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A Comparison of Lifestyle Exercise, Aerobic Exercise, and Calisthenics on Weight Loss in Obese Children

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Previous research has shown that lifestyle exercise is superior to programmed aerobic exercise programs for the long-term treatment of childhood obesity. The present study is designed to evaluate the reliability of this finding, with the addition of a low-intensity calisthenics group to control for nonspecific aspects of participating in an exercise program. Results showed similar and significant weight changes across the exercise conditions during the year of treatment for parents and children. However, during the next year of observation, children in the lifestyle group maintained their weight change, while children in the other two groups gained significant amounts of weight. Similar trends were observed for parents. The results for children replicate the positive effects of lifestyle exercise on child weight control.

The comprehensive treatment of childhood obesity involves the combination of a diet and an exercise program (Wing & Jeffery, 1979). Exercise is designed to increase caloric expenditure, thus increasing the degree of negative energy balance, and accelerating the rate of weight loss. The combination of diet and aerobic exercise (Dahlkoetter, Callahan, & Linton, 1979) or diet and lifestyle exercise (Epstein, Wing, Koeske, & Valoski, 1984; Stalonas, Johnson, & Christ, 1978) has been demonstrated to be superior to diet alone in three studies using adults, but was not shown to be superior in the one published comparison using children (Epstein et al., 1984).

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One major limitation of previous research on exercise and obesity has been the failure to include groups that control for the nonspecific aspects of exercise. Exercise programs that emphasize increased energy expenditure must be compared to a plausible, low expenditure exercise program in order to control for the nonspecific effects of being in an exercise program during weight control. This is particularly important because the effects of increased energy expenditure due to exercise are small compared to the effects of dieting (Epstein & Wing, 1980). These nonspecific effects cannot be examined in studies comparing exercise to nonexercise groups. Rather, a "placebo" exercise group is needed as regular exercise, independent of the caloric cost, may indirectly suppress eating by removing opportunities to eat or reducing appetite, or by increasing commitment to the diet part of the program (Epstein & Wing). Moreover, compliance to any treatment program, independent of the specifics of the treatment, may have direct effects on treatment endpoints. Compliance to active or placebo treatment has been shown to affect outcome for obesity, cancer, heart disease, alcoholism, and schizophrenia (see review by Epstein, 1984). Thus, it may be that the act of complying to the exercise, and not the specifics of the exercise program, exerts strong effects on factors that influence weight loss.

Despite the importance of exercise to weight control, little is known about the contribution of different types of exercise programs to treatment success. The major form of exercise that has been studied for weight loss is aerobic exercise, since aerobic exercise is associated with a greater rate of caloric expenditure than other types (Brownell & Stunkard, 1980). Aerobic exercise programs may be broken down into two categories. First, there are those that are *programmed* and involve regular bouts of exercise at intensities designed to improve cardiovascular fitness. Second, there are programs that involve integrating the exercise into the person's *lifestyle* without an emphasis on exercise intensity, by such things as walking or bicycling to work, walking up and down stairs or walking at lunch.

These two types of programs can be made isocaloric, and thus should produce equal effects on weight loss, but the programmed aerobic exercise should produce greater changes in fitness (Epstein, Wing, Koeske, Ossip, & Beck, 1982). Unfortunately, one trade-off for the improved fitness associated with aerobic exercise is its association with a decrease in adherence, presumably related to greater level of exercise intensity and work required (Epstein, Koeske, & Wing, 1984). Previous research has shown isocaloric programmed and lifestyle exercise programs are associated with equal weight changes at 2 months, but that superior fitness changes are produced by programmed aerobic exercise. However, lifestyle exercise has been associated with superior weight change at both 6 and 18 months (Epstein et al., 1982).

While the initial comparison of lifestyle and programmed exercise suggested that lifestyle programs may be better than programmed exercise for long-term weight control (Epstein et al., 1982), additional research is needed before lifestyle exercise can be promoted. First, the long-term superiority of lifestyle exercise must be replicated. Second, both lifestyle and aerobic exercise must be compared to a plausible, no-treatment control group. The present study is designed to assess the reliability of the effects of diet plus lifestyle versus diet plus programmed aerobic exercise over an extended two year observation interval. An active control group that was provided low-expenditure calisthenics exercises was included in the comparison to permit examination of the nonspecific effects of exercise.

METHODS

Subjects

Obese parents and children from 41 families were selected for participation in the study. The criteria for acceptance in the program included: (a) child between the ages of 8–12, (b) child and at least one participating parent > 20% over ideal weight for height, (c) parent and child showing no problems that would interfere with regular exercise. Complete data were available for 35 families, which represent 85% of the families beginning the study. The sample included 21 girls and 14 boys.

Procedure

After baseline screening of interested subjects, those that met the above criteria were selected and randomized into one of three groups, diet plus programmed aerobic exercise ($N = 13$), diet plus lifestyle exercise ($N = 12$), and diet plus calisthenic exercise ($N = 10$). Families assigned to each of these programs were seen weekly for 8 sessions, monthly for an additional 10 sessions, and then were seen at 24 months for measurement. The general and specific components of each program follow.

Common Treatment Components

Diet. Each child and parent were provided a 1,200 kilocalorie diet, based on our traffic light diet (Epstein, Wing, & Valoski, in press). In this diet, foods are divided into five food groups (fruits and vegetables, grains, milk and dairy, high protein, and other) and coded according to colors of the traffic light. Green foods (GO) are those that are less than 20 kilocalories per average serving, and can be eaten as much as desired. Yellow foods (CAUTION) are those within 20 calories of the average value for foods within their food group, and Red foods (STOP) are those at least 20 calories greater than the average food within their food group. Examples of the foods, and nutrient intakes for children aged 1–6 and 8–12 who followed this diet have been presented elsewhere (Epstein et al., in press). During treatment, children and parents kept daily food records which were used to provide feedback on caloric intake and nutritional balance. Once children had lost to within 10% of their ideal weight, they were placed on a maintenance program, in which caloric intakes were increased by 100 calorie increments as long as weight was maintained. Parents were provided growth charts to evaluate their child's height and weight progress.

Exercise programs. The aerobic exercise program was a walk, run, bicycle or swim program, based on the family's preference. The parents and children were to exercise three times per week beginning at one mile of walking or running, two miles of bicycling or one-fourth mile of swimming, and advancing in regular intervals up to three miles of running or walking, six miles of bicycling, or three-fourth mile of swimming. Participants were instructed in heart rate monitoring, and trained to exercise at 60%–75% of their age-adjusted maximal heart rate.

The lifestyle exercise program was designed to be isocaloric to the aerobic exercise program, although the subjects were allowed to choose exercises or activities from an exercise menu, and were not instructed to exercise at a particular intensity. Thus, while the programmed aerobic exercise subjects might run for a mile in the evening at aerobic intensity, the lifestyle subjects might walk one-half mile back and forth from school. Subjects could not count exercises that they had been doing before they began the program, or exercises that were part of the school gym program.

The calisthenics program involved having subjects perform 6 of 12 calisthenics three times per week. The repetitions for each exercise were increased in intervals similar to those used for the programmed exercise group.[1] The caloric expenditure for the calisthenics used was assessed by having two research assistants perform the exercises, with the energy expenditure obtained during the exercise by indirect calorimetry (McArdle, Katch, & Katch, 1981). The expenditure for the six most intense exercises done at the maximal number of repetitions was approximately one-third the expenditure for the first level of aerobic or lifestyle exercise.

Behavioral components. Four behavioral procedures were used to influence behavior change, self-monitoring, modeling, contingency contracting and parent management. Self-monitoring involved having parents and children record their caloric intake and exercise behavior in small "habit books." At the end of each day, the total amounts of each were transferred to a summary sheet in the back of the habit book. Modeling involved teaching the parents and children the importance of each setting a good example for one another. Contingency contracting for the parents required the deposit of $85.00 which was returned to them for attendance as follows: $15 for attending six of the seven treatment meetings, $5 for attending eight of the monthly meetings, and $15 for attending the 6-month and the 12-month measurements. Parent management involved instructing the parents in the use of modeling and reinforcement for child behavior change and maintenance of behavior. Parents were taught to

[1] The twelve calisthenics, with the beginning number of repetitions provided in parentheses, were: 1) Around the world—placing hands on hips and bending to the side, forwards, to the side, and backwards (10); 2) sit-ups (4); 3) jumping jacks (10); 4) toe touches (10), 5) knee push-ups (4); 6) sitting toe touches (10); 7) walking on hips—sitting on the floor and "walking" by moving the buttocks (10); 8) arm circles (10); 9) knee-chest lifts (10); 10) bicycle in the air (10); 11) touch three places—toe touches to the right, in front of and to the left of the body (10); and 12) leg raises (5).

administer a structured incentive system to promote behavior change. Children were reinforced for adherence to the diet and one of three exercise programs. At the first treatment meeting, parents checked reinforcers that would be acceptable to them from a reinforcement menu that included activities and privileges, but not food or material reinforcers. The children then divided the potential reinforcers into three categories which were assigned three different point values. Children earned points each week for adherence to the diet and exercise parts of the program. After approximately 6 months (dependent on the child's performance) on the system, the parents were encouraged to fade out the point system and utilize social reinforcement to regulate child eating and exercise behavior.

Compliance to the program was reinforced as follows: children earned seven points per week for staying under the calorie limit of 1,200 calories, six points per week for meeting the exercise goal, and two bonus points per week for eating four or fewer red foods. The point values were set up so that perfect adherence for 1, 2, or 3 weeks would earn enough points for the three levels of reinforcers.

Measurement

Height was measured on a laboratory constructed height board, calibrated in one-eighth inch intervals. Weight was measured on a balance beam scale, zeroed daily. Percent overweight was established in reference to ideal weight for height, age and sex (Metropolitan Life Insurance Company, 1959; Robinson, 1968). Body mass index was calculated according to the following formula: kg/m^2.

Physical work capacity was assessed at baseline, 2, 6 and 12 months for parents and children using a graded bicycle ergometry test in which the subject worked for 3 min at a workload, with the workloads increasing at 3-min intervals. The workloads began at 150 kpm, and increased in 150 kpm increments for the children and mothers, and began at 300 kpm and increased in 300 kpm increments for the fathers. The heart rate during the last min (steady state heart rate) at each workload was entered into a linear regression equation to predict the amount of work the subject could do at 150 beats per min (PWC_{150}).

Eating behavior was measured at baseline, 6 and 12 months by use of a standardized inventory of eating behaviors (Eating Behavior Inventory, EBI; O'Neil, Currey, Hirsch, Malcolm, Sexauer, Riddle, & Taylor, 1979). During the initial 8 weeks of treatment, compliance to three aspects of the program, eating (keeping below 1,200 calories per day), exercise (the number of weeks in which the exercise goal was met) and self-recording (the mean number of days per week that recording was complete) were assessed by review of the daily habit record books.

Methods of Analysis

Changes in weight and percent overweight for the three groups over time were analyzed by analysis of covariance procedures with baseline values as the covariate. Dunn multiple comparison tests were used to

TABLE 1
WEIGHT AND RELATIVE WEIGHT CHANGES FOR CHILDREN AND PARENTS IN THE PROGRAMMED, LIFESTYLE, AND CALISTHENICS GROUPS

	I Programmed aerobic	II Lifestyle	III Calisthenics	p
		Children		
Percent Overweight				
0	47.8 (15.2)	48.3 (17.2)	48.0 (23.2)	NS
2	37.0 (14.8)	35.5 (15.8)	37.2 (27.0)	NS
6	30.4 (13.1)	28.7 (20.9)	27.3 (26.7)	NS
12	31.5 (15.4)	32.2 (21.3)	30.5 (26.0)	NS
24	41.0 (17.5)	30.3 (24.3)	40.8 (27.0)	<.05 II < I, III
Weight				
0	123.9 (22.2)	124.0 (25.1)	123.9 (37.1)	NS
2	116.5 (21.6)	115.2 (24.4)	116.5 (37.4)	NS
6	114.0 (20.8)	112.7 (26.2)	116.5 (38.6)	NS
12	126.3 (26.7)	121.7 (24.2)	121.6 (40.5)	NS
24	150.2 (32.8)	133.5 (26.8)	148.7 (47.3)	<.05 II < I, III
		Parents		
Percent Overweight				
0	49.6 (17.9)	50.0 (21.3)	50.2 (12.2)	NS
2	40.9 (18.3)	40.2 (22.5)	42.5 (9.9)	NS
6	36.7 (19.5)	35.0 (24.5)	38.8 (12.9)	NS
12	39.6 (22.6)	38.0 (27.1)	43.8 (17.7)	NS
24	48.9 (24.9)	42.5 (25.9)	47.1 (21.3)	<.10
Weight				
0	211.4 (31.8)	211.3 (40.4)	211.5 (35.0)	NS
2	199.4 (29.6)	198.6 (41.2)	199.5 (28.1)	NS
6	193.1 (31.5)	191.2 (44.2)	193.2 (27.8)	NS
12	197.7 (35.2)	195.9 (45.8)	201.1 (37.9)	NS
24	210.2 (36.1)	200.8 (43.1)	206.4 (41.3)	<.10

Note. Standard deviations in parentheses.

compare the adjusted means. Pearson product moment correlation coefficients were used to relate parent with child changes across the various time periods, and compliance with weight change during treatment. Finally, relative weight and weight change at 12 and 24 months was predicted using multivariate linear regression procedures.

RESULTS

Treatment Differences

The adjusted absolute weight and percent overweight for children and their parents at 0, 2, 6, 12 and 24 months are shown in Table 1. The child results showed significant ($p < .05$) differences between the three

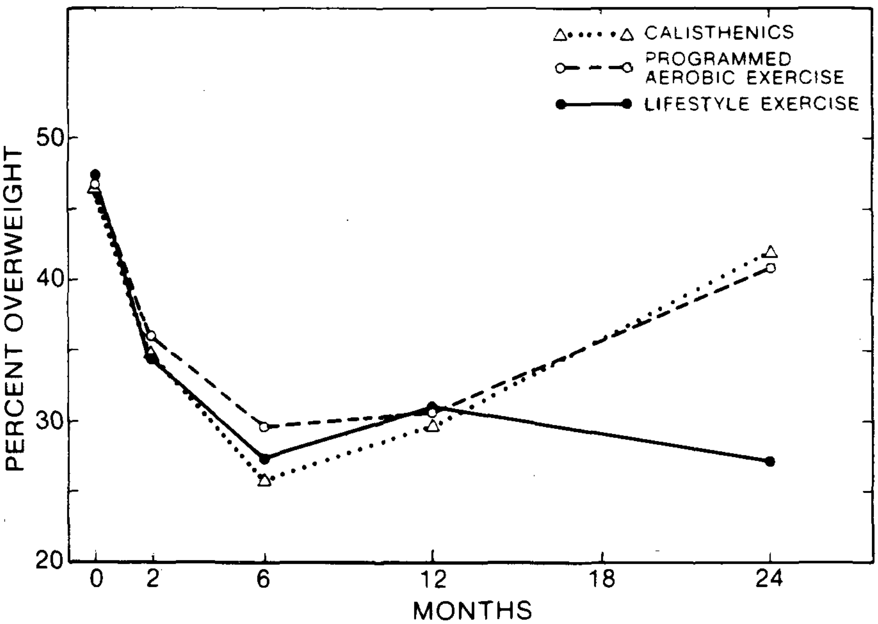

FIG. 1. Percent overweight for children in the three groups at 0, 2, 6, 12, and 24 months.

groups only at the 2-year follow-up. Significant decreases in percent overweight were observed for all three groups from 0 to 2, 6, and 12 months. At month 24, the lifestyle group had maintained relative weight changes, while the other two groups had returned to baseline levels. Absolute weight showed a similar pattern, with equal treatment effects shown for all groups up to 12 months. Over the 24-month study, subjects in the lifestyle group had gained 10 pounds, while subjects in the other two groups had gained over twice that amount.

Parents also showed significant ($p < .05$) decreases from baseline to 2, 6, or 12 months. However, significant differences were not shown for parent percent overweight or weight across groups at month 24, though a similar pattern for the children was observed, with better long-term changes for the parents in the lifestyle group.

Fitness data were available for 29 of the 35 children at baseline, 2, 6 and 12 months. No significant improvements in fitness were observed for children after 2 months. After 6 months children in the lifestyle group showed significant ($p < .05$) improvement in fitness from pre (407.3 ± 186.7) to 6 months (515.0 ± 205.5), but they returned to baseline levels of fitness at 1 year (440.7 ± 131.3). Children in the aerobic exercise group were the only subjects to show significant ($p < .05$) effects at 1 year (394.3 ± 154.3 to 517.0 ± 153.9). No changes in fitness were observed for children in the calisthenics group. Parent fitness data, available for 18 parents at 6 months and 15 parents at 12 months, showed no improvements in fitness at any measurement.

Children showed significantly ($p < .001$) improved eating behavior from pre to 6 months and 1 year, with no differences across groups. The average EBI went from 69.4 at baseline to 88.4 at 6 months and 86.1 at 1 year. Parents showed similar average improvements in eating behavior ($p < .01$), going from 68.8 at baseline to 93.8 at 6 months and 90.5 at 1 year. No differences were observed across groups.

The compliance results showed no differences during treatment across children or parents on the number of days per week below 1,200 calories, the number of weeks meeting the exercise goal, and the number of weeks that recording was complete. On the average across groups, children kept under 1,200 calories for 6 days of the week, met the exercise goal for 3.5 weeks, and recorded completely for 6.3 days per week. Parents kept under the calorie limit for 5.6 days per week, met the exercise goal for 2.9 weeks, and recorded completely for 5.7 days per week.

Compliance and BMI change during the first 8 weeks of treatment were related for exercise ($r = -.35, p < .05$) and recording ($r = -.69, p < .01$) for children, and for keeping below the calorie limit ($r = -.46, p < .01$), exercise ($r = -.44, p < .01$) and recording ($r = -.54, p < .01$) for parents.

Parent/Child Relationships

The relationship between parent and child relative weight (BMI) changes increased across time, with correlations of $r(33) = .31, p < .10$ from 0–6 months, $r(33) = .45, p < .01$ from months 6–12, and $r(33) = .49, p < .01$ from months 12–36. Parent and child treatment compliance were related for diet $r(28) = .49, p < .005$; exercise $r(25) = .61, p < .001$; and days recorded completely $r(28) = .51, p = .003$.

Prediction of Relative Weight at 12 and 24 Months

Multiple linear regression analyses were used to predict BMI at 12 and 24 months for the children and parents (Table 2). The predictors included initial BMI, BMI change from 0–6 months for the prediction of 12 month results and 0–12 months for prediction of 24 months, exercise group (since there were no differences in change between the aerobic and calisthenics groups, this variable was coded lifestyle/nonlifestyle exercise) age, sex, initial PWC_{150}, 6-month or 1-year change in PWC_{150}, initial EBI, 6-month or 1-year change in EBI, and diet and exercise compliance during treatment. The results showed that two variables predicted relative weight at 1 year for the children, initial BMI, and the amount of BMI change from baseline to 6 months. At 2 years initial BMI and type of exercise (lifestyle/nonlifestyle) were significant predictors. Parental relative weight at 1 year was predicted using initial relative weight, relative weight change from 0–6 months, and initial fitness. Finally, predictors of parent relative weight at 2 years were initial relative weight and relative weight change from 0–12 months. Each of the regression equations accounted for a large majority of the variance, with a range from 70% to 98.5%.

TABLE 2
PREDICTION OF RELATIVE WEIGHT AT 12 AND 24 MONTHS

Predictor	Multiple R	R squared	R^2 change	Beta weight	F change
			Children		
BMI at 12 months					
Pre BMI	.762	.581	.581	.762	<.001
BMI 0–6	.930	.865	.284	.535	<.001
BMI at 24 months					
Pre BMI	.617	.381	.381	.617	.011
Lifestyle Ex	.839	.704	.323	−.649	.002
			Parents		
BMI at 12 months					
Pre BMI	.948	.898	.898	.948	<.001
BMI 0–6	.987	.974	.076	.301	<.001
Pre PWC	.992	.985	.011	−.137	.034
BMI at 24 months					
Pre BMI	.929	.864	.864	.929	<.0001
BMI 0–12	.965	.932	.068	.275	.015

Note. Lifestyle ex refers to exercise group (lifestyle versus nonlifestyle).

DISCUSSION

The results of the present study replicate the long-term superiority of lifestyle exercise over programmed aerobic exercise for weight control in obese children for treatment intervals from 18 (Epstein et al., 1982) to 24 months (present study). The long-term superiority of lifestyle exercise over programmed aerobic exercise is likely to be due to the better long-term adherence associated with it. Difficulties in adherence to programmed aerobic exercise over time are well known (Martin & Dubbert, 1982). The effectiveness of lifestyle exercise should not be surprising, as children can easily incorporate lifestyle exercise into their daily life with less response cost than necessary for aerobic exercise.

Significant effects on weight were shown for children, but not adults, even though the direction of change across the three groups was similar for both parents and children. This may be due to one of two factors. First, since the program was designed for children, parents may have concentrated more on producing and maintaining habit change for their children than for themselves. Second, the three exercise groups may operate differently for adults and children. It may simply be more difficult for adults to maintain their exercise behavior than for children, or it may be that the exercise programs need to be different for parents and children (Epstein et al., 1984).

The similarity of weight changes across the three groups over the first

8 weeks of treatment may in part be related to similarities in adherence across the three programs. While the three groups were provided different programs, results showed that adherence to recording or to exercise were related to weight change regardless of the actual exercise performed. These results are consistent with the notion that the effects of exercise on weight are not due totally to the expenditure effects of exercise. Although the three groups differed in the amount of caloric expenditure prescribed, they did have similar self-monitoring and performance feedback, and similar short-term adherence. It may be that the short-term equality across groups was due to a main effect of compliance, independent of the content of the groups, as has been shown for a variety of other problems (Epstein & Cluss, 1982). Exercise is often reported in the popular press to be an important component of weight control, and the regular practice of exercise may have effects on eating that are not dependent on energy expenditure.

One major limitation in the present study was the absence of adherence data beyond the initial 8 weeks. While extended measures were not available, examination of the weight data suggests that similarities in adherence patterns may have persisted over the first year of observation. At the end of 2 years, the differential weight effects suggest differences in adherence to exercise. However, as we have previously stated (Epstein, Koeske, & Wing, 1984), end points such as weight or fitness change should not be used to estimate adherence. Thus, without independent measures of adherence to exercise, it is not possible to definitely attribute the differential weight change to exercise adherence.

Children in the lifestyle and aerobics exercise groups showed fitness improvements. The lifestyle group improved at 6 months, but was back to baseline at 1 year. The aerobics group showed a more delayed response, but had significant fitness improvements at 1 year. The pattern of fitness improvement observed in the present study is different from previous research (Epstein et al., 1982), which showed the superiority of aerobic compared to lifestyle exercise on fitness at 2 months, but no differences at 6 months. Since the aerobic exercise involved greater intensity exercise than lifestyle exercise or calisthenics, better fitness changes for the aerobic group would be expected at all measurements. The failure to show the predicted fitness effect in the present study may result from inadequate adherence to exercise across the three groups. Adults and children adhered to the exercise prescriptions less than one-half of the time during the first 8 weeks, suggesting low adherence rates to the exercise throughout. Adherence data throughout the 2 years of observation would have been useful to document adherence differences across groups, and to better understand the pattern of fitness change.

The regression analyses demonstrated the importance of both initial relative weight and relative weight change from 0 to 6 months in predicting child relative weight at 1 year. The effects of lifestyle exercise were significant at 2 years, in addition to initial relative weight for children. For parents, initial relative weight, relative weight change in the first 6 months of treatment and initial fitness were additional predictors of relative weight at 1 year. Initial fitness was positively related to weight change, so that parents who were more fit benefited more. Both initial relative weight and relative weight change from 0 to 12 months were significant predictors of parent relative weight at 2 years.

The results of the present study are consistent with the previous comparison of lifestyle and aerobic exercise (Epstein et al., 1982), but the time course of the changes were different. Previously, the superiority of lifestyle exercise was shown at 6 months (Epstein et al., 1982), while in the present study no differences were noted after the first year of treatment. There were several differences in the design of the studies that may account for the different pattern of results. First, the exercise expenditure per session and per week were greater in the first study (Epstein et al., 1982), which could account for the earlier appearance of between group differences. Exercise adherence is negatively related to expenditure (Epstein, Koeske, & Wing, 1984), so that the decreases in adherence to aerobic exercise and differences between aerobic and lifestyle exercise may have appeared earlier. Second, the present study had both children and their parents as treatment participants, while the initial study (Epstein et al., 1982) treated only the children. The additional support provided by parents in the present study may have been sufficient to improve the effects of dieting, the major influence on weight control (Epstein & Wing, 1980), which could counteract some of the problems in adherence for children in the aerobic program, or low expenditure in the calisthenics group, so that differences in weight took longer to appear.

In summary, these results suggest that lifestyle exercise shows a reliable superiority over programmed exercise in the maintenance of long-term weight losses in children. In addition, the comparability of short-term changes for all three exercise programs (lifestyle, programmed aerobics, and calisthenics) suggests that at least some of the efficacy of exercise in weight control results from nonspecific rather than specific (i.e., caloric expenditure) factors. Additional research on other beneficial effects of lifestyle exercise is needed, as is research on improving the adherence of obese persons to programmed aerobic exercise.

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