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Weight loss and changes in generic and weight-specific quality of life in obese adolescents

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Abstract
Purpose To investigate how weight loss correlates with changes in generic and weight-specific quality of life (QoL).
Methods Youth generic (YQOL-S) and weight-specific instruments (YQOL-W) from 133 youth age 11–19 were analyzed at the beginning and end of 4-week immersion camp sessions known to produce weight loss. Paired samples *t* tests were used to test mean difference between baseline and final Body Mass Index (BMI) and YQOL-S and YQOL-W scores. YQOL-S and YQOL-W scores were transformed to values between 0 and 100, with higher values indicating better QOL. Cohen's *d* effect sizes were calculated to assess magnitude of effects. Percent weight loss (as % of baseline weight), change in BMI (baseline kg/m^2—follow-up kg/m^2), and change in % overweight ((BMI—50th% BMI for age and sex)/50th% BMI for age and sex × 100) were calculated. Multiple regressions were used to model final YQOL scores in the 11–14 and 15–19 age groups as functions of each measure of weight change, sex, age, and baseline YQOL score.
Results Youth experienced significant reductions in BMI (Mean change = 3.7, SD = 1.4, $t = 34.1$, $P < 0.001$) and in the other measures of weight change. YQOL-S and YQOL-W scores improved significantly ($P < 0.001$), and effect sizes were 0.61 and 0.66, respectively.
Conclusion Changes in generic and weight-specific quality of life scores are associated with weight loss. The weight-specific measure is slightly more sensitive to weight changes; however, when controlling for modifiers, the YQOL-W remained significantly associated with weight loss, while the generic QoL measure did not.

Keywords Weight loss · Childhood obesity · Quality of life

Abbreviations

PRO	Patient-reported outcomes
QOL	Quality of life
YQOL-R	Youth quality of life-research instrument
YQOL-S	Youth quality of life-surveillance instrument
YQOL-W	Youth quality of life-weight instrument
zBMI	Standardized z score BMI

Introduction

Previously, we reported on cross-sectional measurement properties of a new weight-specific quality of life measure

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for adolescents, the Youth Quality of Life-Weight module (YQOL-W) [1]. In this article, we investigate how weight loss is associated with change in weight-specific and generic quality of life and provide effect sizes for the YQOL-W for use in future studies.

Evaluating the ability of a patient-reported outcome (PRO) instrument to detect change requires evidence that the PRO instrument can identify differences in scores over time in individuals or groups who have changed with respect to the measurement concept [2, 3]. One approach is to study PRO change scores in relation to an intervention of known effectiveness [4], in this case, to produce changes in weight. Immersion programs, including weight loss camps, that include cognitive behavior therapy are remarkably effective at producing weight loss in obese and overweight adolescents [5–7] For example, in a recent review of 22 evaluations of immersion treatments, the authors noted that, "compared with results highlighted in a recent meta-analysis of outpatient treatments these immersion programs produced an average of 191% greater reductions in percent overweight at post-treatment and 130% greater reduction at follow-up" [7]. Understanding how quality of life (QoL) is associated with participation in these immersion treatments and the weight loss produced may provide valuable information for evaluating the effectiveness of obesity treatments.

Previous research indicates that while the primary motivation for adolescents attending weight loss camps is to experience dietary and weight change, an important collateral effect is changes in psychosocial functioning [6, 8]. Improvements in social acceptance and social and emotional functioning have been found, as well as in quality of life [6, 9]. Participants in a weight loss camp demonstrated improved IWQOL-Kids scores, suggesting responsiveness of the IWQOL-Kids to support the camp intervention, although the measure did not track weight loss [9].

As discussed in Morales et al. [10], the YQOL-W adds to the literature in providing a measure built from the ground up using adolescent views to craft items [11]. To evaluate ability to detect change, we investigated the relative strengths of both a generic and weight-specific QoL measure to detect change associated with weight management and weight loss in generic and weight-specific QoL.

Methods

Participants and procedures

This study utilized a convenience sample of weight loss campers at 8-week Wellspring Camps over the 3-month (June–August) period in 2008 operating in California, New York, and Texas. Wellspring Camps are fee-based weight loss camps with proven initial weight loss on average of 4 lbs of weight loss per week through diet, activities, cognitive behavior therapy (CBT), nutrition and culinary education, family involvement and Internet-based continuing care available for one year after camp [12, 13]. Camps run by Wellspring focus on three primary behavioral goals (very low fat diet, targeting 0 fat g, but accepting < 20 g per day; 10,000 steps per day measured on a pedometer; and 100% consistency of self-monitoring eating and activity). These goals become a focus and serve the overall mission of developing "healthy obsessions" [14]. Wellspring also uses intensive cognitive behavioral therapy (4× per week) to help campers maximize their commitments to change (e.g., decisional counseling), self-regulatory skills (e.g., planning, goal setting, self-monitoring and problem solving), and stress management. Campers use a self-help book to guide them in this process [14], and parents participate in a 3-day family workshop and receive a book that is a parent's guide to the approach [13]. The camp intervention is similar for all age groups, although the content is tailored to make it age-appropriate for younger (11–14) and older (15–19) campers.

Study invitation letters were mailed from Wellspring Camps to camper families for passive parental consent for youth to participate in quality of life baseline and follow-up surveys. Campers were eligible for study if they were between the ages of 11–19 years of age (and, if 19, not more than one year out of high school), were enrolled in 4-week or 8-week sessions, and had a weight and height measurement taken within 7 days of survey baseline and follow-up date. Wellspring Camp staff administered baseline questionnaires to $n = 194$ 4-week campers ages 11–19 at the start of camp and within a few days of end of camp. Additionally, to be included in the study the time between baseline and follow-up surveys was not to be less than 21 days (enrolled in 3 weeks of camp). Seattle Children's Hospital IRB approval was obtained to analyze the de-identified camper data.

Measures

Anthropometric measures

Campers at each camp had weight and height measurements taken weekly by trained staff using Tanita and Detecto weighing scales and standard wall chart stadiometers (TANITA Corporation, model WB 110A, 2001, Tokyo, Japan; DETECTO Cardinal Scale Manufacturing Co., Model WB 110A, 2005; QuickMedical Corp, model QM338 Wall Growth Chart, Issaquah, WA).

Three measures of weight loss were examined. Standardized body mass index (zBMI) was computed according

to age- and gender-specific normative data provided by the Centers for Disease Control and Prevention [15] % overweight [= 100 × (BMI—50th percentile BMI for age and gender)/(50th percentile BMI for age and gender)], a measure commonly used in clinical weight management settings, was calculated for both baseline and follow-up. Finally, % Weight loss was calculated [= 100 × (baseline − follow-up change in body weight, kg)/(baseline body weight, kg)] to evaluate terminal follow-up weight loss outcome.

Generic QoL

To measure generic quality of life, the 8-item Youth Quality of Life- Surveillance (YQOL-S) measure assesses youth's perceptions of getting along with parents, looking forward to the future, feeling alone in life, feeling good about self, enjoying life, being satisfied with life, feeling life worthwhile, and comparing their life with others. The response scale ranges from 0 "not at all" to 10 "very much". The YQOL-S correlates >0.90 with the longer YQOL-R, a 41-item generic quality of life measure. The YQOL-S has been previously used to examine associations between self-reported engagement in health risk behaviors [16].

Weight-specific QoL

Previously published in this Journal [10], the YQOL-W measures weight-specific QoL and provides a total and sub-domain scores for self (4 items), social (12 items), and environment (5 items). Using the same response scale as the YQOL-S, example items include "*I feel depressed about my weight*" (self), "*Because of my weight, I feel uncomfortable at social events*" (social), and "*Because of my weight, it is hard to find clothes that fit me*" (environment).

Additional demographic variables of age, sex, race, parent's education were measured using standard items from National Longitudinal Study of Adolescent Health [17].

Data analysis

Analytic methods

To examine differences between eligible and ineligible campers (data not shown) *P*-values were examined using *t* tests of differences in means for continuous measures, and Fisher's exact tests for homogeneity in percentages for categorical responses. Paired samples *t* tests were run to compare baseline and follow-up mean differences for all weight measures. Cohen's *d* effect sizes were calculated to assess the magnitude of changes [Cohen's d = (mean of change)/(standard deviation of change)]. All analyses were performed using SPSS (version 18.0 for Windows; SPSS, Inc., Chicago, IL).

To assess how the YQOL-W responded to changes in weight, a multiple regression model was created with the YQOL-W final score as the dependent variable. The independent variables were the YQOL-W score at baseline, weight change, sex, age, and camp location. If the weight change variable was significant in this model, we considered this to suggest that weight change accounts for some variation not explained by the other independent variables. This model was run with both weight changes in kilograms and as a percent of initial body weight and the estimated beta coefficient and standard errors were calculated from individual regression models. Separate regression models were run for campers age 11–14 and 15–19.

In regression models, we controlled for baseline QOL score to account for initial differences in quality of life at start of camp. Additionally, days between baseline and follow-up quality of life surveys were controlled to account for differences in days of exposure to camp environment. Age, gender, and age x gender interaction are correlated with quality of life outcomes and weight measures like BMI.

Results

Of the 194 campers completing the survey, a total of $n = 61$ (31% of total) were ineligible: 18 (29% of ineligible) based on age and education eligibility (those 19 years of age, more than one year out of high school); 31 (50% of ineligible) because of missing weight, height, or age measures at baseline or follow-up (necessary information to compute zBMI scores); and twelve (20% of ineligible) completed baseline surveys more than 7 days from the start of camp. The baseline and final weight measurements used in analysis were matched to the closest survey dates. No significant differences in age, education, gender, parent education, and BMI %tile were found comparing the 194 participants with the final analytic cohort of 133 4-week camp observations.

Participant characteristics

Table 1 describes demographic characteristics of 4-week camp attendees from camp locations in California ($n = 36$), New York ($n = 72$), and Texas ($n = 25$) by age groups 11–14 and 15–19. The majority of campers (84.2%) were obese (≥95th BMI % tile-for-age), 15.4 ± 2.0 years of age, female (85%), white (73.5%), and had a mother (73.8%) and/or father (71.5%) graduate from college, and

Table 1 Demographics of main analytic cohort ($n = 133$)

4-Week camp attendees	Total		11–14 years		15–19 years	
	n	%	*n*	%	*n*	%
Age (years)			63	47.4	70	39.8
	[15.4 ± 2.0]		[13.6 ± 0.9]		[16.9 ± 1.3]	
Education (last grade completed)						
5–7	31	23.3	31	49.2	0	0
8–9	51	38.4	31	49.2	20	28.6
10–11	37	27.8	1	1.6	36	51.4
12+	14	10.5	0	0	14	20.0
Sex (female)	113	85.0	50	79.4	63	90.0
Race/ethnicity						
African-American	1	0.8	1	1.6	0	0
Hispanic	9	6.8	5	8.1	4	5.7
White	97	73.5	45	72.6	52	74.3
Mixed/other	25	18.9	11	17.7	14	20.0
Parent's education (college graduate)						
Mother	96	73.8	46	75.4	50	72.5
Father	88	71.5	40	72.7	48	70.6
Days between surveys	[20.5 ± 2.4]		[21.3 ± 2.5]		[19.9 ± 2.4]	
BMI percentile at baseline						
≥ 95th	112	84.2	56	88.9	56	80.0

[mean ± SD] are reported for age and for days between surveys

Missing values: race/ethnicity ($n = 1$); mother's education ($n = 3$); father's education ($n = 10$)

Table 2 Description of weight change ($n = 133$)

4-week camp attendees	Baseline		Follow-up		Change[a]	
	Mean	SD	Mean	SD	Mean	SD
BMI	34.0	6.0	31.3	5.5	2.8***	1.0
Female	33.7	5.9	31.0	5.4	2.7***	0.9
Male	36.0	6.8	32.7	6.1	3.4***	1.1
11–14 ($n = 63$)	33.5	6.3	30.5	5.7	3.0***	1.0
15–19 ($n = 70$)	34.5	5.8	32.0	5.3	2.5***	0.9
zBMI	2.1	0.4	1.9	0.4	0.2***	0.1
11–14 ($n = 63$)	2.2	0.4	0.2	0.1	0.2**	0.1
15–19 ($n = 70$)	2.0	0.4	0.2	0.1	0.2**	0.1
% Overweight	70.6	29.7	56.3	26.5	14.2***	5.2
11–14 ($n = 63$)	76.0	32.2	59.7	28.9	16.2***	5.4
15–19 ($n = 70$)	65.7	26.5	53.3	24.0	12.4***	4.4
% Weight loss	–	–	–	–	7.4***	2.1
11–14 ($n = 63$)	–	–	–	–	8.7***	2.2
15–19 ($n = 70$)	–	–	–	–	6.8***	1.9

Body mass index (zBMI) was computed according to age- and gender-specific normative data from Centers for Disease Control and Prevention

% Overweight = 100 × (BMI − 50th percentile BMI for age and gender)/(50th percentile BMI for age and gender)

% Weight loss = 100 × (baseline − follow-up change in body weight, kg)/(baseline body weight, kg)

**$P < 0.01$

***$P < 0.001$

[a] Change = (baseline − follow-up) measure of weight

38.4% had completed most recently 8th or 9th grade. Campers ineligible for inclusion in this study differed significantly from those eligible in ethnic distribution with eligible campers 75% White and mixed (19%) compared to ineligibles 25% White and mixed (33%) ($P < 0.001$).

Changes in weight, percent weight loss, and BMI

Table 2 describes weight change in 4-week attendees between baseline and follow-up. In all weight measures BMI (2.7 ± 0.9 females; 3.4 ± 1.1 males), zBMI (0.2 ± 0.1), % overweight (14.2 ± 5.2), and %weight loss (7.4 ± 2.1) significant weight loss was detected between baseline and follow-up. The results in all weight measures were similar for both 11–14 and 15–19 age groups.

Changes in generic and weight-specific QoL

The correlation between the YQOL-S and the YQOL-W at baseline was 0.58 and 0.62 at follow-up. Table 3 describes changes and effect sizes between generic and weight-specific quality of life total and self, social and environment sub-domain scores between baseline and follow-up overall and by age group. All quality of life scores detected significant change at the $P < 0.001$ level at follow-up. Both the generic YQOL-S and the weight-specific YQOL-W resulted in comparable moderate Cohen's *d* effect sizes overall (range 0.52–0.69), and for 11–14 year age group (range 0.52–0.79) and 15–19 year age group (range 0.49–0.70).

Correlation between YQOL-S and YQOL-W

Table 4 describes the correlation between generic YQOL-S and YQOL-W for change scores overall and between age groups. Pearson correlation between the total perceptual score on the YQOL-S and the total score on the YQOL-W ($r = 0.30$) and for YQOL-W domain scores (Self $r = 0.14$, Social $r = 0.31$, Environment $r = 0.24$) as well as broken down by age groups suggest that the instruments are not measuring the same concept.

Weight loss and change in QoL

Table 5 describes regression analysis modeling change in quality of life from weight loss, controlling for baseline QoL score, days between assessment surveys, age, gender, and age × gender interaction. In adjusted analysis, change in zBMI was significantly associated with change in total

Table 3 Description of YQOL-S and YQOL-W changes and effect sizes ($n = 133$)

4-week camp attendees	Baseline		Follow-up		Change[a]		Effect size
	Mean	SD	Mean	SD	Mean	SD	Cohen's d[b]
YQOL-S	71.0	17.9	78.9	17.6	7.9***	12.9	0.61
11–14 ($n = 63$)	76.4	16.5	83.1	16.7	6.7***	12.8	0.52
15–19 ($n = 70$)	66.1	17.9	75.2	17.7	9.1***	13.0	0.70
YQOL-W Total	49.2	26.1	59.9	26.9	10.7***	16.1	0.66
11–14 ($n = 63$)	58.5	24.5	69.6	23.7	11.1***	14.8	0.75
15–19 ($n = 70$)	40.8	24.7	51.2	26.9	10.4***	17.3	0.60
Self	40.6	27.8	50.9	27.1	10.3***	15.4	0.67
11–14 ($n = 63$)	49.3	26.4	60.8	25.2	11.4***	14.5	0.79
15–19 ($n = 70$)	32.7	26.9	42.0	25.8	9.4***	16.2	0.58
Social	53.9	27.5	62.9	27.5	9.0***	17.2	0.52
11–14 ($n = 63$)	63.3	25.4	72.0	24.4	8.8***	15.6	0.56
15–19 ($n = 70$)	45.5	26.7	54.5	27.7	9.1***	18.7	0.49
Environment	44.8	28.1	57.2	29.5	12.4***	18.1	0.69
11–14 ($n = 63$)	54.4	27.7	67.3	26.3	12.9***	16.7	0.77
15–19 ($n = 70$)	36.1	25.7	48.1	29.4	12.0***	19.4	0.62

***$P < 0.001$

[a] Change = (follow-up − baseline) quality of life measure

[b] Cohen's d = (mean of change)/(standard deviation of change)

Table 4 Correlation between Generic YQOL-S and YQOL-W for change ($n = 133$)

4-Week camp attendees	Δ YQOL-S Total	Δ YQOL-W Total	Δ YQOL-W Self	Δ YQOL-W Social	Δ YQOL-W Environment
Δ YQOL-S Total	1.00	0.30**	0.14	0.31**	0.24*
11–14 ($n = 63$)	1.00	0.26*	0.12	0.30*	0.17
15–19 ($n = 70$)	1.00	0.34*	0.16	0.32*	0.30*
Δ YQOL-W Total	0.30**	1.00	0.79***	0.96***	0.81***
11–14 ($n = 63$)	0.26*	1.00	0.824***	0.95***	0.81***
15–19 ($n = 70$)	0.34*	1.00	0.77***	0.96***	0.82***
Δ YQOL-W Self	0.14	0.79***	1.00	0.68***	0.52***
11–14 ($n = 63$)	0.12	0.82***	1.00	0.71***	0.58***
15–19 ($n = 70$)	0.16	0.77	1.000	0.66	0.48***
Δ YQOL-W Social	0.31**	0.96***	0.68***	1.00	0.68***
11–14 ($n = 63$)	0.30*	0.95***	0.71***	1.00	0.64***
15–19 ($n = 70$)	0.32*	0.96***	0.66***	1.00	0.70***
Δ YQOL-W Environment	0.24*	0.81***	0.52***	0.68***	1.00
11–14 ($n = 63$)	0.17	0.81***	0.58***	0.64***	1.00
15–19 ($n = 70$)	0.30*	0.82***	0.48***	0.70***	1.00

Pearson correlation coefficients, correlation of generic and weight-specific QoL

* $P < 0.05$

**$P < 0.001$

***$P < 0.0001$

($P < 0.01$), self ($P < 0.001$), social ($P < 0.01$), and environment ($P < 0.05$) YQOL-W scores. The regression shows that changes in the generic YQOL-S scores were not significant. % weight loss was significantly associated with total ($P < 0.05$), self ($P < 0.05$), and social ($P < 0.01$) YQOL-W scores, but not in the YQOL-W environment or YQOL-S scores. To interpret Table 5 results, it should be acknowledged that with a 1 percentile unit BMI change in YQOL-W is expected to be small (e.g., an increase in YQOL-W score of 2.52 units), whereas, with zBMI, a 1 unit corresponds to 1 standard deviation zBMI change resulting in a greater magnitudes of change in YQOL-W (e.g., an increase in YQOL-W of 46.55 units). Regression results were similar for both age groups included in the analyses with the exception that % weight loss was no longer statistically significant for YQOL-W scores.

Discussion

As found in previous studies, the weight loss camps reported in this study were successful in producing weight loss in youth attendees. These results support the study design used in this paper to assess the ability of generic and

Table 5 Regression analysis modeling change in QOL from weight loss ($n = 133$)

4-Week camp attendees	ΔYQOL-S b (se)	Δ YQOL-W Total b (se)	Δ YQOL-W Self b (se)	Δ YQOL-W Social b (se)	Δ YQOL-W Environment b (se)
BMI	0.96 (1.08)	2.52 (1.43)	1.31 (1.33)	2.91 (1.51)	1.04 (1.61)
11–14 ($n = 63$)	0.04 (1.64)	0.16 (1.98)	1.37 (1.91)	0.66 (2.06)	1.88 (2.18)
15–19 ($n = 70$)	0.06 (1.65)	3.36 (2.36)	2.15 (2.11)	3.26 (2.55)	2.63 (2.74)
zBMI	3.57 (12.55)	46.55*** (15.56)	47.90**** (13.98)	48.91*** (16.44)	35.90** (17.99)
11–14 ($n = 63$)	9.44 (16.57)	38.61** (19.08)	40.03** (17.60)	39.80** (20.02)	22.19 (21.62)
15–19 ($n = 70$)	32.32 (19.69)	65.60** (26.78)	57.94** (24.17)	66.01** (28.94)	68.61** (31.76)
% Overweight	0.21 (0.21)	0.47 (0.28)	0.23 (0.26)	0.55 (0.30)	0.18 (0.32)
11–14 ($n = 63$)	0.02 (0.31)	0.05 (0.37)	0.27 (0.36)	0.11 (0.39)	0.37 (0.41)
15–19 ($n = 70$)	0.02 (0.34)	0.67 (0.49)	0.42 (0.44)	0.65 (0.53)	0.53 (0.57)
% Weight loss	0.32 (0.52)	1.58** (0.67)	1.50** (0.62)	1.86*** (0.70)	0.56 (0.77)
11–14 ($n = 63$)	0.07 (0.73)	0.88 (0.87)	0.85 (0.84)	1.20 (0.90)	0.10 (0.98)
15–19 ($n = 70$)	0.01 (0.81)	1.96* (1.13)	1.67* (1.02)	2.14* (1.22)	1.14 (1.33)

Weight loss = (baseline − follow-up) measure of weight

Controlling for baseline QOL score, days between assessment surveys, age, gender, and age × gender interaction

Δ = (follow-up − baseline) change in quality of life measure

b (se) = estimated beta coefficient and standard error from individual regression models

* $P < 0.10$

** $P < 0.05$

*** $P < 0.001$

**** $P < 0.0001$

weight-specific quality of life measures to detect changes in weight produced by an intervention of known effectiveness, i.e., immersion obesity treatment. The weight loss observed, uncontrolled, was associated with significant changes in both the generic (YQOL-S) and weight-specific (YQOL-W) measures of quality of life.

These findings support other published reports that weight management can change adolescent perceptions. In a 12-week weight management program in Connecticut, obese adolescents at 1 year ($N = 25$) showed a significant decrease in BMI z scores and mean percentage body fat and an increase in self-concept scores [18]. Other undoubtedly interrelated changes that have correlated with weight loss in adolescents include: increases in global self-esteem, perceived athletic competence, satisfaction with physical appearance, moods, and psychopathology [8, 12, 19]. A recent review of immersion treatments for youth found mixed results with long-term follow-up, with weight gain for some treatments and weight loss for others [7]. One study of Wellspring camps similar to those participating in this study found continued change in reduction in percent overweight from end of immersion to 18-month follow-up [7, 12, 17].

Interestingly, Kolotkin [9] found significant change in the IWQOL-Kids, another measure of weight-specific quality of life, with camp attendance. These observed changes, however, were not associated with weight loss. Clearly both weight loss and the camp experience can affect social and psychological outcomes, including weight-specific quality of life.

The effect sizes for the YQOL-S and YQOL-W were similar. Of importance, however, when controlling for important potential covariates such as age, sex, and weight at baseline, the YQOL-W remained significantly associated with weight loss, while the generic QoL measure did not. This finding supports previous research that condition-specific measures are more responsive to changes than generic measures [20]. This result also suggests that age, sex, and weight should be included as controls in any association between weight loss and QoL.

Statistically significant changes were observed in all three YQOL-W domains (Self, Social, Environment) in relation to weight loss, i.e., on average campers lost 7.4% of their body weight and YQOL-W change scores (Table 5) were highly associated with body weight change. The camp experience may be augmenting this effect as both weight management and weight loss could produce such changes. For example, items in YQOL-W may be as sensitive to weight management as to weight loss itself. The item, "*Because of my weight I am embarrassed to eat around other people",* could be affected both by the camp experience of eating together, as well as, by CBT weight

management counseling about positive self-esteem, and actual weight loss. We were unable to collect additional measures, such as attitudes toward the camp experience and psychosocial measures that might have helped to separate the effects of the camp experience from the effects of weight loss.

BMI during treatment is relatively insensitive to body weight changes. The lack of a favorable change in BMI, the most traditional weight change measure, can be defeating to a camper who is working hard on his or her treatment regimen but is not seeing a measured effect. This may be a reason for youth to become less adherent to their treatment plan [21].

Alternatively, the BMI *z* score has been used by researchers for some time. For campers in this study, a change in zBMI of 1 standard deviation unit is associated with a 46.55 YQOL-W increased score change. The zBMI score is the deviation of the BMI value for an individual from the mean value of the reference population (sex and age specific) divided by the standard deviation for the reference population. The number of standard deviations an individual is for BMI above or below the mean (zBMI) is not used widely in clinical practice due to difficulties for both clinicians and laypersons to understand without proper explanation. However, such explanation in the clinician–youth interaction may be worthwhile.

In Wellspring Camps, % weight loss is the measure used to track change in weight since it is most easily interpreted by campers and camp staff and is an individual-specific measure, reflecting change from baseline weight [12]. In clinical settings, a modest weight loss, such as 5–10% of total body weight, is likely to produce health benefits, such as improvements in blood pressure, blood cholesterol, and blood sugars. Interestingly, this study demonstrates significant effects to QoL from weight loss in only the zBMI and % weight loss measures. These findings suggest that what measurement tool clinicians or interventionists use to track participants in weight loss programs may be crucial to measuring successful weight loss. These results support the value of using % overweight in clinical context, but other related measures could prove helpful as motivators, such as the zBMI. For example, BMI percentile (relative weight status on CDC normative data) is very easily calculated on the CDC Web site [22] or the Wellspring Web site [23]. The Wellspring BMI calculator can inform children and parents about the child's BMI percentile, but also graphically depicts the percentile and provides feedback about projected adult weight if weight loss does not occur.

There are several limitations to this study. Selection bias could explain some of these results. Campers were from families that had college education and predominantly white. The weight change, however, and corresponding changes in the QoL measures are unlikely to be attributed entirely to the specific characteristics of the campers. Impaired QoL is also more likely detected in treatment-seeking individuals compared to community-based samples [24, 25]. Caution should be taken, however, in generalizing results to different income and ethnic groups.

Further study of weight loss camps with camp-specific measurement may be able to differentiate effects of camp from effects of weight loss. A randomized trial of immersion treatment would be necessary, possibly using a factorial design, though feasibility, expense, and cost-effectiveness would likely be significant concerns.

A strength of this study is the use of four measures to describe weight change in campers: BMI, zBMI, % overweight, and % weight loss. Each of these weight change measures has different underlying assumptions and distributions. The magnitude of change in QoL scores for the different measures demonstrates this point. For the YQOL-W Total score, the loss of 1 BMI unit is associated with a 2.52 YQOL-W increased score change. For clinicians, BMI and BMI percentiles and % overweight (the percentage of the youth's BMI that is above the 50th percentile for age and sex) have great utility in the clinical setting and are used more frequently and most appropriately by primary care providers [26].

Conclusion

The YQOL-W is a 21-item instrument that can be used for weight-specific applications in youth populations. If the researcher is interested in comparing youth in a study of weight with youth in other populations, items from the 8-item generic YQOL-S instrument can be used. For example, the generic item worded in a positive direction, "*I feel good about myself*" can be related to the more specific weight-related item expressed as a negative effect, "*Because of my weight I feel ashamed about my weight …*" Thus, the two measures are complementary in assessing QoL from a positive as well as a negative perspective.

The newly developed YQOL-W is sensitive to weight change in adolescents 11–19 years of age undergoing weight loss in a weight intervention program of known effectiveness. Further use of this measure in other weight management programs is encouraged.

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Conflict of interest statement Daniel Kirschenbaum is employed, in part, by Wellspring, a company that provides immersion treatment programs for overweight young people and adults.

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