A Token Economy for Exercise Adherence in Pediatric Cystic Fibrosis: A Single-Subject Analysis*

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Objective In cystic fibrosis (CF), adherence to airway clearance techniques (e.g., chest physiotherapy and exercise) is poor. Exercise is important because pulmonary difficulties are associated with the highest mortality rate. Despite this, very little research has focused on exercise adherence in CF. This study examined a token economy for increasing exercise in children with CF. Methods An ABAB single-subject design evaluated a token economy for increasing and maintaining exercise in three children with CF. Patient report, parent report, and physiological measures were used to assess treatment integrity, medical stability, and changes in exercise. Results Measures suggested that treatment integrity was strong. Results indicated strong treatment effects for all participants without negative medical side effects. Follow-up of 1 and 3 months supported continued exercise for all participants. Conclusions A token economy effectively increased exercise in children with CF, and the single-subject design highlighted some of the intricacies of individualized treatment of adherence. Implications and recommendations for further research are discussed.

Key words adherence; cystic fibrosis; reversal design; single-case designs.

Cystic fibrosis (CF) is the most common lethal hereditary disease among Caucasians and affects 1 in 2,500 births in the United States. Approximately 30,000 individuals in the United States currently have CF. The life expectancy has risen in the past decade, and the estimate of the median life expectancy is ~36.9 years (Cystic Fibrosis Foundation Registry, 2006).

CF negatively impacts the functioning of several major organ systems, with the most serious effects occurring in the lungs and pancreas. Respiratory disease has been associated with the highest mortality rate in this population, accounting for 85–95% of deaths (Cystic Fibrosis Foundation Registry, 2006; Equi, Balfour-Lynn, Bush, & Rosenthal, 2002). In addition to lung disease, approximately 85–90% of individuals with CF are pancreatic insufficient, which ultimately leads to malnutrition (Dodge & Turck, 2006; Stark et al., 1995). The resultant malnutrition has been found to be associated with both decreased lung functioning (Borowitz, 1996; Milla, 2007) and recovery from bacterial infection (Dodge & Turck, 2006; Gurwitz, Carey, Francis, Crozier, & Levison, 1979; Kraemer, Rudeberg, Hadorn, & Rossi, 1978).

Given the high morbidity associated with pulmonary disease, prevention of lung disease progression through methods of clearing the airways of the abnormal mucus and suppression of bacterial accumulation is essential (e.g., Stenbit & Flume, 2008). There are a variety of airway clearance techniques used to remove excess mucus including chest physiotherapy (CPT), positive expiratory pressure therapy, inhalation therapy, high-frequency chest wall oscillation systems, and exercise (Marshall, Rosenfeld, & Ramsey, 2000; Stark et al., 1995; Yankaskas, Marshall, Sufian, Simon & Rodman, 2004). Exercise in particular has been identified as an excellent supplement to effective airway clearance techniques, such as CPT (Baldwin, Hill, Peckham, & Knox, 1994; Thomas, Cook, & Brooks, 1995). Further, studies of exercise have revealed additional benefits including weight gain and improved endurance (e.g., Alison et al., 1994; Cerny, Cropp, & Bye, 1984; Heijerman, 1993).
Hornick & Marks, 1998), mobility, muscle strength (Hornick & Marks, 1998), disease status (Edlund et al., 1986), and heightened self-esteem (Hornick & Marks, 1998). Regular exercise also has been found to preserve lung functioning (Moorcroft, Dodd, Morris & Webb, 2004; Schneiderman-Walker et al., 2000). A recent Cochrane review of the CF exercise literature concluded that although results were variable across studies and there are few randomized controlled trials, there is sufficient evidence to indicate that exercise has a positive impact on exercise capacity, lung function, and strength (Bradley & Moran, 2008).

Unfortunately, there are few studies examining adherence to exercise or other airway clearance methods for pediatric patients with CF (for a review, see Bernard & Cohen, 2004). In fact, a search of the literature revealed only two case studies using behavioral techniques to increase adherence to CPT and airway clearance (Hagopian & Thompson, 1999; Stark, Miller, Plienes, & Drabman, 1987) and no published studies of behavioral techniques to increase exercise in children with CF. Although there are no specific data regarding adherence to exercise in CF, research suggests that adherence to the complex and extensive treatment regimen for CF is poor (below 50%) (Modi et al., 2006). Barriers to adherence include forgetting, oppositional behavior, time management difficulties, side effects, and patient–provider miscommunication (Modi & Quittner, 2006). Self-report data suggest that patients with CF are more adherent with prescribed medications (e.g., Fong, Dales, & Tierney, 1990; Gudas, Koocher, & Wypij, 1991) than airway clearance (e.g., Fong et al., 1990; Gudas et al., 1991), which is problematic given that pulmonary functioning is the main determinant of survival (Walters, 2000). However, it should be noted that a recent study using a multimodal assessment of adherence found that self-report data inflated adherence rates, and more objective measures found that adherence to frequency of CPT was 51% and adherence to enzymes ranged from 27% to 43% (Modi et al., 2006).

Although there are no studies examining behavioral interventions for CF exercise adherence, there is a rich literature promoting exercise in other chronic illnesses. For example, behavioral techniques have proven effective for children managing diabetes (for a review, see Wysocki, 2006), and behavioral shaping and a token economy increased adherence to exercise in children and adolescents with hemophilia (Greenan-Fowler, Powell, & Varni, 1987). The most extensive evaluation of the use of behavioral techniques to increase exercise is with childhood obesity (for reviews, see Epstein, 2003; Jelalian & Saelens, 1999). For example, token economies have been found effective in increasing exercise (Epstein, Koeske, Zidansek, & Wing, 1983; Epstein, Wing, Koeske, Ossip, & Beck, 1982), and providing children exercise choices is beneficial (Epstein et al., 1982). In short, there is a strong body of literature supporting behavioral approaches for enhancing exercise in pediatric psychology.

The purpose of this single-subject design study was to examine the effect of a token economy behavioral intervention on increasing exercise adherence in children with CF. Consistent with past research with other pediatric populations (e.g., Epstein et al., 1982, 1983), it was predicted that the intervention would effectively increase the exercise behavior of the participants. The single-subject design provides a fine-grained examination of the effectiveness of interventions on target behaviors and variability in individuals, which is lost in group design studies. Thus, this approach should highlight some of the often missed details regarding adherence for CF exercise.

### Method

#### Participants

Inclusion criteria included the following: (a) school-aged child diagnosed with CF, (b) medically recommended exercise, (c) nonadherence to exercise despite standard efforts (e.g., encouragement by medical center staff and family), (d) current non–school-related exercise that was no more than two times per week for a maximum of 20 min each time, and (e) forced expiratory volume in 1 s [FEV1] falling in the mildly impaired range. Established ranges for illness severity are ≥70% for mild, 40–69% for moderate, and ≤39% for severe lung disease (Taussig, 1995). Past research has indicated that the majority of individuals with mild lung disease can exercise safely at the same intensity as their same-aged peers; however, individuals with more severe lung disease often require supplemental oxygen during exercise (e.g., Webb, Dodd, & Moorcraft, 1995).

Six patients met inclusion criteria, and five were approached to participate; 1 patient was not approached because the child did not attend scheduled medical appointments. Of the patients approached, two patients did not participate for the following reasons: one declined due to parental medical problems, and one child began the baseline phase of the study, but her parents refused to complete the exercise diaries and the participant subsequently had to be dropped from the study. Study participants included three female (two 12-year-olds and one 8-year-old), Caucasian, patients with CF receiving...
services in a rural medical center (CF Center). See Table I for additional demographic information.

### Design

A variant of the single-subject reversal (withdrawal) design, specifically the ABAB design, was used in this study. Two advantages of this design are that it provides two evaluations of the treatment compared to baseline and it ends on a treatment phase, which is important from a clinical standpoint (Rapoff & Stark, 2008). This design was selected because it allows for more definitive conclusions to be drawn about the effectiveness of the treatment in changing the target behavior than other single-subject approaches (Kazdin, 1998). Single-subject designs are a good choice when evaluating a new intervention; these data can be followed-up with larger scale group studies.

### Measures

#### Background Information

A background information form was completed by the parents and assessed child gender, child age, child race, parent age, parent and spouse education level, family income, and who lives at home with the child.

#### Exercise Exertion Criteria

The Children’s OMNI Scale of Perceived Exertion is a self-report measure of exercise exertion (Robertson et al., 2000) that was used to help ensure children and parents understood the expected level of aerobic exertion that qualified as “exercise.” The measure consists of a child self-report rating that ranges from 0 (“not tired at all”) to 10 (“very, very tired”), which allows children to rate their level of exertion for a variety of activity types and intensities (Robertson et al., 2000; Utter, Robertson, Nieman, & Kang, 2002). The particular criterion score that counted as “exercise” was determined by the physical therapist individually for each child, based on children’s self-report on the scale and therapist perception of exertion. The scale has been validated in children ranging from 8 to 12 years (Robertson et al., 2000; Utter et al., 2002). Psychometrics are sound. For example, researchers found that OMNI scores were correlated between .94 and .97 with another scale of perceived exertion (Lagally & Robertson, 2006).

#### Outcome Measure

Exercise diaries were used to track minutes of exercise per day. The child and parent(s) independently documented frequency, type, and duration of exercise during non-school hours. Additionally, parents recorded what occurred immediately after the child exercised, daily pedometer readings, and length of time the pedometer was worn. Children recorded exertion ratings on days when they engaged in exercise. During the treatment phases, the parents and children were also asked to record if the child received her small reward postexercise and if the child turned in points for a larger prize. The experimenter called the child and parent(s) approximately three times per week to collect diary information.

Exercise diary data served as the primary outcome measures (i.e., graphs of exercise across 2-day periods and average days exercised per week). Parents and children both provided separate diaries of children’s exercise duration. In the majority of instances, parent and child data were in agreement. When there was a discrepancy, the researcher attempted to clarify with the family to obtain the correct estimate. In the few instances where this was unsuccessful, parent report was used.

#### Integrity

A Sportline® pedometer was used to check exercise diary data by providing a gross measure (step-count totals) of the participant’s exercise and in turn verify that the child had increased activity. This study was designed to assess exercise during non-school hours; thus, children were instructed to wear the pedometer after school and on the weekends. Since the pedometers were worn for several hours each day, on days when exercise occurred, pedometer totals were expected to be only slightly higher. The pedometer measures and stores 7 days of information and allowed the experimenter to obtain the total weekly data directly from the device and compare these data with

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Note. *Pre* refers to the initial visit to the CF Center and “post” is just after the end of data collection for the return to treatment phase.
the exercise diary data. The pedometer has demonstrated adequate validity when compared to actual steps and actual distance (e.g., Crouter, Schneider, Karabulut & Bassett, 2003) and good reliability (e.g., Cronbach’s alpha > .99; Schneider, Crouter, Lukajic, & Bassett, 2003).

To examine treatment integrity during the reversal phase, at the end of the phase, the experimenter asked the parents, “During the past two weeks, did you ever inadvertently reward your child for exercise?” Children were asked, “During the past two weeks, did your parents give you any rewards for exercise?”

Medical Monitoring
In order to ensure that participants did not lose significant weight as a result of the increase in exercise, body mass index (BMI) and skin fold body fat indices were measured at the initial visit to the CF Center (pre) and just after the end of data collection for the return to treatment phase (post).

Procedure
The exercise diary data were used to determine when study phase changes were made. The specific criteria were the following: (a) there were three or more stable data points, (b) there was a predictable pattern in the data, or (c) there was no pattern, but the data points were predictably random.

Baseline Phase
The baseline phase of the study began with an initial visit to the CF Center. The experimenter met with the child and parent(s) to explain the procedures of the study and obtain informed consent and child assent. They were given brief definitions of the type of exercise targeted in this study (i.e., exercise during which the child’s rating on the Children’s OMNI Scale of Perceived Exertion matches or exceeds the recommendation made by the physical therapist) and explanations about how to complete the exercise diaries and properly use the pedometer. Also, parents and children were provided a list of types of activities that qualified as exercise. This list was created on a case-by-case basis by the physical therapist at the CF Center. Qualifying activities required continuous (e.g., soccer, dancing) instead of intermittent movement (e.g., baseball, golf). Additionally, parents and children were informed that all families that completed the study would be entered in a drawing for a $100 cash prize.

The researcher administered the background information form, the nurse obtained the participant’s height and weight (which were subsequently used to calculate BMI), and the physical therapist assessed skin fold body fat percentage. At this time, the physical therapist determined the appropriate exertion rating for exercise sessions for each child, and the researcher subsequently explained how to use the Children’s OMNI Scale of Perceived Exertion.

Treatment Phase
Treatment consisted of two parts: training and implementation. During training, the experimenter went to the child’s home for three 2-hr sessions. The first hour of the first session consisted of training the parent(s) to set up a token economy to reinforce the child’s exercise behavior. The target exercise amount was approximately four times per week for 20 min. Both the child and parent(s) participated in the session. The token economy was designed so that the child earned a small, immediate reward (e.g., special snack, small amount of money) each time the child exercised. Specifically, after completion of an exercise session, children pulled one prize out of a grab bag that contained approximately 10 different types of small rewards. The grab bag was used to help build anticipation and make the prize more rewarding. Also, the child was able to earn a point for each 10 min of exercise that could be exchanged for larger prizes. The list of prizes generated by the child, parent(s), and experimenter consisted of concrete items that were well defined and difficult for the child to satiate on (e.g., staying up for 30 min past their bedtime, playing their favorite game with their parent(s) for 20 min, going to see one movie that the child chooses). Although specific reward point levels varied by participant, the typical lowest prize level was set at 4 points, the equivalent of half of the target exercise quota for the week. Larger prizes were offered for about 8 points, the equivalent of 1 week of exercising at the target level. The child also had the option to save and pool her points to cash in for larger prizes.1

During the second hour, the experimenter met with the child to teach her how to properly exercise to ensure that she was exercising at the appropriate level. This was done in a standardized fashion across subjects and included instructions in stretching pre- and postexercise. Each child was provided an age-appropriate exercise tape [TAEO® Junior (Volume 1)] with a 20-min exercise program, which the experimenter helped the child learn to perform correctly in order to reach the appropriate exercise level. The Children’s OMNI Scale of Perceived Exertion was used to measure the child’s exercise level, and the experimenter helped the parent(s) use the token economy system.

1 A copy of the manual containing additional information about the token economy system can be obtained from the authors.
reinforcement system. Finally, it was explained that the child could choose to use the exercise tape or any other activities on the previously mentioned list of appropriate exercises as long as the child exercised every other day (approximately four times per week) for at least 30-min sessions (5 min of preexercise stretching, 20 min of exercise, and 5 min of postexercise stretching).

During the second 2-hr session, the experimenter provided the parent(s) and child information about proper diet for children with CF. Because an increase in exercise causes increased calorie expenditure, the purpose of this session was to ensure that the parent(s) and child were aware of the proper diet given the increased calorie expenditure. The contents of this 1-hr session were provided by a nutritionist at the CF Center. During the second hour, the experimenter met with the child to practice the exercise routine and observed the parent(s) implementing the token economy and corrected any errors.

During the third 2-hr session, the experimenter met with the parent(s) and child for ~1 hr to discuss any problems encountered with the token economy and problem solve with the family about how to rectify them. A pamphlet created by the experimenter was provided to the parent(s) about common problems encountered with token economies (e.g., diminished motivation in prizes, using the system during vacations). During the second hour, the experimenter met with the child and observed the child perform an exercise that the child chose from the list of approved exercises. This provided some evidence that the child could generalize the correct level of exercise across types of exercise. It also provided some flexibility to the child in selecting an exercise the child enjoyed and might be more likely to do consistently, which adds to the external validity of the study. Using, the OMNI scale, the experimenter checked that the child was exercising at the appropriate level.

The implementation part of the treatment phase was designed to determine whether the intervention effectively increased the child’s quantity of exercise. Additionally, it provided some evidence of the ability of the parent(s) and child to use the token economy system. It should be noted that although the token economy was the key feature of the intervention, social reinforcement, expectations, framing, education, monitoring, attention, feedback, and other behavioral components are part of this token economy system.

Reversal Phase
During this phase, the experimenter went to the participants’ homes and removed the token economy and the pamphlet about problems associated with the token economies. A rationale for the return to baseline was provided. Specifically, parents were told that it is important to see if the token economy was necessary for the child to continue exercising. The parent(s) were instructed to return to their typical behavior before the token economy was introduced (e.g., no prizes for exercising). Children were informed that points would not be earned and prizes would no longer be given for exercise; however, children were permitted to spend any points they had already earned.

Return to Treatment Phase
During this phase, the token economy materials were returned, and the parent(s) were instructed to begin using the system again. If the parent(s) or children inquired about problems encountered with the token economy during the triweekly experimenter phone calls, they were encouraged to do their best on their own and that the experimenter was not permitted to provide assistance. The rationale for this was to encourage self-sufficiency with the program in the hopes that it would lead to better long-term success. At the end of this phase, children returned to the CF Center, and the child’s BMI and skin fold body fat were measured by the appropriate staff.

Follow-up
One-month and three-month follow-ups were conducted by collecting exercise data for 2–4 weeks at each time point. Data collection was conducted in the same manner as during the treatment phases of the study.

Results
Integrity
Despite problems with the pedometers including parents forgetting to write down the reading, children forgetting to wear the pedometer, and the pedometer breaking (broken pedometers were replaced within 2 days), the majority (73%) of the daily readings across phases were recorded. To compare the pedometer readings across phases, the average daily miles per hour was calculated for each phase. Pedometer readings for the return to treatment phase for Participant 3 were not used because the child frequently chose to participate in activities that the pedometer was not designed to record (e.g., swimming), making readings inaccurate. All three participants demonstrated a higher average daily pedometer reading during the treatment phases than the baseline phases, which was consistent with exercising more during treatment conditions than during baseline conditions. When the experimenter assessed the reliability of the parents’ and child’s reporting
of the pedometer readings by accessing the stored information and comparing it to the reported pedometer readings, the stored information matched the parent/child diary report within 0.1 miles for all three participants, indicating accurate reporting.

To ensure that parents were not rewarding exercise during reversal, this variable was assessed at the end of the reversal phase. For all three participants, parent and child verbally denied that the child received immediate or delayed rewards for exercise performed during the reversal phase.

**Treatment Effects**

**Participant 1**

Prior to beginning the study, the mother reported that the participant did not exercise at all. The baseline phase was 18 days, and the participant completed almost no exercise during this time, exercising only once and for only 10 min. During the training phase, the participant exercised at the appropriate level, and she exercised relatively consistently during the second part of the treatment phase. Her number of minutes exercised dropped to zero on two occasions, first due to illness and second due to choosing not to exercise. She then returned to exercising consistently at the prescribed level. During the reversal phase, she exercised more than she did in the baseline phase, but less than in the treatment phase. On one occasion, the patient went for a 2-hr hike with her friend’s family, which accounts for the outlying data point. When the return to treatment phase was implemented, the participant’s mother adjusted the prizes for the token economy, and the participant’s exercise increased and was highest during this phase (Fig. 1).

**Participant 2**

Participant 2 demonstrated very little exercise during the baseline phase, exercising only one time over a period of 12 days. During the training phase, she exercised above the expected level. She then consistently exercised for 2.5 weeks at the prescribed level. During the reversal phase, she returned to her baseline level of exercise. Finally, in the return to treatment phase, the participant again began exercising at the prescribed amount. In fact, over a period of 20 days, she only missed one prescribed exercise session (Fig. 2).

**Participant 3**

Participant 3 attended a weekly dance class throughout the baseline and treatment phases, but not during the reversal and return to treatment phases due to the class ending. The dance class accounts for the single day of exercise each week during the 26 days of the baseline phase.
Compared to the baseline phase, the participant increased her frequency of exercise during the implementation part of the treatment phase. However, the amount of exercise completed varied. Some variation was expected due to the fact that the participant was enrolled in the weekly dance class. There were also two occasions over the 26-day period when the participant did not exercise at all. On one of these occasions, the child was too ill to exercise. During the reversal phase, the participant completed no exercise. In the return to treatment phase, the participant’s exercise increased significantly. During the 18-day period, the participant only missed one exercise session and primarily exercised well above the prescribed amount (Fig. 3).

### Average Days Exercised Per Week

Data also were analyzed by calculating the mean number of days exercised per week for each phase of the study. A bar graph was created to demonstrate changes across phases (Fig. 4). Days when the child exercised were defined as days when the child exercised for at least 10 min. If the child exercised at the prescribed level, every other day, the average days exercised per week would be 3.5 days. All participants had higher frequency of days exercised during the treatment phases.

### Medical Monitoring

For all three participants, BMI and fat percentage did not change significantly from baseline to conclusion of the study (Table I).

### Follow-up

All three participants demonstrated higher levels of exercise at the 1- and 3-month follow-ups than at baseline. Participants 2 and 3 had increased exercise fairly significantly although with notable variability in duration of exercise. Participant 1 exercised the least of the three participants. It should be noted that she experienced a pulmonary exacerbation just prior to her 1-month follow-up, was healthy for about 1 week, and then was hospitalized so the follow-up was ended. Her 3-month data were difficult to interpret because she went on a school trip where she was active but exercise was not recorded. Of note, she was just beginning a dance class at the end of the 3-month follow-up.

### Discussion

The primary objective of this study was to assess the efficacy of a token economy reinforcement system on increasing exercise in children with CF. Results suggest that token
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...economies are an effective technique to increase exercise in children with CF. This is consistent with past studies supporting token economies for increasing exercise in other chronic populations (e.g., obesity; Epstein et al., 1982, 1983), as well as token economies for other CF adherence issues (e.g., diet; Stark, Bowen, Tyc, Evans, & Passero, 1990).

Of the three participants, Participant 2 most strongly demonstrated the effectiveness of the token economy. This participant consistently exercised every other day when the token economy was in place and consistently did not exercise when the intervention was not being used. Participant 1 also consistently exercised during the treatment phase and consistently did not exercise during the baseline and reversal phases; however, her exercise during the return to treatment phase was significantly higher than during the initial treatment phase. The increase in exercise coincided with the parent changing the rewards. Although this change could be viewed as a change in one of the study variables, it actually represents how the token economy is best used in practice. In order for a token economy to be effective, the individual must be motivated by the rewards (Barkley, 1987), and as part of the training for the token economy, parents were instructed to develop a new prize list with their child if she no longer seemed motivated by the current rewards. The increase in amount of exercise from the treatment to the return to treatment phase for Participant 1 speaks to the importance of selecting the rewards for the target behavior.

Figure 3. Results by phase of minutes exercised across days for Participant 3. Each data point on the graph represents the number of minutes exercised across 2 days.

Figure 4. Average number of days exercised per week by phase for each participant.
In comparison to the other two participants, data for Participant 3 demonstrated less stability. Although the token economy intervention was effective in increasing the amount of exercise over the baseline rate, the amount of exercise completed during each exercise session was not as consistent as that of the other two participants. There are several possible explanations for the inconsistency. First, there was some discrepancy between the child and parent report about the amount of exercise the child completed. Because the parent worked and could not always personally monitor the child during exercise, there were a few occasions when the child would report exercise and the parent would either report less exercise or no exercise because no adult witnessed the exercise. Additionally, the parent and child at times disagreed about the child’s exertion level. Consequently, the child may have thought that she had met the recommended exercise goal, but the parent did not agree. In fact, given child report only (instead of parent and child agreement that was used to graph the data), the amount of exercise would be more consistent. Aside from disagreements between parent and child, the child’s age may have played a role. Whereas older children may be better at self-regulating their exercise, younger children may require additional guidance. This guidance could come in the form of parental monitoring or child participation in structured exercise activities (e.g., sports teams).

One final thing to note about the third participant’s data is that there was a significant increase in amount of exercise that occurred during the middle of the return to treatment phase. At that point in the phase, the child began swimming for several hours a day. This child reported that she greatly enjoyed swimming, and it is likely that she would have done this particular exercise regardless of whether the token economy was in place. Past studies have indicated that children prefer to have a choice in exercise (Epstein et al., 1982). In the current investigation, it appears that the type of exercise the child participates in is an important variable and that exercise can be something that the child has intrinsic motivation to do if it is a preferred activity. Thus, a token economy may be necessary to reinforce a child for engaging in a nonpreferred activity or trying new types of exercise.

Follow-up data indicated long-term maintenance of increased exercise. All three participants were exercising above baseline levels, although less consistently (in frequency and duration) than during treatment phases. This may indicate the need for additional therapist/medical team involvement to help maintain exercise. This could take the form of “booster sessions” during clinic visits to help problem solve issues with the token economy and obstacles to exercise.

Medical monitoring was conducted in order to ensure that the treatment did not negatively impact the participants’ body mass or body fat. Both BMI and body fat measures remained stable, with one participant demonstrating an increase in BMI over the short duration of the study. Because exercise is commonly associated with weight loss, and weight loss is not a desired outcome for children with CF, it is noteworthy that these parameters remained stable across the study. Given past research suggesting that over time, children’s health may improve with regular exercise (e.g., Edlund et al., 1986), it will be important for future studies to examine the long-term health benefits of exercise on children with CF.

A significant strength of this investigation is that it begins to fill a void in the literature. Although several studies have examined behavioral techniques to increase adherence to other aspects of the CF treatment regimen, currently there are only two studies (Hobbs, Strutton, & Kramer, 1988; Tuzin, 1983) that examine behavioral interventions for increasing exercise for children with CF and neither of these studies has been published (Bernard & Cohen, 2004). An additional strength of the intervention used in this study is that it appears to be easy for parents to learn and utilize. Due to the complicated medical regimen of children with CF, it is important that interventions designed to increase adherence to treatment recommendations alleviate not exacerbate the problem. Token economies seem to be good treatment options for increasing adherence to exercise because they take little time to use on a daily basis and yet still are powerful motivators for children. This is the ideal combination for an intervention with this population. A final strength of this study is the use of a single-subject design, which allows for increased understanding of the effects of interventions by allowing for flexibility in the approach and close evaluation of individual variability and details unavailable in group design research. Given the complexity of pediatric diseases and the multifaceted nature of working with families in a medical system, single-subject designs are especially well suited to study pediatric psychology phenomenon.

Several limitations of the current investigation should be noted. First, the sample size is small, which limits the generalizability of the study results. Also impacting the generalizability of the study is the uniformity of the sample. Although an attempt was made to have both boys and girls who ranged in age from 8 to 12 years participate in the study, the sample was all Caucasian girls. It will be important to demonstrate the effectiveness of
this intervention with families who have additional stressors (e.g., parental illness) or more global issues with non-adherence, such as the families that refused participation or had to be excluded from the current study. Additionally, even though a brief assessment of treatment integrity was conducted, it cannot be determined definitively that parent behavior (e.g., amount of encouragement given to exercise) was consistent across phases. Further, although conducting the study in the participant’s home bolsters the current study’s external validity, as a result, there was less control of parent behavior. A more detailed assessment of treatment integrity would have been helpful in ruling out variance in parent behavior as a possible confound or to illuminate any changes in parent behavior that may be inherent in the parent implementing an intervention of this nature.

Feasibility of implementation for clinicians is another important aspect to consider. A potential model to increase feasibility of administration of this intervention would be to conduct the training session at the child’s medical appointment. If the physician has caloric intake concerns, information about increasing caloric intake when exercising could be provided via handouts or an informational session with a dietician. Then either follow-up phone calls to assess effectiveness and assist parents with problem-solving the token economy or a follow-up face-to-face session could be conducted, depending on the needs of the family. Also, although three exercise sessions were used in this study to help standardize exercise across participants, a discussion and/or handouts about exercise or a one-time session with a physical therapist would likely be sufficient for most families.

Future research in this area should focus on replication of the study results with larger samples and broader populations. Of note, it is expected that the token economy will be equally effective with boys and girls; however, given that boys between the ages of 6 and 15 years appear to have better pulmonary functioning than girls in the same age range (Rosenfeld, Davis, FitzSimmons, Pepe, & Ramsey, 1997), it is important to assess the necessity and utility of this treatment technique with child and adolescent males. Additionally, this study included individuals with mild impairment in lung functioning; future research should explore techniques to increase exercise in children with moderate to severe impairment in lung functioning. It also will be important to identify and further examine critical treatment components of the token economy (e.g., social reinforcement, tangible rewards). Additionally, a close examination of exercise choices and related exertion to health benefit ratio would help clarify recommendations given to patients with CF. Finally, it will be important for future studies to include a follow-up period to determine if treatment gains maintain longer term and to assess the long-term health benefits of regular exercise in this population. Part of the follow-up should be to gradually fade out tangible behavioral components (e.g., tokens) and shift to social reinforcement (e.g., praise) and subsequently self-reinforcement in order to promote long-term lifestyle change in exercise behavior.

Overall, a token economy appears to be a viable treatment technique for children with CF because it is relatively time-effective and cost-efficient. Moreover, the token economy detailed in this study is easy to understand and implement. Given the extensive treatment regimen for children with CF, it is important for treatment to be beneficial without causing too many additional demands on the family or child. The token economy package detailed in this study meets both these criteria; it requires little extra work on the part of the family and it effectively increases exercise.

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References


