ORIGINAL ARTICLE

Longitudinal quality of life improvement in underserved rural youth with obesity

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Summary

Objective

ACT! (Actively Changing Together) is a family- and community-based intervention targeting youth with obesity. The objective of this study was to establish the longitudinal impact on Health-Related Quality of Life (HRQoL) as well as the relationship with anthropometric and demographic factors.

Methods

Youth ($n = 75$) aged 8–14 years meeting criteria for overweight or obesity were referred to the programme. Twelve, 90-min classes in English and Spanish were held at the YMCA. Demographics and anthropometrics were assessed, as well as HRQoL that was measured with the child-reported Pediatric Quality of Life Inventory (PedsQL™) 4.0 Generic Core Scale. Data was collected at three follow-up points after completion of the intervention: initial follow-up ($n = 65$), 6 ($n = 41$) and 12 months ($n = 25$). Analysis included paired dependent t-tests between baseline and follow-up, and Pearson's correlations on HRQoL, anthropometric and demographic data.

Results

PedsQL scores significantly improved from baseline to all follow-up timepoints (initial follow-up immediately following the intervention, and 6 and 12 months post intervention). Over time, body mass index Z-Score and per cent body fat displayed various points of significance and strengthening correlations.

Conclusions

Longitudinal improvements in HRQoL were sustained up to 12 months following a family- and community-based intervention in this underserved population. Anthropometric measures continuously correlated with and contributed to HRQoL outcomes.

Keywords: Behavioural science, childhood obesity, lifestyle modification, quality of life.

Introduction

In the USA, prevalence of obesity among children and adolescents was recently reported to be 17%, and prevalence of extreme obesity was approximately 6% (1,2). While some areas report declines in paediatric obesity rates, there remains a clear disparity between ethnic groups, with Hispanic/Latino youth being among the highest in rates of childhood obesity (3–5), especially if they are from lower socioeconomic areas (2,6). Risk for childhood obesity is complex and influenced by a variety of known factors including but not limited to infant feeding practices, socioeconomic status, parent–child relationships, culture and language, food security status, and parental body weight (7–11).

Hispanic/Latino heritage has been shown to be a contributing risk factor for the development of obesity and type 2 diabetes among both adults and children (12–14). Additionally, rural residence (15) and living in communities with limited options for safe outdoor recreating are also risk factors for health disparities (16). Regardless of social, environmental and cultural circumstance, the

detrimental impact on all youth with obesity includes metabolic, social, emotional and psychological sequelae (13,17). Impact on the healthcare system expenditure is complex, including but not limited to increased use of emergency rooms visits, office visits and prescription drugs than their normal weight peers among adolescents with obesity (18).

Health-Related Quality of Life (HRQoL), an important measure of overall health, includes constructs in social, physical and psychological well-being and functioning (19), and should be considered along with anthropometric status as an indicator for disease burden (20). Expectantly, youth with obesity have been shown to have lower HRQoL compared with normal or overweight peers (21–23), and indeed, HRQoL has been shown to increase following weight loss (24,25). Low HRQoL in turn can perpetuate declining physical and mental health – subjecting them to many challenges as they grow into late adolescence and young adulthood. HRQoL measures can be correlated with weight status, which contributes to the psychological health of youth (17). Thus, addressing the multiple components of the disease, including HRQoL, is hypothesized as a successful component to youth lifestyle interventions (21,23). In addition, family, social and school functioning are an important aspect of all paediatric life, so engaging family members and parents has been shown to be an important consideration in weight management and HRQoL of youth (14,26–28). Community-based approaches can also lead to better HRQoL outcomes (29,30). In this study, the impact of an instructor-led, family and community intervention on HRQoL in youth with obesity in a rural, underserved population was evaluated.

The primary purpose of this study was to examine the impact of a brief, family and community-based lifestyle intervention on youth HRQoL in a rural, underserved population. A secondary purpose to this study was to evaluate the impact of the anthropometric findings on HRQoL outcomes. We hypothesized the ACT! (Actively Changing Together) intervention would improve HRQoL scores and improve body mass index (BMI) Z-Score and per cent body fat immediately after the intervention, and that those effects would be sustained 6 and 12 months post intervention.

Methods

Yakima, Washington, USA, represents an ideal location to study an underserved and lower socioeconomic population. This agricultural community with a low population density (56 persons per square mile) is located 150 miles southeast of Seattle, Washington, USA (31), and is nearly a 3-h drive and over a mountain pass from the nearest research university, children's hospital or tertiary care centre. Many Yakima neighbourhoods have limited access to outdoor exercise opportunities because of weather and safety concerns. Care for this population is provided by small community hospitals and clinics. The median household income in 2014 was reported at 18.8% lower than the national average, and the region consists of approximately 45% white, non-Hispanic and 47.7% Hispanic/Latino (31). In 2010, one in three adults and one in seven adolescents had obesity. Lastly, the area has numerous risk factors related to the social determinants of health (32), and little is known about HRQoL in these youth.

Study design

ACT! Get up, Get Moving! Childhood obesity programme is an evidence-based intervention developed by Seattle Children's Hospital and in use in Seattle-area YMCAs since 2008. The programme, described elsewhere (33) targets youth that meet BMI-for-age percentile overweight or obesity standards between the ages of 8 and 14 years. Previous analyses found an initial improvement in anthropometric outcomes and eating behaviours after participation in the programme. One main objective was to improve HRQoL in youth participants, but little data is available on this topic (33). Additionally, little is known as to the programme's effectiveness on HRQoL in a more rural, underserved Hispanic/Latino and Spanish-speaking population, or the interaction with anthropometric and demographic factors beyond the 12-week intervention design. Upon conclusion of the current study, ACT! continues to be offered by the YMCA and Yakima Valley Memorial Hospital.

Social cognitive theory is commonly used as a theoretical framework for health behaviour change interventions and chronic disease self-management programmes (34–36). The core determinants of the social cognitive theory (perceived self efficacy, knowledge, outcomes expectations, goals, etc.) were appropriately adapted for ACT!. The family-based component of this programme reflects the idea that children learn eating and activity behaviours from their families, and those behaviours are modifiable.

Youth aged 8–14 years were referred by a primary care provider upon meeting inclusion criteria (BMI-for-age ≥85th percentile, also open to those with comorbid conditions, if applicable). Youth were required to speak either English or Spanish and have a co-enrolled parent/guardian in the programme. Participants were not permitted to switch language sessions during the study. Nominal incentives were offered to the youth and co-enrolled parent at each data collection point. Also,

participating families were given complementary family memberships to the YMCA during the ACT! programme and for 6 months after conclusion of their 12-week class. Three sessions of the ACT! programme (Summer, Winter and Fall) allowed year-round referral.

The curriculum for ACT! focuses on lifestyle modification – healthy eating, increased physical activity and behaviour modification. A YMCA fitness staff member and a health educator facilitated the 12 weekly classes. Each 90-min class was held in the afternoon or evening at the YMCA. Classes included a mixture of separate and combined activities for youth and the co-enrolled parents/guardians. Parents and youth spent a total of 60 min together during each class performing enjoyable physical activities and learning healthy living topics. The 30 min spent apart allowed the youth to continue to exercise with their peers in the programme and the parents/guardians to learn and improve parenting skills, nutritional decision-making, troubleshooting barriers to healthy living and reducing sedentary time at home (Table 1). Material was adapted to be culturally sensitive and appropriate for both English and Hispanic/Latino populations. This adaptation was accomplished using focus groups of Spanish speaking families and medical Spanish interpreters, followed by review from bilingual community health providers and programme facilitators from the Latino community (33). Institutional Review Board approval was obtained from Pacific Northwest University of Health Sciences and Yakima Valley Memorial Hospital for this study. Informed consent/assent was obtained from both the parent/guardian and youth at baseline and again at 6-month follow-up for returning families.

Measures and tools

Household demographics were collected at baseline from the co-enrolled parent/guardian. Anthropometric data collection included height, weight, waist circumference and per cent body fat. Weight and per cent body fat were measured using the Detecto® PD150 Body Fat Analysis Scale (Cardinal Scale Manufacturing Co., Webb City, MO, USA). YMCA fitness staff and study investigators obtained anthropometric data.

HRQoL was measured using the Pediatric Quality of Life Inventory (PedsQL™) 4.0 Generic Core Scale. The PedsQL™ is a 23-item empirically validated, age-specific survey, with two major subdomains of psychosocial and physical functioning averaged to form a total HRQoL score. Psychosocial health is a combination of scores based on minor subdomains of school, emotional and social functioning. Thus, the PedsQL™ assesses the multiple dimensions of health: physical, mental and social as originally recommended by the World Health Organization (37). Child-reported HRQoL using this modality has been previously demonstrated as a reliable and consistent tool (38).

The primary outcome of this study was youth self-reported HRQoL. Measurements for HRQoL and anthropometric data were taken at four time-points: (i) baseline

Table 1 General time allotment and topics for the ACT! Get up, Get Moving! programme

Time and weekly class topics for ACT!	
Time allotment (30 min each)	
Parents and youth together – Fun family physical activities	
Parents and youth separate – Youth: physical activities; parents; skills/health topics	
Parents and youth together – Nutrition topics/activities	
Topics by week	
Parent group topic	*Nutrition topic* (*youth and parents*)
Week 1: Overcoming barriers/reasons to attend ACT!	MyPlate
Week 2: SMART goals and goal tracking	Portion sizes
Week 3: Engaging kids in making changes together	What is normal eating?
Week 4: Social support: grandparents/ extended family	Hunger scale
Week 5: Starting conversations with kids/teens	Importance of family meals
Week 6: Role model exercise as a way of life	Importance of breakfast
Week 7: Family Grocery store tour - "healthy meal on a budget."	–
Week 8: Sedentary activity	Healthy Living Goals
Week 9: If you slip, don't give up	Re-Think Your Drink
Week 10: Fitness for all abilities	Fast food
Week 11: Planning for special occasions	Screen time management
Week 12: Celebration	–

– 1 week prior to start of the intervention; (ii) initial follow-up – upon completion of the 12-week intervention; (iii) 6 months after the intervention concluded; and (iv) 12 months after the intervention concluded. Only those who completed the initial 12-week programme were invited for follow-up at 6 and 12 months.

Analyses

Psychosocial and physical HRQoL scores were calculated at each time point according to PedsQL® scoring guidelines with a score of 100 representing the highest HRQoL rating (38). Omnibus Analyses of Variance were run for all statistical inquiries. HRQoL scores were analyzed with paired dependent *t*-tests between baseline and each follow-up period. BMI Z-Score was calculated for participants prior to analyses according to the lambda-mu-sigma method described by the Center for Disease Control and Prevention (39).

Differences in gender or language class regarding HRQoL scores and anthropometric measures were analyzed using one-way ANOVA. Pearson's correlations (*r*) were performed between HRQoL, anthropometric and demographic factors with calculation of the coefficient of determination (R^2). All analyses were performed using SPSS v22 with a *p*-value set to <0.05.

Data from participants who no-showed or dropped-out before the conclusion of the 12-week intervention were excluded from this analysis. For those who completed the initial intervention, but failed to follow-up at 6 months then proceeded to return at 12 months post intervention, data were included in analysis.

Results

Of the 75 youth that began the ACT! programme, 68 (91%) completed all 12-weeks. Seven dropouts and three participants that completed the programme were excluded from the analysis because of missing or incomplete PedsQL® forms. Sixty-five (87%) youth with an average age of 10.8 years (standard deviation [SD] = 1.66) were included in the analysis. At 6 and 12 months, 41 (55%) and 25 (33%) youth, respectively, returned for follow-up. For boys, average weight was 71.62 kg (SD = 21.5) at baseline, 72.8 kg (SD = 22.1) at initial follow-up, 75.7 kg (SD = 20.5) at 6-month follow-up and 76.2 kg (SD = 20.8) at 12-month follow-up. For girls, average weight was 67.7 kg (SD = 18.2) at baseline, 68.4 kg (SD = 18.2) at initial follow-up, 72.5 kg (SD = 18.4) at 6-month follow-up and 80.9 (SD = 18.3) at 12-month follow-up. There were no significant differences in weight changes by gender. Average BMI Z-Scores at baseline were 2.25 (SD = 0.34) and 2.19 (SD = 0.40) for males and

females, respectively. Average BMI and per cent body fat of the cohort at baseline were 30.38 (SD = 5.50) and 29.78 (SD = 9.30), respectively. Gender and class participation (English vs. Spanish) were distributed evenly and analyzed for differences based on HRQoL outcomes and anthropometric measurements (Table 2). Notably, the only consistently observed difference was a higher per cent body fat at each measurement point among females. Household demographics are summarized in Table 3. The demographics of this study sample represent the population of Yakima, WA (i.e. low socioeconomic status, significant Hispanic/Latino population and low education level).

Primary outcome – HRQoL

Omnibus Analyses of Variance were run for all statistical inquiries and the significance of those models allowed for tests of simple effects. Results for the psychosocial subdomain were $F_{(3,57)} = 6.42$ (*p* = 0.001), and the physical subdomain were $F_{(3,57)} = 3.28$ (*p* = 0.027). Child-reported HRQoL outcomes by major subdomain at each time point are summarized in Figure 1 and minor subdomains in Table 4. Total psychosocial HRQoL scores significantly improved at all three time-points: from baseline to initial follow-up (74.8 vs. 81.2, *p* < 0.001), baseline to 6-month follow-up (72.0 vs. 83.1, *p* < 0.001) and baseline to 12-month follow-up (76.8 vs. 87.1, *p* < 0.001). Total physical HRQoL scores also significantly improved from baseline to initial follow-up (76.4 vs. 84.3, *p* < 0.001), baseline to 6-month follow-up (76.6 vs. 85.1, *p* < 0.001) and baseline to 12-month follow-up (78.7 vs. 85.8, *p* = 0.014). Thus, the primary hypothesis of this study was supported at each time point in each subdomain. A medium to large effect size using *Cohen's d* was observed in each major subdomain at each time point (*d* = 0.50–1.10). These data identify a global improvement in HRQoL outcomes resulting from the intervention. There were no statistical differences within the groups for the subdomain of school functioning (*p* > 0.05). Average change in score per participant is summarized in Table 5. This shows clinically useful average values of improvement were consistent over time. Parent evaluations of the child's HRQoL were also analyzed, with no significant difference between child and parent reports. These values are not displayed here as they are similar to those reported in previous studies (21,23,40).

Secondary outcomes – anthropometrics and correlations

Change of BMI Z-Score, per cent body fat and waist circumference longitudinally are summarized in Table 6. There was a statistically significant decrease in BMI

Table 2 Mean, SD and significance via ANOVA based on gender and language session.

Time point	Measurement	Measurements by gender and language Mean (SD)		*p*-value	Mean (SD)		*p*-value
		Male (*n* = 36)	Female (*n* = 29)		English (*n* = 32)	Spanish (*n* = 33)	
Baseline	Psychosocial HRQoL	75.57 (12.58)	73.16 (19.72)	0.551	70.67 (18.75)	78.21 (12.12)	0.058
	Physical HRQoL	77.69 (14.68)	74.74 (19.63)	0.490	76.17 (17.39)	76.57 (16.86)	0.926
	Total HRQoL	76.31 (11.66)	73.72 (18.89)	0.500	72.59 (17.47)	77.65 (12.48)	0.182
	BMI Z-Score	2.25 (0.34)	2.19 (0.40)	0.496	2.28 (0.37)	2.18 (0.36)	0.250
	Per cent Body Fat	25.77 (8.80)	34.94 (7.45)	*<0.001	31.94 (7.80)	27.62 (10.40)	0.065
	Waist circumference	39.10 (5.72)	37.24 (4.46)	0.158	39.09 (5.35)	37.48 (5.09)	0.218
Initial follow-up	Psychosocial HRQoL	79.12 (13.52)	83.73 (14.39)	0.196	78.94 (17.16)	83.32 (9.85)	0.218
	Physical HRQoL	82.68 (12.83)	86.18 (12.88)	0.283	83.24 (15.55)	85.22 (9.86)	0.541
	Total HRQoL	80.34 (12.28)	84.78 (12.74)	0.163	80.43 (15.73)	84.16 (8.55)	0.240
	BMI Z-Score	2.20 (0.36)	2.13 (0.45)	0.458	2.22 (0.43)	2.12 (0.38)	0.315
	Per cent Body Fat	25.17 (8.69)	34.30 (7.51)	*<0.001	31.47 (7.71)	26.86 (10.31)	*0.047
	Waist circumference	38.40 (5.24)	36.80 (4.58)	0.200	38.48 (5.05)	36.91 (4.86)	0.207
6-month follow-up	Psychosocial HRQoL	84.95 (9.12)	80.62 (13.82)	0.260	80.58 (13.20)	86.02 (8.34)	0.152
	Physical HRQoL	87.35 (9.30)	82.03 (16.20)	0.216	84.84 (16.14)	85.29 (7.79)	0.917
	Total HRQoL	85.78 (7.58)	81.16 (13.42)	0.193	82.10 (12.84)	85.76 (7.02)	0.302
	BMI Z-Score	2.20 (0.39)	2.13 (0.49)	0.583	2.16 (0.50)	2.17 (0.36)	0.923
	Per cent Body Fat	26.41 (8.87)	35.25 (8.15)	*0.002	31.51 (8.42)	29.72 (10.69)	0.551
	Waist circumference	39.88 (5.69)	38.72 (4.74)	0.483	39.96 (5.64)	38.69 (4.84)	0.437
12-month follow-up	Psychosocial HRQoL	86.70 (8.13)	87.58 (10.20)	0.805	86.07 (10.39)	88.11 (7.11)	0.560
	Physical HRQoL	85.41 (8.57)	86.36 (11.20)	0.804	85.11 (11.56)	86.54 (7.15)	0.705
	Total HRQoL	86.21 (6.52)	87.15 (10.10)	0.771	85.71 (10.16)	87.55 (5.00)	0.562
	BMI Z-Score	2.14 (0.36)	2.06 (0.71)	0.682	2.17 (0.62)	2.03 (0.25)	0.527
	Per cent body fat	25.59 (7.92)	34.93 (8.37)	*0.038	31.75 (9.15)	22.02 (3.92)	*0.039
	Waist circumference	39.40 (4.88)	40.22 (6.92)	0.736	41.27 (6.19)	37.53 (3.95)	0.108

*$p < 0.05$
BMI, body mass index; HRQoL, Health-Related Quality of Life; SD, standard deviation.

Z-Score at initial and 6-month follow-up. Per cent body fat and waist circumference showed various, but not consistent statistical significance over each time point.

The secondary hypothesis of this study was also supported in the case of BMI Z-Score, per cent body fat and waist circumference at specific follow-up and HRQoL subdomains. Correlation testing found HRQoL was impacted by BMI Z-Score and per cent body fat, longitudinally. Over time, BMI Z-Score and per cent body fat displayed various points of significance and strengthening correlations. The coefficient of determination (R^2) was calculated for each Pearson's *r* to reveal the contribution of anthropometric measures on HRQoL (Figure 2).

Per cent body fat represented an anthropometric measure with significant impact on both psychosocial and physical HRQoL. Specifically, per cent body fat had significant impact on school, emotional and social functioning. School functioning correlated at 12 months ($r = -0.56$; $p = 0.019$); emotional functioning correlated at baseline ($r = -0.26$; $p = 0.037$) and 12 months ($r = -0.53$; $p = 0.029$); and social functioning correlated at baseline ($r = -0.31$; $p = 0.014$) and 12 months ($r = -0.58$;

$p < 0.001$). These correlations indicate an increasing HRQoL as per cent body fat decreased. Per cent body fat correlated with physical HRQoL at baseline ($r = -0.26$; $p = 0.040$) and 6 months ($r = -0.33$; $p = 0.047$).

As expected, BMI Z-Score correlated only with physical HRQoL at baseline ($r = -0.25$; $p = 0.044$), initial follow-up ($r = -0.25$; $p = 0.051$), 6 ($r = -0.32$; $p = 0.055$) and 12 months ($r = -0.47$; $p = 0.020$). Waist circumference correlated with social functioning at 6 ($r = -0.41$; $p = 0.012$) and 12 months ($r = -0.42$; $p = 0.040$).

Family income was the only household demographic factor correlated with HRQoL outcomes. As family income increased, small correlations with school functioning ($r = 0.29$; $p = 0.033$) and physical HRQoL at baseline, only, were observed ($r = 0.27$; $p = 0.046$).

Discussion

The current study evaluated the impact of a family and community based intervention on HRQoL of youth with overweight or obesity. A 12-week intervention can

Table 3 Household demographics of youth and parent participants.

	Household demographics		
Demographic		*n*	Per cent of households
Parent education	High school, GED or below	36	55
	Some college	7	11
	College graduate	15	23
	N/A	7	11
Annual family income	<$25,000	20	31
	$25,000–$49,999	24	37
	$50,000–$74,999	4	6
	$75,000–$99,999	2	3
	$100,000+	5	8
	N/A	10	15
Parent ethnicity	White, non-Hispanic	18	28
	Hispanic/Latino	41	63
	N/A	6	9
Co-enrolled adult	Mother	46	71
	Father	13	20
	N/A	6	9
Marital status	Single	6	9
	Living with significant other (not married)	6	9
	Married	43	66
	Divorced	4	6
	N/A	6	9
Persons in household	Two people	1	2
	Three people	6	9
	Four people	18	28
	Five people	16	25
	Six people	7	11
	Seven people	5	8
	N/A	12	18
Primary language spoken by parent	English	33	51
	Spanish	23	35
	Both	3	5
	N/A	6	9
Parent receives income from job?	Yes	48	74
	No	11	17
	N/A	6	9

GED, General Educational Development.

significantly improve HRQoL in this population initially. Moreover, longitudinal follow-up revealed sustained improvement in HRQoL ratings at 6 and 12 months after conclusion of the intervention.

The early teenage years have been identified as key indicators for the association of obesity and other risky behaviour (17). Often, the professional and lay community may focus heavily on the more obvious impacts of health intervention programmes such as anthropometric measures. However, HRQoL factors heavily into the overall health of the youth with overweight or obesity. The CDC emphasizes the importance of HRQoL as a valid measurement of unmet needs and intervention outcomes (41).

A study by de Beer *et al.* found that youth with obesity had significantly lower HRQoL in the total score, physical score, and social functioning than youth without obesity (22). Preliminary reports on the ACT! programme and HRQoL in an urban/suburban environment showed statistically significant improvements in the emotional function, physical function and total HRQoL, but not in the school or social functions (33). A novel component of the current study was the impact and sustainability of this community-based intervention in a rural, agricultural community with a large Hispanic/Latino population. Previously, this community had no access to organized resources for youth with overweight or obesity. In the current study, a significant increase in all subdomains was observed, except school functioning.

The success of this family and community-based programme on HRQoL is potentially due to several key factors. One component was the successful collaboration between community, healthcare, and academic entities (33). Collaboration between healthcare professionals in the region referred youth meeting criteria to the programme. Additionally, the YMCA professionally and consistently received and worked with the youth that were referred to the programme. This community-healthcare-academic alliance potentially enables the perpetuation of this programme in similar environments without grant money from research or government institutions as has been suggested previously (42). For example, the ACT! programme is financially sustained in Seattle by a sliding fee scale for enrollees, and is free to enrollees in Yakima because of financial support by the Yakima YMCA and Yakima Valley Memorial Hospital Foundation. The role of academic entities in the current study was valuable for design and redesign of outcome measures. Thus, these partnerships created a strong network of support for these youth and their families with lasting impact on the community.

Another major contributor to this programme's success was a combination of the family inclusion (required co-enrolled parent) and social interaction with peers during the programme. Engaging family members and parents has been shown to be a key component of successful weight management interventions targeting children and adolescents even in the most challenging of clinical situations (26). Higher parental BMI has been associated with higher child BMI in Hispanic/Latino populations, (10) thus engaging the entire family in the intervention has inherent potential for success. Parents could also feel reassured that their children had a safe place to play and exercise with the YMCA as the main fitness partner. Much of the success from the family involvement is complemented by the social cognitive theory
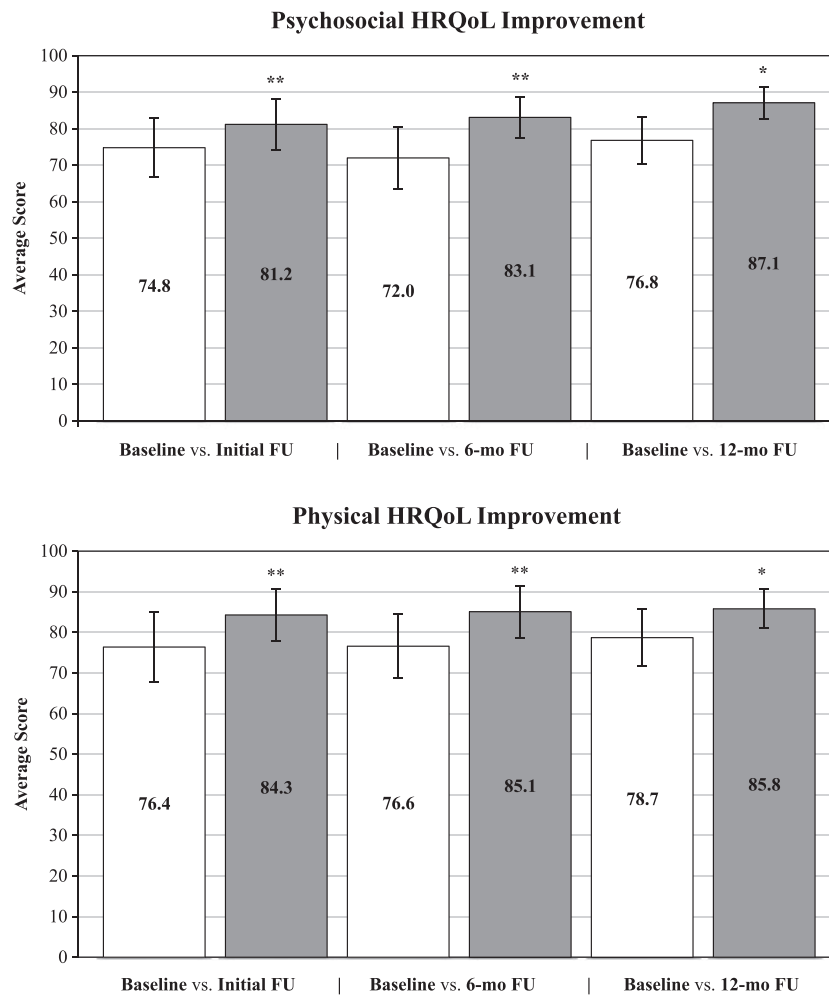
Psychosocial HRQoL Improvement

Physical HRQoL Improvement

Figure 1 Longitudinal HRQoL Improvement. Paired dependent *t*-test of child reported psychosocial (A) and physical (B) HRQoL based on follow-up period. FU, follow-up; HRQoL, Health-Related Quality of Life; **$p < 0.001$; *$p < 0.05$

basis of the ACT! programme (43). Also, the social interactions between peers during the class was highly valued by participants as measured by a qualitative end-of-intervention analysis.

The cultural influence of the current study participants and its implications cannot be overlooked. It has been estimated that Latinos are the fastest growing population in the USA with potentially one in three children being of Hispanic/Latino ethnicity by 2030 (44). The current study included 63% Hispanic/Latino youth. A systematic review of paediatric obesity interventions in a Hispanic/Latino population identified three statistically significant influencers on anthropometric data – a parental component, theory-driven and dedicated intervention staff (14). The current study included all three of these components, and the findings of the programme in this report are agreeable with these established factors.

Also important to consider is the socioeconomic status of those involved in this study. With some variance in ethnic subgroups, previous reports show that lower education and parental income are associated with higher rates of obesity (12). Many of the participants of the current study were at or below the state median income – representing a working class with limited resources. This means that time and energy are important considerations in any intervention targeting behaviour change. One of the benefits of the ACT! programme was the brief time of intervention held at a familiar community location. Savoye *et al*. evaluated a similarly structured but more intensive family-based intervention. They demonstrated sustained improvements in anthropometric markers after 24 months following a 12-month, bi-weekly, intervention. However, this study had a high dropout rate during the course of the intervention, and HRQoL was not measured among

Table 4 Quality of life changes at each time point compared with baseline measurements in each subdomain.

	Mean (SD) Baseline	Initial follow-up	p-value,95% CI	Effect size	Longitudinal HRQoL outcomes by subdomain 6-month Baseline	Mean (SD) follow-up	p-value, 95% CI	Effect size	12-month Baseline	Mean (SD) follow-up	p-value,95% CI	Effect size
Psychosocial	74.78 (16.23)	81.12 (13.99)	<0.001, −9.55 to −3.24	0.51	72.05 (17.20)	83.08 (11.42)	<0.001, −14.89 to −7.20	0.96	76.79 (12.76)	87.05 (8.85)	<0.001, −14.79 to −5.74	0.90
School*	76.27 (17.68)	76.98 (15.96)	NS	–	74.70 (18.68)	79.46 (15.53)	NS	–	78.33 (15.06)	81.85 (14.35)	NS	–
Emotional	69.61 (21.79)	81.15 (17.07)	<0.001, −16.50 to −6.59	0.58	66.89 (23.01)	83.65 (16.57)	<0.001, −22.68 to −10.83	0.94	71.48 (18.80)	89.26 (12.30)	<0.001, −25.29 to −10.37	0.95
Social	78.41 (20.67)	85.75 (17.75)	0.002, −11.92 to −2.76	0.40	74.60 (22.98)	86.22 (15.25)	<0.001, −17.40 to −5.85	0.67	80.55 (19.97)	90.09 (9.87)	0.013, −16.89 to −2.19	0.51
Physical	76.44 (17.11)	84.26 (12.87)	<0.001, −11.72 to −3.92	0.50	76.57 (15.85)	85.05 (12.82)	<0.001, −12.11 to −4.85	0.78	78.70 (13.95)	85.80 (9.53)	0.014, −12.64 to −1.55	0.51
Total HRQoL	75.23 (15.35)	82.35 (12.59)	<0.001, −10.23 to −4.02	0.57	73.63 (15.74)	83.78 (10.60)	<0.001, −13.31 to −6.98	0.82	77.45 (12.02)	86.59 (8.00)	<0.001, −13.54 to −4.75	1.07

*Statistical modeling was not significant on school subdomain

CI, confidence interval; HRQoL, Health-Related Quality of Life; NS, not significant; SD, standard deviation.

Bold signifies a major subdomain of HRQOL.

Table 5 Average change by participant at each follow-up interval representing clinically significant changes in HRQoL.

	Absolute mean improvement (95% CI; *p*-value)		
	Baseline vs. Initial follow-up	Baseline vs. 6-month follow-up	Baseline vs. 12-month follow-up
Psychosocial HRQoL	6.4; (3.2–9.5; <0.001)	11.0; (7.2–14.9; <0.001)	10.3; (5.7–14.8; <0.001)
Physical HRQoL	7.8; (3.9–11.7; <0.001)	8.5; (4.8–12.1; <0.001)	7.1; (1.5–12.6; <0.014)

CI, confidence interval; HRQoL, Health-Related Quality of Life.

participants (26). Results from Sacher *et al.* in a 9-week intervention are in contrast, where the retention rate was near 100% for enrolled youth (28). The current study also had a high retention rate for the 12-week intervention (91%), despite the logistical challenges faced by participants in a low socioeconomic area.

The BMI Z-Scores may best summarize the physical changes of the participants in the current study at each follow-up period. The increased weight finding alone is confounded in this population because of natural growth and maturity of youth, evidenced by a significantly decreased average BMI Z-Score at each follow-up. The measurements for per cent body fat and waist circumference are also confounded by the nature of youth growth and maturity, but show similar differences as the BMI Z-Score measures and are helpful in evaluating the health status of the youth. This reflects the benefit of using BMI Z-Scores to describe this youth population. This measurement considers the youth age and growth as accurately as possible compared with national averages (39). It should be noted that these findings are consistent with the initial findings of Grow *et al.* in evaluating the ACT! programme (33).

A secondary analysis of this study was to evaluate the contribution of anthropometric measures on HRQoL outcomes. Per cent body fat represented an anthropometric measure with significant impact on both psychosocial and physical HRQoL. Specifically, per cent body fat had greatest impact on the social, emotional and school subdomains (in decreasing order). It is notable that the only difference between gender was noted in the per cent body fat of females remaining significantly higher than males throughout the study. The importance of this finding may impact the correlation of per cent body fat with HRQoL outcomes in a manner not evaluated in this study. BMI Z-Score correlated with physical HRQoL only, and represents an expected relationship with similar contribution to HRQoL as reported elsewhere (22,29). It is reasonable that the statistically small, yet significant, reduction of BMI-Z-Score still contributed to the increased HRQoL scores.

There are a number of strengths to this study. Major strengths included parents exercising with their children, cultural/language appropriate curriculum and a multifaceted approach. As part of this approach, youth and parents made food decisions together, while parents learned problem solving for important topics like bullying, food battles at home, etc. Retention of a sufficient number of participants for statistical significance and moderate effect size was also a strength.

This study was not without limitations. The lack of a control group was decided against because of the high community need for services targeting this population and limited research personnel and funding available. Also, the total subjects of this study represent participants over three different seasonal groups (Summer, Fall and Winter). This could potentially impact adherence to new exercise and eating habits learned in the programme because of weather, school activities, family obligations and community events. However, no significant differences were found between these time periods. It is important to note that no physical activity monitoring (accelerometer, etc.) was employed because of budget constraints, but eating and exercise habits were assessed via survey. Although there was a decrease in return to follow-up at 6 and 12 months, validated strategies were used in the recruitment and retention design of this study, especially the consistency of the bi-lingual staff at the YMCA, Yakima Valley Memorial Hospital and incentives (45). Additionally, the exclusion of a total of 10 youth participants (seven failed to complete the study, three with incomplete data) is expected to have a minimal impact on the overall findings of the study.

Significant improvements in HRQoL following a 12-week community and family-based lifestyle intervention were observed. The novel finding of this study was the longitudinal impact of this brief intervention in a rural, medically underserved community. Significant positive improvements in HRQoL measurements were continuous up to 12 months following the conclusion of the intervention. Anthropometric measures were established as contributing factors to psychosocial and physical HRQoL characteristics. The ACT! programme represents a logistically sustainable programme with positive improvements in the lives of youth with obesity and their families.

Table 6 Anthropometric measurements of youth participants, longitudinally

	Mean (SD)		p-value, 95% CI	Anthropometric measures over time Mean (SD)		p-value, 95% CI	Mean (SD)		p-value, 95% CI
	Baseline	Initial follow-up		Baseline	6-month follow-up		Baseline	12-month follow-up	
BMI Z-score	2.23 (0.37)	2.17 (0.40)	>0.001, 0.037–0.077	2.25 (0.35)	2.17 (0.43)	>0.001, 0.044–0.13	2.18 (0.38)	2.11 (0.50)	0.83, −0.01 to 0.14
Per cent body fat	29.78 (9.37)	29.16 (9.32)	0.006, 0.18–1.05	30.19 (9.25)	30.62 (9.54)	0.189,−1.08 to 0.22	27.64 (9.41)	28.89 (9.07)	0.061, −2.57 to 0.07
Waist circumference (inches)	38.27 (5.24)	37.69 (4.98)	0.006, 0.18–0.99	38.20 (4.76)	39.33 (5.23)	0.001, −1.76 to −0.50	37.88 (4.76)	39.71 (5.60)	>0.001, −2.63 to −1.03

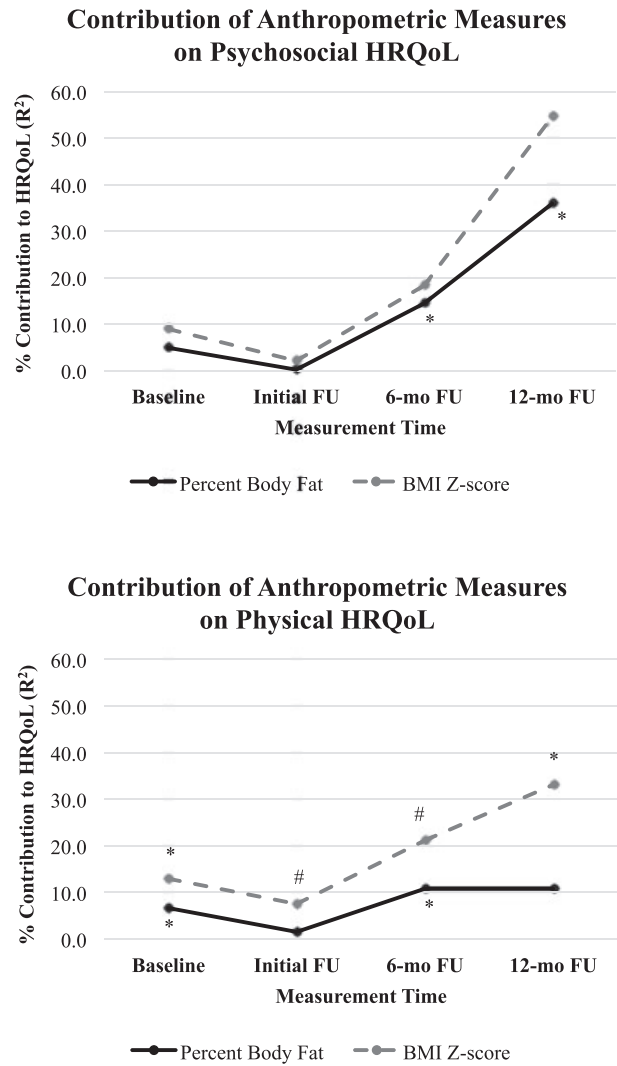BMI, body mass index; CI, confidence interval; SD, standard deviation.

Figure 2 Longitudinal Anthropometric and HRQoL Correlations. Anthropometrics and psychosocial (A) and physical (B) HRQoL using coefficient of determination (R2) to represent statistical contribution. BMI, body mass index; FU, follow-up; HRQoL, Health-Related Quality of Life; *$p < 0.05$; #$p = 0.05$

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Conflict of Interest Statement

No conflict of interest was declared.

Author contributions

Kathaleen Briggs Early, Joyce P. Yi-Frazier and Steven Engebretsen conceived the design and carried out the

study. At the time of this work, Steven Engebretsen was a third year Osteopathic Medical Student and was the primary author of the manuscript. Robert Sorrells analyzed and interpreted the data. All authors were involved in writing the paper and had final approval of the submitted and published versions.

References

1. Ogden CL, Carroll MD, Lawman HG, et al. Trends in obesity prevalence among children and adolescents in the united states, 1988-1994 through 2013-2014. *JAMA* 2016; **315**: 2292–2299.

2. Skinner AC, Perrin EM, Skelton JA. Prevalence of obesity and severe obesity in US children, 1999-2014. *Obesity (Silver Spring)* 2016; **24**: 1116–1123.

3. Robbins JM, Mallya G, Wagner A, Buehler JW. Prevalence, disparities, and trends in obesity and severe obesity among students in the school district of Philadelphia, Pennsylvania, 2006–2013. *Prev Chronic Dis* 2015; **12**: E134.

4. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA* 2014; **311**: 806–814.

5. Falbe J, Cotterman C, Linchey J, Madsen KA. Ethnic disparities in trends in high BMI among California adolescents, 2003–2012. *Am J Prev Med* 2016; **51**: e45–e55.

6. Wells NM, Evans GW, Beavis A, Ong AD. Early childhood poverty, cumulative risk exposure, and body mass index trajectories through young adulthood. *Am J Public Health* 2010; **100**: 2507–2512.

7. Gaffney KF, Brito AV, Kitsantas P, Kermer DA. Early feeding practices and weight status at one year of age: a comparison of Hispanic immigrant mother–infant dyads with participants of the infant feeding practices study II. *Childhood Obesity* 2016.

8. Anderson SE, Keim SA. Parent-child interaction, self-regulation, and obesity prevention in early childhood. *Curr Obes Rep* 2016; **5**: 192–200.

9. Ohri-Vachaspati P, Lloyd K, Delia D, Tulloch D, Yedidia MJ. A closer examination of the relationship between children's weight status and the food and physical activity environment. *Prev Med* 2013; **57**: 162–167.

10. Morello MI, Madanat H, Crespo NC, Lemus H, Elder J. Associations among parent acculturation, child BMI, and child fruit and vegetable consumption in a Hispanic sample. *J Immigr Minor Health* 2012; **14**: 1023–1029.

11. Dave JM, Evans AE, Saunders RP, Watkins KW, Pfeiffer KA. Associations among food insecurity, acculturation, demographic factors, and fruit and vegetable intake at home in Hispanic children. *J Am Diet Assoc* 2009; **109**: 697–701.

12. Salsberry PJ, Reagan PB. Comparing the influence of childhood and adult economic status on midlife obesity in Mexican American, white, and African American women. *Public Health Nurs* 2009; **26**: 14–22.

13. Butte NF, Cai G, Cole SA, Comuzzie AG. Viva la familia study: genetic and environmental contributions to childhood obesity and its comorbidities in the Hispanic population. *Am J Clin Nutr* 2006; **84**: 646–654quiz 673-644.

14. Branscum P, Sharma M. A systematic analysis of childhood obesity prevention interventions targeting Hispanic children: lessons learned from the previous decade. *Obes Rev* 2011; **12**: e151–e158.

15. Lutfiyya MN, Lipsky MS, Wisdom-Behounek J, Inpanbutr-Martinkus M. Is rural residency a risk factor for overweight and obesity for U.S. children? *Obesity (Silver Spring)* 2007; **15**: 2348–2356.

16. Gordon-Larsen P, Nelson MC, Page P, Popkin BM. Inequality in the built environment underlies key health disparities in physical activity and obesity. *Pediatrics* 2006; **117**: 417–424.

17. Strauss RS. Childhood obesity and self-esteem. *Pediatrics* 2000; **105**: e15.

18. Wright DR, Prosser LA. The impact of overweight and obesity on pediatric medical expenditures. *Appl Health Econ Health Policy* 2014; **12**: 139–150.

19. Cui W, Zack MM, Wethington H. Health-related quality of life and body mass index among US adolescents. *Qual Life Res* 2014; **23**: 2139–2150.

20. Tsiros MD, Olds T, Buckley JD, et al. Health-related quality of life in obese children and adolescents. *Int J Obes (Lond)* 2009; **33**: 387–400.

21. Pinhas-Hamiel O, Singer S, Pilpel N, Fradkin A, Modan D, Reichman B. Health-related quality of life among children and adolescents: associations with obesity. *Int J Obes (Lond)* 2006; **30**: 267–272.

22. de Beer M, Hofsteenge GH, Koot HM, Hirasing RA, Delemarre-van de Waal HA, Gemke RJ. Health-related-quality-of-life in obese adolescents is decreased and inversely related to BMI. *Acta Paediatr* 2007; **96**: 710–714.

23. Ul-Haq Z, Mackay DF, Fenwick E, Pell JP. Meta-analysis of the association between body mass index and health-related quality of life among children and adolescents, assessed using the pediatric quality of life inventory index. *J Pediatr* 2013; **162**: 280–286e281.

24. Lasikiewicz N, Myrissa K, Hoyland A, Lawton CL. Psychological benefits of weight loss following behavioural and/or dietary weight loss interventions. A systematic research review. *Appetite* 2014; **72**: 123–137.

25. Zeller MH, Modi AC, Noll JG, Long JD, Inge TH. Psychosocial functioning improves following adolescent bariatric surgery. *Obesity (Silver Spring)* 2009; **17**: 985–990.

26. Savoye M, Nowicka P, Shaw M, et al. Long-term results of an obesity program in an ethnically diverse pediatric population. *Pediatrics* 2011; **127**: 402–410.

27. O'Neil ME, Shewokis PA, Falkenstein KK, et al. Psychosocial factors and health perceptions in parents and children who are overweight or obese. *Obesity (Silver Spring)* 2010; **18**: 1558–1565.

28. Sacher PM, Kolotourou M, Chadwick PM, et al. Randomized controlled trial of the MEND program: a family-based community intervention for childhood obesity. *Obesity (Silver Spring)* 2010; **18**: S62–S68.

29. Fullerton G, Tyler C, Johnston CA, Vincent JP, Harris GE, Foreyt JP. Quality of life in Mexican-American children following a weight management program. *Obesity (Silver Spring)* 2007; **15**: 2553–2556.

30. Chomitz VR, McGowan RJ, Wendel JM, et al. Healthy Living Cambridge Kids: a community-based participatory effort to

promote healthy weight and fitness. *Obesity (Silver Spring)* 2010; **18**: S45–S53.

31. US Census Bureau. State and County Quick Facts: Yakima & King Counties 2016 [updated March 14]. Available from: http://www.census.gov/quickfacts/table/PST045215/53077.

32. Washington State Department of Health. Yakima County Chronic Disease Profile 2015 2015 [updated February 2015; cited 2015 March 15]. Available from: http://www.doh.wa.gov/portals/1/Documents/Pubs/345-271-ChronicDiseaseProfileYakima.pdf.

33. Grow HM, Hencz P, Verbovski MJ, et al. Partnering for success and sustainability in community-based child obesity intervention: seeking to help families ACT!. *Fam Community Health* 2014; **37**: 45–59.

34. Lorig KR, Ritter PL, Laurent DD, Plant K. Internet-based chronic disease self-management: a randomized trial.[see comment]. *Med Care* 2006; **44**: 964–971.

35. Bandura A. Health promotion by social cognitive means. *Health Educ Behav* 2004; **31**: 143–164.

36. Elder JP, Ayala GX, Harris S. Theories and intervention approaches to health-behavior change in primary care. *Am J Prev Med* 1999; **17**: 275–284.

37. WHO. Constitution of the World Health Organization basic document. World Health Organization, 2009.

38. Varni JW, Limbers CA, Burwinkle TM. How young can children reliably and validly self-report their health-related quality of life?: an analysis of 8,591 children across age subgroups with the PedsQL 4.0 Generic Core Scales. *Health Qual Life Outcomes* 2007; **5**: 1.

39. Flegal KM, Cole TJ. Construction of LMS parameters for the Centers for Disease Control and Prevention 2000 growth charts. *Natl Health Stat Report* 2013; **63**: 1–3.

40. Yi-Frazier JP, Hilliard ME, Fino NF, et al. Whose quality of life is it anyway? Discrepancies between youth and parent health-related quality of life ratings in type 1 and type 2 diabetes. *Qual Life Res* 2016; **25**: 1113–1121.

41. Centers for Disease Control (CDC). HRQOL Concepts 2016 [cited 2016 August 1]. Available from: http://www.cdc.gov/hrqol/concept.htm.

42. Israel BA, Parker EA, Rowe Z, et al. Community-based participatory research: lessons learned from the Centers for Children's Environmental Health and Disease Prevention Research. *Environ Health Perspect* 2005; **113**: 1463–1471.

43. Murnan J, Sharma M, Lin D. Predicting childhood obesity prevention behaviors using social cognitive theory: children in China. *Int Q Community Health Educ* 2006; **26**: 73–84.

44. US Census Bureau. Population by Race and Hispanic Origin: 2012 and 2060 [cited 2015 March]. Available from: https://www.census.gov/newsroom/cspan/pop_proj/20121214_cspan_popproj_13.pdf.

45. Guzman A, Richardson IM, Gesell S, Barkin SL. Recruitment and retention of Latino children in a lifestyle intervention. *Am J Health Behav* 2009; **33**: 581–586.