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ORIGINAL ARTICLE

Response to a standard behavioral weight loss intervention by age of onset of obesity

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Summary

Background

The purpose of this study was to examine weight loss, physical activity, fitness and diet changes in response to a standard behavioral weight loss intervention in adults with self-reported juvenile onset ($n = 61$) or adult onset ($n = 116$) obesity.

Methods

Participants ($n = 177$; 43.0 ± 8.6 years; body mass index [BMI] = 33.0 ± 3.4 kg m^{-2}) engaged in an 18-month standard behavioral weight loss intervention. Participants were randomized into three different intervention groups as part of the larger parent trial. BMI, physical activity, fitness and diet were assessed at baseline, 6, 12 and 18 months. Separate adjusted mixed models were constructed using SAS version 9.4 (SAS Institute, Cary, NC).

Results

There was significant weight loss, increased physical activity, improved fitness and reduced caloric intake over time ($p < 0.001$). There were no significant differences in these outcome variables by obesity onset group. However, there was a significant group by time interaction for fitness ($p = 0.001$), with the adult onset making significantly greater gains in fitness from baseline to 6 months ($p < 0.001$); however, this difference was no longer present at 12 or 18 months.

Conclusions

With the exception of fitness at 6 months, weight loss, physical activity and diet did not differ between juvenile onset and adult onset participants, suggesting that those with juvenile onset obesity are equally responsive to a standard behavioral weight loss intervention in adulthood.

Keywords: Obesity, physical activity, weight loss interventions.

Introduction

Approximately 77% of adolescents with obesity remain obese as an adult, which may increase their risk for developing coronary heart disease, type 2 diabetes and other metabolic risk factors. (1) Moreover, 40% of adolescents with obesity meet the criteria for severe obesity by 30 years of age (2,3). Individuals with a consistently high body mass index (BMI) from childhood through adulthood are at an increased risk of hypertension, elevated LDL, reduced HDL, elevated triglyceride levels and carotid-artery atherosclerosis (4). However, those who are overweight or obese during childhood, but are non-obese in adulthood, have a similar risk profile to those who were never overweight or obese in childhood or adulthood (4). Thus, successful behavioral weight loss interventions are necessary for prevention of disease and premature death in adults with obesity, especially those who have had an elevated weight status since childhood.

Standard behavioral weight loss interventions focus on behavior modification in adults with obesity (5,6). These types of interventions typically include behavioral techniques such as problem solving, goal setting and self-monitoring of eating and exercise behavior to achieve overall goals of caloric restriction and increased engagement in exercise (7). However, there is variability in the weight losses achieved with these interventions. Field *et al.* have suggested that the variability in results of behavioral interventions and overall small effects could be due to the fact that all types of overweight and obesity are currently grouped together (8). Currently, weight loss interventions in adulthood do not take into account whether the individual has been obese throughout their lifetime or only recently. Given the degree to which behavioral patterns are shaped during childhood, it is reasonable to assume that those with juvenile onset obesity may have a different response to adult lifestyle interventions. It is possible that these individuals do not respond as well to the physical activity and diet-related components of a standard behavioral weight loss intervention compared with their adult-onset counterparts (9,10), which may impact weight loss. Understanding whether differences exist in response to a standard behavioral weight loss intervention between those with juvenile onset obesity and adult onset obesity may facilitate development of more effective interventions for this population.

The primary purpose of this study was to examine whether there was a difference in weight loss between individuals with self-reported juvenile onset obesity compared to those with adult onset obesity in response to an 18-month standard behavioral weight loss intervention. In addition, this study examined whether there was a difference in change in physical activity, fitness, dietary composition and total calorie intake between participants with juvenile onset and adult onset obesity. We hypothesized that in response to a standard behavioral weight loss intervention (i) participants with juvenile onset obesity would lose significantly less weight in comparison to those with adult onset obesity and (ii) there would be differences in physical activity, fitness, dietary composition and total caloric intake between onset groups.

Materials and methods

Participants

Participants included in this study were part of a randomized clinical trial (6). Participants were recruited through newspaper, television, radio and direct mail advertisements and were instructed to call the study staff to be screened for eligibility and get a brief overview of the study. Inclusion criteria were (i) BMI $\geq$25.0 to $<$40 kg m^{-2} and (ii) between 18 and 55 years of age. Exclusion criteria included (i) history of cardiovascular disease; (ii) presence of metabolic conditions that may affect body weight; (iii) conditions that would prevent increasing engagement in physical activity; (iv) self-reported engagement in $\geq$20 min d^{-1} for $\geq$3 d week^{-1} of physical activity over the prior 6 months; (v) medications that would affect body weight or heart rate; (vi) sustained weight loss of $\geq$5% within the past 12 months and (vii) women pregnant in the past 6 months, currently pregnant or planning to become pregnant in the next 18 months.

Eligible participants attended an orientation session and were given more information about the randomization, assessment procedures and intervention components of the study. Interested participants provided their written informed consent to participate in the study on the day of their baseline assessment. Participants were randomized (stratified by gender) into the three intervention groups after completion of their baseline assessment using a randomization sequence generated by the biostatistician of the parent study (6). Outcomes were assessed on four separate occasions at 0, 6, 12 and 18 months of the intervention with data collected by trained staff. Assessment staff were aware that the participants were enrolled in a weight loss program, so to reduce potential bias the staff did not have access to prior assessment data during subsequent measurement periods. Further details regarding assessment protocols have been published previously (6). Study procedures were approved by the University of Pittsburgh Institutional Review Board. Individual level data are not publically available due to local Institutional Review Board restrictions; associated protocols may be available upon request.

Participants were categorized according to age of onset of obesity based on their response to the weight history questionnaire completed at baseline. The specific question stated, 'Select whether you were extremely underweight, underweight, normal weight, overweight or extremely overweight at each of the following ages'. The age categories were as follows: (i) Pre-School; (ii) Elementary School; (iii) Junior High (12–14 years); (iv) High School (15–18 years); (v) 19–25 years and (vi) 26–35 years. Participants were categorized as 'juvenile onset' ($n = 68$) if they reported being overweight or extremely overweight at age 15–17 (i.e. overweight or obese as they transitioned into young adulthood). Participants who indicated overweight or extremely overweight at an earlier age in childhood, but were not overweight or obese at age 15–17, were not included in the analysis ($n = 18$). All other participants who reported being overweight or obese between the ages of 19–55 years were categorized as 'adult onset' ($n = 116$). Self-report has been used previously to categorize individuals as juvenile onset by answering a similar question 'Were you overweight as a child or teenager?' (11).

Outcome assessments

BMI

Body weight was assessed to the nearest 0.1 kg using a calibrated scale with the participant dressed in a cloth hospital gown. Height was assessed using a wall-mounted stadiometer and recorded to the nearest 0.1 cm. BMI was computed as kg m^{-2}.

Cardiorespiratory fitness

Fitness was assessed by a submaximal graded-exercise test to 85% of the participants' age-predicted maximal heart rate computed as 220 minus the age of the participant. Heart rate was assessed via 12-lead electrocardiogram throughout the duration of the exercise test and in recovery. Participants walked on a treadmill at a speed of 3.0 mph at 0% incline. Speed remained constant throughout the duration of the test, and incline increased 1% every minute during the test. The test was terminated when the participant reached ≥85% of their age-predicted maximum heart rate. The time (minutes : seconds) it took to reach 85% of participants' maximal heart rate was used to represent fitness.

Physical activity

Physical activity minutes per week were assessed using the Paffenbarger Physical Activity Questionnaire, initially developed for the Harvard Alumni Study (12). Participants were asked questions about the amount of time per week they spent walking for exercise or transportation, engaging in sport, fitness, or recreational activities and the number of flights of stairs climbed daily. Participants provided data on the number of days per week and average duration of each physical activity they reported. Physical activity minutes per week were calculated from the number of days per week and duration (minutes) per session of self-reported moderate-to-vigorous physical activity including walking for exercise or transportation and sport, fitness or recreational activities. This questionnaire was completed at each assessment time point.

Dietary intake and eating Behaviours

A food frequency questionnaire was used to determine energy intake (kJ d^{-1}) and macronutrient composition (as percent of total kJ) (13). Total daily energy intake was calculated from the food frequency questionnaire, and macronutrient composition (% fat, % carbohydrate and % protein) was computed for each of the macronutrients. The Eating Behaviour Inventory (EBI) was used to assess eating behaviors associated with weight loss including self-monitoring of food intake and weight, food responses to emotions and grocery shopping with a list (14). The EBI is a 26-item inventory with higher scores associated with greater engagement in weight loss behaviors (14).

Intervention

The full intervention protocol has been published previously (6). In brief, the parent study examined whether additional strategies at the initiation of intervention or at predetermined times over the intervention enhanced participant 18-month weight loss (6). Participants were randomized into one of three intervention groups: (i) standard behavioral weight loss; (ii) standard behavioral weight loss with additional strategies at the initiation of the intervention or (iii) standard behavioral weight loss with additional strategies at predetermined times over the intervention period. All three of the intervention groups received (i) group intervention sessions; (ii) a dietary prescription for reduced caloric intake and (iii) a prescription for physical activity. Participants were instructed to attend group intervention sessions weekly during months 1–6 and biweekly during months 7–18. Sessions were led by an interventionist trained in nutrition, exercise or health psychology and lasted approximately 45 min. Additional strategies utilized in two of the intervention groups included supervised exercise at group sessions, additional campaigns to promote physical activity and additional telephone intervention contacts. However, all groups and study participants received the same dietary and physical activity prescription.

The dietary component of the intervention included a caloric prescription based on current weight and a reduction in fat intake to 20–30% of total energy intake. Energy intake was prescribed at 5,023 kJ (1,200 kcal) d^{-1} for participants weighing ≤90 kg and 6,279 kJ (1,500 kcal) d^{-1} for participants weighing >90 kg. Participants were asked to self-monitor their calorie intake by recording a food diary, which was provided to them. They were asked to turn in their food diaries weekly and later received feedback from the interventionist to encourage maximal adherence to their caloric prescription.

All participants were prescribed a weekly physical activity goal. Initially, participants were prescribed a weekly physical activity goal of 100 min $week^{-1}$. On Week 5, this prescription was increased to 150 min $week^{-1}$, and on Week 9, it was increased to 200 min $week^{-1}$, where it remained for the duration of the study. Participants were encouraged to engage in physical activity on at least 5 d $week^{-1}$ in bouts lasting at least 10 min in duration. They were prescribed physical activity at a moderate-to-vigorous intensity, which was defined as a Rating of Perceived Exertion of 11–15 on the Borg 15 category scale (15). Participants were instructed to self-monitor their exercise along with their food intake in the diaries provided to them. Interventionists reviewed weekly physical activity diaries and provided encouragement to meet or continue meeting their weekly physical activity goals (6).

Statistical analysis

Differences in baseline characteristics of the participants by onset category (juvenile onset and adult onset) were analysed using chi-squared tests for categorical variables and *t*-tests for continuous variables. The Wilcoxon Rank-Sum test was used to test for significant differences in non-normally distributed baseline data.

To examine differences in the outcome variables by onset category, separate mixed effects models were fit to the outcomes across each time point (baseline, 6, 12 and 18 months). Each model was adjusted for the following covariates: age, gender, race (Caucasian vs. non-Caucasian), treatment group, time and treatment group by time interaction. Analyses were focused on onset effect, time effect and onset by time interaction effect. Results from the mixed model analyses are presented as the least square mean with 95% confidence interval. Included in the analyses were all participants that completed baseline and one follow-up assessment. Statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

Results

There were 218 participants randomized in the parent trial, with 23 removed from the study after randomization due to reasons that made them ineligible to continue the study (pregnancy, relocation, etc.). Of the 195 participants remaining, 18 were excluded from analyses as they were not able to be categorized as juvenile or adult onset by the criteria defined for this study. They were unable to be categorized into either group because they indicated overweight or extremely overweight at an earlier age in childhood but were not overweight or obese at age 15–17. Dropout rates were not significantly different between juvenile onset and adult onset groups.

Baseline characteristics

Table 1 presents the baseline characteristics of the final analysis sample by onset group. There were no significant differences at baseline between onset group for gender, race/ethnicity or education. In addition, based on chi-squared analysis, there was no significant difference between juvenile onset and adult onset groups and treatment randomization ($p = 0.909$). The juvenile onset group was significantly younger (39.7 [25th, 75th percentiles: 40.3, 50.4] years vs. 47.0 [25th, 75th percentiles: 32.1, 47.6] years; $p < 0.0001$) and had a higher BMI (BMI 33.7 ± 3.3 kg m^{-2} vs. 32.6 ± 3.4 kg m^{-2}; $p = 0.047$) at baseline compared with the adult onset group. The juvenile onset group was more fit at baseline than the adult onset group with a median test time of 9.7 min [25th, 75th percentiles: 7.3, 13.7], compared with 8.7 min [25th, 75th percentiles: 5.2, 12.0] for the adult onset group ($p = 0.023$) (Table 1). There were no significant differences at baseline between the juvenile onset and adult onset groups for physical activity, daily caloric intake, EBI score or macronutrient composition.

Outcome variables

Weight loss

Both the juvenile onset and adult onset groups experienced significant weight loss over time ($p < 0.001$) (Figure 1). The weight loss from baseline at 6 months in the juvenile onset group was −8.7 kg (95% CI, −10.8 kg to −6.7 kg) and −9.4 kg (95% CI, −11.0 kg to −7.9 kg) in the adult onset group. Weight loss from baseline to 12 months in the juvenile onset group was −7.8 kg (95% CI, −10.4 kg to −5.2 kg) and −8.8 kg (95% CI, −10.6 kg to −6.9 kg) in the adult onset group. Weight loss from baseline at 18 months in the juvenile onset group was −5.2 kg (95% CI, −8.0 kg to −2.5 kg) and −7.1 kg (95% CI, −9.1 kg to −5.2 kg) in the adult onset group. There was no significant effect of obesity onset ($p = 0.351$) or obesity onset × time interaction ($p = 0.264$) (Table 2).

Fitness

Both the juvenile onset and adult onset groups experienced significant improvement in fitness over time ($p < 0.001$). There was a significant onset × time interaction ($p = .041$) for improvement in fitness (Table 2). Post-hoc analyses showed that the adult onset group had significantly ($p < 0.001$) greater gains in fitness from baselines to 6 months compared with the juvenile onset group. There was no significant difference between

Table 1 Unadjusted baseline characteristics by onset of obesity

Baseline characteristics (n = 177)	Adult onset (n = 116)	Juvenile onset (n = 61)	p-value
Age	47.0 (40.3, 50.4)	39.7 (32.1, 47.6)	<0.001
BMI	32.6 ± 3.4	33.7 ± 3.3	0.047
Gender (% *female*)	89(76.7%)	50(82.0%)	0.419
Race/ethnicity (%):			0.403
Asian	0 (0.0)	1 (1.6)	
Black	39(32.8)	18(29.5)	
Hispanic	1 (0.9)	0 (0.0)	
Caucasian	75(64.7)	41(67.2)	
Other	1 (0.9)	1 (1.6)	
Education status (%):			0.834
High school	11(9.5)	9(14.7)	
Vocational training	7(6.0)	4(6.6)	
College education	73(62.9)	34(55.7)	
Graduate degree	25(21.6)	13(21.3)	
Physical activity (*min week*$^{-1}$)	35.0 (0.0, 140.0)	35.0 (0.0, 107.0)	0.501
Graded-Exercise Test (*mins to 85% max HR*)	8.7 (5.2, 12.0)	9.7 (7.3, 13.7)	0.023
Dietary intake (*kJ d*$^{-1}$)	8 331.8 (5,971.7, 10,772.3)	8 011.6 (6,423.4, 9,815.3)	0.894
Eating Behaviour Inventory (*EBI*) *score*	70.3 ± 9.0	68.9 ± 8.8	0.342
Dietary protein (% *daily*)	13.9 (12.3, 16.3)	14.6 (13.0, 16.9)	0.138
Dietary fat (% *daily*)	38.7 ± 6.7	39.3 ± 6.4	0.597
Dietary carbohydrate (% *daily*)	47.4 ± 8.4	46.0 ± 7.6	0.282

Data are presented as means ± SD, median [25th percentile, 75th percentile] or n(%).

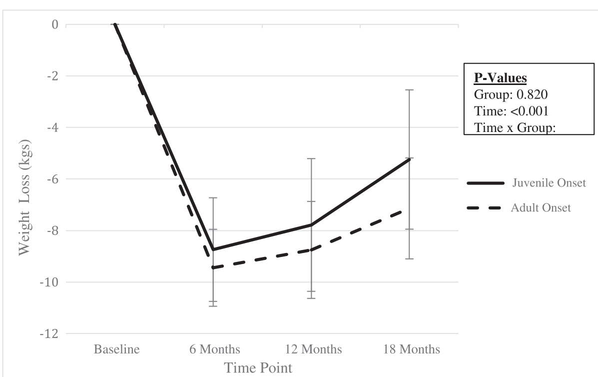

Figure 1 Weight loss by onset of obesity at 6, 12 and 18 months.

groups in improvement of fitness from 6 to 12 months or 12 to 18 months.

Physical activity

There was an overall significant improvement in physical activity in both the juvenile onset and adult onset groups over time ($p < 0.001$). There was a significant difference between obesity onset groups ($p = 0.001$), but there was no significant obesity onset × time interaction ($p = 0.410$) for physical activity.

Dietary intake, EBI score and macronutrient composition

There was a significant reduction in daily caloric intake in both the juvenile onset and adult onset groups ($p < 0.001$) as well as a significant improvement in EBI scores in both the juvenile onset and adult onset groups ($p < 0.001$). There was a significant increase in percentage of daily protein, reduction in percentage of daily fat and increase in percentage of daily carbohydrates ($p < 0.001$). However, there was no significant effect of obesity onset or obesity onset × time interaction for any of the dietary measures.

Discussion

Contrary to our initial hypothesis, the results of this study suggest that age of onset of obesity does not appear to

Table 2 Body weight, physical activity, fitness and dietary composition by onset of obesity at baseline, 6, 12 and 18 months

	Least square mean (95% CI)				*p*-value[a]		
	Baseline	*6 Months*	*12 Months*	*18 Months*	*Group*	*Time*	*Group × time*
Weight (kg)					0.049	<0.001	0.272
Juvenile onset	101.9 (98.7, 105.1)	92.8 (89.6, 96.1)	93.8 (90.2, 97.4)	96.3 (92.6, 100.1)			
Adult onset	99.1 (96.7, 101.5)	89.5 (87.0, 91.9)	90.1 (87.5, 92.8)	91.8 (89.0, 94.5)			
Weight change from baseline (kg)					0.351	<0.001	0.264
Juvenile onset		−8.7 (−10.8, −6.7)	−7.8 (−10.4, −5.2)	−5.2 (−8.0, −2.5)			
Adult onset		−9.4 (−11.0, −7.9)	−8.8 (−10.6, −6.9)	−7.1 (−9.1, −5.2)			
BMI (kg m^{-2})					0.013	<0.001	0.249
Juvenile onset	34.3 (33.4, 35.2)	31.1 (30.0, 32.1)	31.5 (30.3, 32.6)	32.4 (31.2, 33.6)			
Adult onset	33.1 (32.4, 33.8)	29.7 (29.0, 30.5)	30.0 (29.1, 30.9)	30.6 (29.7, 31.5)			
Exercise Test Time (min)					0.189	<0.001	0.019
Juvenile onset	11.7 (10.6, 12.8)	14.4 (13.2, 15.6)	15.4 (14.0 16.7)	14.7 (12.7, 15.6)			
Adult onset	9.9 (9.1, 10.8)	14.2 (13.3, 15.1)	14.3 (13.3, 15.3)	13.9 (12.9, 14.9)			
Physical activity (min week^{-1})					0.001	<0.001	0.4103
Juvenile onset	85.7 (49.2, 122.3)	259.6 (207.9, 311.3)	174.9 (109.2, 240.7)	193.1 (113.6, 272.5)			
Adult onset	101.5 (74.4, 128.7)	314.0 (275.6, 352.5)	261.7 (216.2, 307.2)	259.3 (204.9, 313.8)			
Dietary intake (kcal d^{-1})					0.801	<0.001	0.878
Juvenile onset	2,191.7 (1,962.6, 2,420.8)	1,517.8 (1,352.0, 1,683.7)	1,722.9 (1,517.2, 1,928.5)	1,704.1 (1,463.1, 1,945.2)			
Adult onset	2,202.5 (2,033.3, 2,371.7)	1,480.7 (1,356.0, 1,605.4)	1,646.7 (1,496.9, 1,796.5)	1,708.8 (1,539.1, 1,878.4)			
Eating Behaviour Inventory score					0.223	<0.001	0.849
Juvenile onset	68.8 (66.3, 71.3)	86.5 (83.7, 89.4)	81.5 (78.1, 85.0)	81.3 (77.5, 85.2)			
Adult onset	70.2 (68.3, 72.1)	88.4 (86.3, 90.5)	84.3 (81.8, 86.8)	82.7 (80.0, 85.4)			
Dietary protein (%)					0.317	<0.001	0.369
Juvenile onset	14.7 (13.8, 15.6)	17.0 (16.1, 17.9)	16.3 (15.3, 17.3)	16.7 (15.6, 17.8)			
Adult onset	13.9 (13.3, 14.6)	16.9 (16.3, 17.6)	16.3 (15.6, 17.0)	15.9 (15.1, 16.6)			
Dietary fat (%)					0.734	<0.001	0.866
Juvenile onset	39.0 (37.2, 40.8)	29.7 (27.9, 31.5)	31.2 (29.2, 33.2)	31.6 (29.5, 33.8)			
Adult onset	38.5 (37.2, 39.9)	30.0 (28.6, 31.3)	31.9 (30.5, 33.4)	32.2 (30.7, 33.7)			
Dietary carbohydrates (%)					0.778	<0.001	0.602
Juvenile onset	46.2 (44.1 48.4)	53.5 (51.4, 55.6)	53.0 (50.6, 55.4)	51.7 (49.3, 54.2)			
Adult onset	47.5 (45.9, 49.1)	53.6 (52.0, 55.2)	52.3 (50.6, 54.0)	52.2 (50.5, 54.0)			

[a]Adjusted *p*-values controlling for age, gender, race (Caucasian vs. non-Caucasian), treatment group and treatment group by time interaction.

influence weight loss achieved in a standard behavioral weight loss intervention. Also, in contrast to our hypotheses, there were no significant differences in the pattern of change in physical activity or the change in dietary measures between the juvenile onset and adult onset groups. Several decades ago, a study found that adults who reported being overweight since childhood were able to achieve similar weight loss as those who did not become overweight until adulthood; however, weight was based on self-report (16). The findings from this current study appear to confirm and extend this prior research by comparing clinically measured weight loss between individuals with juvenile onset and adult onset obesity, as well as assessing their diet and physical activity responses to a standard behavioral weight loss intervention.

This study found that while the juvenile onset group had a higher level of fitness at baseline, the adult onset group had significantly greater initial gains in fitness over the first 6 months of the intervention. This difference in baseline fitness may have contributed to the greater initial gains in the adult onset group compared with the juvenile onset group. We were unable to detect differences in physical activity that may have contributed to this different pattern of fitness change between the groups. Moreover, although the adult onset group had significantly greater gains in fitness from baseline to 6 months, in subsequent months, fitness was similar between the two groups, suggesting that this initial difference in response was not sustained. While it is possible that self-reported physical activity limited our ability to detect differences between groups that might explain the different pattern of fitness change, there may be other unknown explanations as well. While speculative, it is possible that the juvenile onset group engaged in lower intensity physical activity, potentially due to adverse experience with physical activity as a child, compared to the adult onset group, which may have contributed to the smaller initial fitness gains. This requires confirmation. Therefore, further research is needed to explore the potential mechanisms behind the greater initial gains in fitness observed in the adult onset group.

In the current study, attrition rates were not statistically different between those with juvenile onset and adult onset obesity across the 18-month study period. These findings are in contrast to a study that found that those with juvenile onset obesity were less likely than their adult onset obesity counterparts to successfully complete a weight loss program (17). The potential reasons for this inconsistency across studies is unclear and warrants additional examination.

This study is not without limitations. The participants volunteered to participate in a research study that included a weight loss program, which may not be representative of adults in the general population who seek other weight loss programs. This study also grouped participants in a post-hoc manner based on self-reported perception of weight status at various ages, which may have been influenced by participant's perception of body size. Rather, future studies should consider specifically recruiting participants based on age of obesity onset and to include an objective method (e.g. health records) to confirm the age of obesity onset. While this study did not detect differences in dietary intake or other eating behaviors by age of obesity onset, these data were based on self-report, which may have influenced the accuracy of these data. In a similar manner, physical activity was assessed via self-report, which may have limited our ability to detect differences by age of onset that would explain the differences in fitness observed in this study.

In summary, the current study suggests that regardless of age of onset of obesity (juvenile vs. adult) there is a similar response to a standard behavioral weight loss intervention for weight loss, and both diet and physical activity changes. Thus, based upon the results presented in this study, it appears that the approach of a standard behavioral weight loss intervention may not need to be tailored to this unique participant characteristic of individuals seeking weight loss treatment. However, these findings require replication in studies specifically designed to recruit participants with juvenile and adult onset obesity and with objective measurements of obesity onset, physical activity and dietary measures to further our understanding of responsiveness to a behavioral weight loss intervention by age of onset of obesity.

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K. R. and J. M. J. conceived the study design. J. M. J. carried out data collection. W. L. assisted with conducting the data analysis. All authors were involved in conceptualizing the data analysis, data interpretation and writing of the manuscript.

Conflict of Interest Statement

Kristie Rupp, Dr. Lang and Dr. Taverno Ross declare no potential conflict of interest. Dr. Jakicic's work has been funded by the NIH, Ethicon/Covidien, Jawbone Inc., Body Media Inc., Weight Watchers International and HumanScale. He is a member of the scientific advisory board for Weight Watchers International.

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