study showed that changes in childrens' weight were not related to changes in mothers' weight. It is also surprising in view of the fact that the character of the parent involvement had a powerful effect on weight loss in the children. These results may be due, in part, to the fact that there was no effort to induce mothers to lose weight, or results may be due to the special nature of mother-child interactions that occur during adolescence. Weight loss in the mothers may not motivate the children at this age.

An important benefit of weight reduction in children may be decreased blood pressure. A strong positive association between degree of obesity and blood pressure has been found, not only among adults,[44] but also among children, based on the Muscatine,[5,45,46] Bogalusa,[47-49] and Evans County[50] studies. Elevated blood pressure in children tends to persist during childhood,[46,51] and there is evidence that adult blood pressure patterns can be

predicted from childhood patterns.[52,53]

It has recently been proposed that weight loss may be the best means of blood pressure reduction in both adults[54,55] and children.[46,49,56] Among adults weight gain has been correlated with increased blood pressure,[57-59] and weight loss has been related to decreased blood pressure.[44,54,55,60] The Muscatine study[45] reported that some children who lost weight also showed decreased blood pressure. The present study confirms and extends these findings.

The blood pressure changes in this study were large and well maintained among children with the highest initial blood pressures. The children with initial systolic pressures greater than 130 mm Hg showed reductions of 16.1 mm Hg after treatment and 17.3 mm Hg at 1-year follow-up. The children with initial diastolic pressures greater than 80 mm Hg decreased by 9.4 mm Hg during treatment and 4.6 mm Hg at follow-up. Changes in systolic pressure were correlated significantly with weight changes, but changes in diastolic pressure were not.

There are three noteworthy aspects of the blood pressure changes in this study. First, the declines in systolic and diastolic pressure were large and enduring. Second, among children with the highest initial pressure, changes in systolic pressure were larger than those in diastolic pressure. Inasmuch as systolic pressure is a predictor of coronary disease in adults,[61] and as elevations in childhood blood pressure tend to persist into adult life,[52,53] these reductions may help to prevent coronary disease as well as hypertension. Third, initial weight and weight change were related more strongly to systolic pressure than to diastolic pressure. Perhaps this difference occurs because excess weight is related more strongly to cardiac output than it is to peripheral resistance. If so, weight loss should reduce cardiac output and systolic pressure more than it reduces peripheral resistance and diastolic pressure. Future research should be directed toward elucidating the mechanism of blood pressure reduction by weight loss.

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