

# An Internet-Based Pediatric Weight Management Program with and without Financial Incentives: A Randomized Trial

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## Abstract

**Background:** Obesity among children is a serious problem and effective programs are scarce. The Internet is a promising weight management tool. Financial incentives to promote weight loss among adults have shown positive results. We compared a standard in-person program for children to an online program with and without financial incentives in terms of 6-month weight change.

**Methods:** Children age 8–15 were randomized to a monthly clinic group (control), an online program, and to the same online program with a financial incentive designed to encourage daily participation.

**Results:** 180 children were recruited (60 per group). Only 37% of children completed the study (55%, 27%, and 28% in the control, online, and online-incentive groups respectively.) 62% of children either maintained or had a decrease in BMI% with no differences by group. Mean BMI% of children decreased by 0.40% with no differences by group. Usage of both online programs declined rapidly after the first month, and only 4 children earned financial incentives.

**Conclusions:** Online programs are associated with high attrition rates, even with financial incentives. However, there is evidence that online programs can achieve results comparable to in-person programs. The structure of successful online incentive programs for children needs further study.

## Introduction

Though there is some evidence that the epidemic of obesity among children in the United States has stabilized, an estimated 31.7% of children ages 2–19 remain overweight or obese.<sup>1</sup> Obesity has become so serious that diseases that were once rare among children are now being encountered frequently.<sup>2</sup> Pediatric type 2 diabetes, for example, was virtually unknown 20 years ago. Today, it constitutes nearly half of all new cases of diabetes among children in some settings.<sup>3</sup> Despite the seriousness of the problem, effective and safe obesity prevention and treatment programs are not widely available.<sup>4</sup> Specialized centers offer intensive counseling programs for obese children that promote behavior modification. Unfortunately, such programs are very expensive and can at best accommodate a tiny fraction of the nation's obese children. The widespread use of medications to treat childhood obesity is likely many years away, and has its own pitfalls. Significant environmental and societal change holds the promise of reversing the prob-

lem. The policies necessary to bring about such change may not be implemented, and even if implemented will take a long time to influence children's health.

To reach a large number of children and have a significant impact upon public health, a weight management program should be practical, effective, and relatively inexpensive. Two promising weight management strategies have emerged that meet these criteria. First, several studies have demonstrated the effectiveness, at least in the short term, of internet-based weight management programs for both children and adults.<sup>5,6</sup> Second, insights from behavioral economics, which has identified common errors that people make in decision making, have been used to design programs that take advantage of these errors which usually undermine the quality of decision making to instead have a positive impact on health. One example is the use of carefully structured financial incentives to promote health behavior change, including behaviors that result in weight loss.<sup>7,8</sup> Financial incentives based on behavioral economics have not been used previously as part of pediatric weight management programs. In this

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study, we compared the impact on weight change of an internet-based weight management program, to an identical program which incorporated financial incentives to promote use, and to our usual, monthly, in-person weight management education and counseling program (control) in a randomized trial.

## Methods

### *Study population and setting*

The Weight Management and Wellness Center at Children's Hospital of Pittsburgh (CHP) was established in 2004 to provide comprehensive care for overweight and obese children, including identification and management of obesity-related illnesses, and delivery of a systematic, in-person, individualized, nutrition and physical activity counseling and educational program. We recruited overweight and obese children (BMI percentile  $\geq 85$ ) age 8–15 (the age group for which our Internet programs were designed) attending initial appointments at the Center. All new patients had a detailed medical evaluation to identify conditions which require close-monitoring or follow-up (e.g. uncontrolled, very high blood pressure, or severe depression). Such children were ineligible for the study, as were children taking weight loss medications, atypical antipsychotic drugs, antidepressants, thyroid medications, and oral steroids. Children taking such medications, like those with conditions identified after medical evaluation, often require frequent, specialized follow-up which is not part of the Internet based arms of the study. To participate in the study, all children had to have regular access (at home, at school, or at a friend or relative's home) to the Internet. There were no other inclusion or exclusion criteria.

### *Interventions*

**Initial Visits.** All children had an identical initial visit which, in addition to a detailed medical evaluation, included comprehensive nutrition and physical activity assessments, and negotiation and setting of goals for behavior change with the child and parent(s). For example, the nutritionist may have identified high rates of fast food consumption as a problem. She and the family would then negotiate a reasonable goal of limiting fast food consumption to no more than once per week. Negotiation of goals was always based on not only what was likely to promote a healthier weight, but also on what each family felt they could achieve. Assessment and goal setting was completed by a nutritionist, and took approximately one hour. All families received written copies of goals.

### *Control group*

Children in the control group were asked to return to the Center monthly for six months. During follow-up visits, a physician or physicians' assistant briefly evaluated the child to identify any changes in medical status or concerns. Children and parents then met with a nutri-

tionist who determined whether goals set at the previous visit were met. Reasons for failing to meet goals were explored, and goals were renegotiated based on the family's input. We have also developed a comprehensive lesson plan based on successful behavioral weight management programs consisting of 12 "lessons for life." The lessons involve education and problem-solving, and were designed to help children adopt strategies to deal with unhealthy eating, increasing physical activity, and the emotional aspects of weight management. Lesson titles included, "Eating well while dining out", "Dealing with teasing and bullying" and "Smart snacking." After each child's progress in meeting goals had been discussed, the nutritionist, child and family together decided upon an appropriate "lesson for life" which the nutritionist then delivered. Ideally, 6 lessons for life were to be completed by the control group over the course of the study.

### *Internet-based group (HB4Life)*

In collaboration with design specialists, we have developed a web-based weight management tool for children called, "Healthy Behaviors for Life" (HB4Life) ([www.hb4life.com](http://www.hb4life.com)). The tool has been available since 2008 and consists of two components: (1) The "Healthy Plate" allows children to monitor their food and beverage intake by searching for, selecting, clicking and dragging animated food and beverage items with a mouse and adding them to a "virtual" plate. Hundreds of foods and beverages can be found in the program's database, and more are added on a regular basis. The program then immediately calculates the fat, sugar, and protein content of the selected foods and drinks as well as the total number of calories. This information is accompanied by links to information about recommended nutrient totals for children, so that users can obtain immediate feedback about the quality of their meals. The program also provides a daily graph of fat, sugar, and calories consumed, so that children can observe how their food choices influence their overall nutrient intake. The tool can be used for self-monitoring and for education (e.g. Children can explore the nutrition content of foods by playing with the tool.); (2) "The Big Five Tracker" is a simple tool through which children record their performance related to five key habits that influence weight. These include sweet beverage consumption, fast food consumption, physical activity, screen time, and eating family dinners. Based on their input, children receive a daily score ranging from 0 to 100. The tool is also available in paper form.<sup>9</sup> Children were expected to input goals from the initial visit which encompassed the "Big Five" into a web page in the system, to serve as a useful reminder as they completed daily logs. A full-time dietician technician manages the HB4Life program, including providing an in-person orientation to new enrollees, and being available by email and telephone to answer questions or address technical concerns. She is also responsible for electronically monitoring usage of the program. All children in the HB4Life group were expected

to complete a daily electronic log consisting of entering all foods and beverages for each meal into the Healthy Plate program and also completing the Big Five Tracker each day for the 6-month study period. Self-monitoring of and providing feedback about behavior are two techniques used in many successful programs which use the Internet to promote health behavior change. The strategies used by HB4Life are therefore consistent with behavior change principles and with established approaches.<sup>10</sup>

#### *Internet-based group with financial incentive (HB4Life+)*

Children assigned to this group used a version of HB4Life which was identical to that of the other internet-based group except that it incorporated a financial incentive system based on behavioral-economic principles. The incentive version, known as HB4Life+, included an electronic bank account whose balance rose and fell according to how frequently children completed their daily logs. The balance is immediately visible upon logging into the system. All children began with \$50 in their accounts. For each day they completed their logs, an additional dollar was added. If they missed one day, the amount in their accounts did not change. If they missed two days, the amount decreased by 25% of the original amount remaining before days were missed. For example, a child with \$100 would lose \$25 after missing two days of logging. After a third missed day, the amount would decrease by \$25 again, and so on until zero dollars remained, after which they could resume earning money by completing logs. The program allowed children to earn a maximum total incentive of \$230 during the 6-month study period. The HB4Life+ incentive system is consistent with two important principles of behavioral economics. First, it is known that even small rewards or punishments can have significant incentive value if they occur immediately.<sup>11</sup> The system immediately displays the amount earned upon logging in. Second, the system is consistent with the mechanism of *loss aversion*.<sup>12</sup> People are more likely to be motivated by the prospect of losing money they believe is already theirs, than the prospect of earning more by carrying out some behavior.

#### *Research payments*

Children in all groups received \$50 for participating in the study (For the HB4Life+ group, this was in addition to what they earned through the incentive system.) This amount was paid in installments. Children received \$10 upon enrolling, \$10 3 months later, and \$30 after returning and completing their six month final evaluation. All payments to children including HB4Life+ incentive payments were in the form of debit cards.

#### *Post-participation questionnaire*

Parents of children enrolled in the two internet-based groups completed a post-participation questionnaire in which they were asked to indicate their extent of agree-

ment (5=strongly agree – 1=strongly disagree) with four questions related to how much they believed their child learned, how helpful the online programs were in managing weight, their overall satisfaction, and whether they would recommend the online programs to others. A summary score for each participant was calculated as the mean of responses to the four questions.

#### *Access to weight management & wellness center staff*

Regardless of group assignment, all children were permitted to contact the medical, nursing, behavioral, or nutrition staff at the Center with any questions or concerns about the study or other issues at any time. This contact could take place in person through appointments or by telephone or email. The idea is based on the observation that some personal contact is often needed to keep people engaged in internet-based programs.<sup>9</sup> Furthermore, the dietician-technician remained in contact with some Internet group participants by phone or email, especially those whose frequency of logging dropped off. All children were expected to return for a final, follow-up evaluation visit six months after enrollment. We provided some flexibility for the timing of the visit depending upon families' schedules, such that visits that were scheduled and took place within 2–3 weeks of the 6-month point were acceptable. All families received at least one reminder phone call in advance of all monthly follow-up (for control group) and final appointments.

#### *Expected parental involvement*

In addition to bringing their children for appointments, parents of children in the control group were expected to provide a supportive home environment in which the entire family assisted children in meeting goals. They were also expected to participate in discussions during all follow-up visits. Parents of children in the two Internet-based groups were expected to: (1) encourage completion of daily logs by providing appropriate access to the Internet and reminders to children; (2) assist children (especially younger children, ages 8–10) with use of the online system; (3) contact the dietician-technician in a timely fashion with any technical problems or other concerns; and (4) bring their children and participate in the 6-month follow-up appointments.

#### *Recruitment and randomization*

We attempted to recruit all eligible subjects during the six-month recruitment period. Once a child was found to be eligible to participate, his parent provided written informed consent. Children were randomized to the three groups using block allocation with a block size of six. The allocation sequence was generated in advance and neither the medical staff determining eligibility nor the research assistants responsible for recruitment could influence the groups to which children were assigned. All children began the study immediately after recruitment. Those in the Internet-based groups received an orientation



to HB4Life or Hb4Life+ by the dietician-technician in addition to the usual evaluation and goal setting that make up the initial appointment.

### *Power and sample size*

We based our power and sample size calculations upon the outcome of mean change in BMI percentile for each group. Assuming  $\sigma = 0.5\%$  (based on data collected from patients seen in the Center over time), a detectable magnitude of effect of 0.5% difference in mean BMI percentile change among the 3 groups,  $\alpha = 0.05$ , and power = 80%, we estimated that 53 patients would be needed for each group (159 total). We set a recruitment goal of 180 patients.

### *Outcomes and analysis*

Study completion was defined as attendance at the 6-month final evaluation appointment. Our two principal outcomes were the mean change in BMI percentile in each group, and the proportion of children in each group whose BMI percentile either decreased or remained unchanged after six months. We chose this second outcome based on the short duration of the study, and knowledge that childhood obesity is extremely difficult to treat and most published research reports of treatment programs reveal modest improvements in weight status, if any.<sup>13</sup> We believe therefore, that maintenance in BMI percentile over a six month period is a reasonable goal for many overweight and obese children and can indeed be counted as a "success." Secondary outcomes included usage of the HB4Life online programs and satisfaction with the online programs among parents based on the short, written questionnaire.

PASW Statistics 18 (IBM, Somers, NY) was used for all descriptive and comparative statistical analyses. Statistical tests and procedures used for key outcomes are described below:

Descriptive statistics were used to summarize demographic and other characteristics of enrollees and study completers. Chi-square analysis was used to identify differences in the number of children in each group whose BMI percentile decreased or remained unchanged. The Kruskal-Wallis test (nonparametric equivalent of ANOVA) was used to identify differences in change in mean BMI percentile among the three treatment groups. An independent samples t-test was used to identify significant differences in parental satisfaction between study

completers in the two online groups. Chi-squared and Mann-Whitney tests were used to compare characteristics of completers and dropouts.

Independent samples t-tests were used to identify differences in website usage rates at different points between the two Internet-based groups.

## Results

### *Baseline characteristics*

We successfully recruited a total of 180 children. 60 were allocated to each of the 3 groups. The mean age of all children at the time of enrollment was 11.53 years with a range of 8.02 to 15.99 years and a SD of 2.09 years. The mean BMI percentile at the time of enrollment was 98.39, with a range of 85.79 to 99.80, and a SD of 1.71%. The sample consisted of 96 girls and 84 boys. There were 146 Caucasian children (81.1%) (145 white, and one South Asian child), and 34 African-American children (18.9%). There were no statistically significant differences in mean age, sex breakdown, racial breakdown, or mean BMI percentile at enrollment among the 3 groups. Table 1 provides a summary of baseline characteristics:

### *Principal results*

The attrition rate was very high. 114 children did not return for their 6-month follow-up (37% overall completion rate.) The completion rates in the control, HB4Life, and HB4Life+ groups were 55%, 27%, and 28% respectively. (The control group had a significantly higher completion rate. No statistically significant difference between completion rates in the two Internet-based groups).

Study completers included 36 girls (14, 10, and 12 in each of groups 1, 2, and 3 respectively), and 30 boys (19, 6, and 5 in each of groups 1, 2, and 3 respectively). Completers included 50 Caucasian children (26, 10, and 14 in groups 1, 2, and 3 respectively) and 16 African American children (7, 6, and 3 in groups 1, 2 and 3 respectively). The racial profile of both enrollees (18.9% African American) and study completers (24.2% African American) was comparable, and also similar to the racial breakdown of patients seen in the Weight Management and Wellness Center in general.

Children in group 1 completed an average of 4.67 visits during the 6 month study period (range, 3 to 7, SD, 1.0).

**Table 1. Baseline Characteristics of Participants**

	Mean Age (years)	Number of Girls	Number of Boys	Number of Caucasian children	Number of African American children	Mean BMI percentile at enrollment
Group 1 (control)	10.90	30	30	48	12	98.76
Group 2 (HB4Life)	11.84	31	29	46	14	98.46
Group 3 (HB4Life+)	11.87	35	25	52	8	97.95
Total	11.53	96	84	146	34	98.39

Forty-two of the children who completed the study (62% of completers) had a BMI percentile which either decreased or remained unchanged at their six month follow-up visit (defined as a “success”). The breakdown of “successes” and “failures” by group was comparable and is shown in Table 2. There was no statistically significant differences in success rates among the three different groups ( $X^2=0.310$ ,  $p>0.05$ ). There was no statistically significant difference in the number of successes between boys and girls ( $X^2=0.314$ ,  $p>0.05$ ) and between Caucasian and African American children ( $X^2=0.012$ ,  $p>0.05$ ).

**Table 2. Successes and Failures by Study Group**

	Group 1 (Control)	Group 2 (HB4Life)	Group 3 (HB4Life+)
Success	22 (66.7%)	10 (62.5%)	10 (58.8%)
Failure	11	6	7

The mean change in BMI percentile for the entire sample of completers was a decrease of 0.40%, with a range of a decrease of 5.41% to a gain of 1.48%. The mean change in BMI percentile was -0.35, -0.70, and -0.22 in the control, HB4Life, and HB4Life+ groups respectively. There were no statistically significant differences in change in BMI percentile among the three groups.

#### *Usage and satisfaction with online programs*

We monitored use of the two online programs on a regular basis. During the first month, children in the HB4Life group logged in an average of 7.57 times (SD, 10.92) compared with 11.18 times (SD, 9.83) for children in the HB4Life+ group ( $p$  value for difference  $>0.05$ , ie not statistically significant). Usage declined dramatically by the end of the study, averaging just 1.83 (SD, 7.57) logins for the HB4Life, and just 1.28 (SD, 5.30) logins for the HB4Life+ group in the sixth month ( $p$  value for difference  $>0.05$ ). Children in the HB4Life+ group logged into the website an average of 50 times over 6 months. By contrast, children in the HB4Life group logged in an average of only 38.4 times over 6 months. This difference, however, was not statistically significant.

Only 4 children in the HB4Life+ group earned money through the incentive program. The amounts earned and each child’s corresponding change in BMI percentile were the following: \$88.33 (-1.02%); \$59.62 (-1.29%); \$50.00 (-0.31%); and \$10.73 (+1.16%). Three of the four children who earned money were therefore “successes.”

We did not explicitly record the number of all electronic or phone contacts between the dietician-technician and the children in the Internet-based arms. As noted, children and parents in the Internet-based arms were welcome to meet in person with any of the Center’s personnel at any time during the study, even though only one 6-month

follow-up was formally arranged. Few families, however, took advantage of this opportunity. The mean number of originally unscheduled follow-up visits was just 0.37 in the HB4Life group and 0.33 in the HB4Life+ group.

Overall, parents were very pleased with the online program. The mean summary score on the post-participation questionnaire was 3.9/5.0. Overall satisfaction scores were not statistically different between the two internet-based groups.

#### *Dropouts*

We compared the 114 dropouts to the 66 children who completed the study with respect to the key baseline characteristics of sex, race, and initial BMI percentile (Table 3). There were no statistically significant differences between completers and dropouts with respect to these variables. To identify whether distance from the Center made a difference with respect to completion of the study, we classified all patients according to location based on home address. Children were classified as (1) local (Pittsburgh and immediately surrounding communities); (2) suburban (surrounding counties); or (3) distant (outside of metropolitan and suburban area).

**Table 3. Characteristics of Completers and Dropouts**

Characteristic	Completers	Dropouts
Number (%) females	36 (54.5%)	61 (53.5%)
Number (%) African American	13 (19.7%)	21 (18.4%)
Mean initial BMI percentile	98.22	98.49

45/96 (47%) local children completed the study, versus just 18/71 (25%) of suburban children and 3/13 (23%) of distant children. The differences in these rates of completion by distance were statistically significant ( $X^2 = 9.26$ ,  $p=0.01$ ).

## Discussion

We were very disappointed by the overall attrition rate of 63%, and the even higher rates for children in the two online groups (73% and 72% for the HB4Life and HB4Life+ groups respectively). Such high attrition rates in pediatric weight management studies, however, are not unusual. One Italian study reported an attrition rate of over 90% over a two-year period.<sup>14</sup> A recent review of attrition from pediatric weight management programs reveals that rates of 55–65% are common.<sup>15</sup> A recent systematic review of web-based weight management programs for children and adolescents, however, revealed much lower attrition rates of 4.9% to 30%.<sup>16</sup> Several papers report African- American race and higher BMI as predictors of attrition from pediatric weight management programs in general.<sup>17–19</sup> Neither race nor initial BMI percentile were predictive of completion in our study.

Reasons cited often by families for dropping out of weight management studies include dissatisfaction with programs (i.e. “not what we are looking for”), and logistical issues such as distance from home and time required to travel to programs.<sup>13</sup> Our study is consistent with these observations as distance from the Center was a significant predictor of follow-up. Ironically, web-based programs are designed to overcome barriers of distance and lack of time, but were associated with low completion rates in our study.

The use of financial incentives based on behavioral economics did not improve completion rates. Usage of both versions of the online program declined precipitously over the six month period. This contrasts with the experience of using such incentives in adults for weight loss, which have been shown to keep patients successfully engaged.<sup>7</sup>

We have limited information about children who dropped out of the study, but can speculate about reasons for the high rate of attrition. The financial incentives for participation (including the \$50 for all participants) may be less meaningful to children than to adults. The average child in our study was only 11.53 years old. The value of money may not be well appreciated by younger children in particular. Most internet-based weight management programs for children and adolescents include a significant component of personal interaction and having substantial personal contact, in-person or remotely, is recommended for internet-based interventions.<sup>14</sup> All children enrolled in our study were assigned to attend at least two in-person appointments in a six-month period. In addition, they were encouraged to contact the Center’s staff whenever they wished with questions or concerns, through clinic visits, email, or telephone. Furthermore, the dietician-technician did contact enrollees in the online groups to encourage their participation when the frequency of their logging declined. This level of personal contact may not have been enough to prevent significant attrition. It should be noted, however, that there needs to be a fine balance between providing personal contact and encouraging children to achieve goals through independent use of a web-based program. If too much personal contact is included as part of a web-based program, the practical advantages in terms of cost and time that the Internet provides are eroded. A completely different approach we could have taken was to use the online programs to supplement our regular clinical program, rather than supplementing the online programs with some personal contact.

It is also possible that the requirement of daily logging for a period of 6 months was too burdensome for many children. Children were encouraged to make logging part of their daily routines (e.g. completing logs just before bedtime), but many children may have grown frustrated or bored with the programs. Since we could not administer satisfaction questionnaires to those who dropped out

and did not return to the Center, we cannot identify specific reasons for dropping out.

Successful completion of the online programs does require some support and encouragement by parents. Low usage of the online programs may be at least partly due to poor engagement by parents, rather than only lack of interest among enrolled children. We did not evaluate the extent to which the parents were engaged, though as noted, most parents were satisfied with the quality of the online programs.

Finally, structuring financial incentives based on behavioral economic principles for children in a manner similar to adults may be ineffective, as children may have different ideas of the value of money and loss and reward. It is possible, for example, that a program that paid out rewards more frequently would be more effective, and it is also possible that the loss feature of the HB4Life+ intervention may have been too harsh and may have led to demoralization and apathy among participants. The type and structure of incentives that could help children to achieve healthier weights is an area worthy of future study.

It is possible that the requirement for participation of having regular access to the Internet may have excluded poorer children, and that the outcomes we observed may not be broadly applicable to children with fewer resources. However, our sample was racially diverse and the children we recruited came from diverse urban, suburban, and rural areas of western Pennsylvania.

The high attrition rates in the internet-based groups likely limited our ability to identify statistically significant differences in change in weight status. Nevertheless, we can draw a few basic conclusions based on our analysis of completers. First, the mean BMI percentile of children in each group and of all children who completed the study declined modestly, a result consistent with previous weight management studies. Children in each group had similar rates of “success” by either maintaining or decreasing their BMI percentiles. Second, our web-based programs were well received by families who used them. Though only a small number of children earned financial incentives in the HB4Life+ group, 3 of 4 that did had significant improvements in their BMI percentiles. Web-based programs with financial incentives may be a suitable weight management strategy for a subset of children. Identifying which children can benefit should also be a priority for future research.

## Conclusions

Financial incentives do not appear to mitigate attrition in Internet-based pediatric weight management programs. Internet-based programs, however, are potentially as effective as in-person programs. More research is needed to identify successful incentive-based strategies to engage children in Internet-based programs.



## Acknowledgements

We wish to acknowledge the invaluable help of Kendra Rust and Sam Arnold in carrying out this study.

This material is based on research sponsored by The Air Force Surgeon General's Office under agreement number FA7014-08-2-0001. The U.S. Government is authorized to reproduce and distribute reprints for Governmental purposes notwithstanding any copyright notation therein.

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## Authors' Disclosure Statement

None of the authors have any financial conflicts to disclose.

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