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The Contributions of Weight Loss and Increased Physical Fitness to Improvements in Health-Related Quality of Life

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Abstract

The relative contribution of obesity versus poor fitness to adverse health outcomes and diminished quality of life remains an area of controversy. Indeed, some researchers contend that poor cardiorespiratory fitness represents a greater threat to health and health-related quality of life than excess body weight. We addressed this issue by providing 298 obese 50–75 year-old women with a six-month lifestyle intervention that incorporated a low-calorie eating pattern coupled with an aerobic exercise program consisting of 30 min/day of brisk walking. The results showed that weight loss exhibited a significant individual contribution to improvements in seven of the nine domains of quality of life assessed by the Medical Outcomes Study Short Form (SF-36). With the exception of physical functioning, however, physical fitness did not significantly contribute to improvements beyond the effects weight loss. Moreover, weight loss functioned as a full mediator of the association between increases in physical fitness and improvements in general health, vitality, and change in health relative to the previous year. Collectively, these findings suggest that for treatment-seeking obese individuals, weight loss rather than increased fitness contributes significantly to improvements in health-realted quality of life.

Keywords

Obesity; Health Related Quality of Life; Physical Fitness; Weight Loss

1. Introduction

The relative importance of improved fitness versus weight loss in the care of the obese person is unclear. Traditionally, excess weight has been viewed as a larger health risk than physical inactivity and thus weight loss has been the primary focus of interventions designed to decrease disease risks associated with obesity. Recently, however, some researchers have provided data showing that physical inactivity may have a greater impact on morbidity and mortality than excess body weight (Blair & Brodney, 1999; LaMonte, Blair, & Church, 2005; Manson et al., 1991; Wei et al., 1999). If increased physical fitness is indeed more important than weight loss for obese individuals, interventions aiming to decrease affected health risks should focus on this goal rather than the traditional goal of weight loss. Most obesity interventions aim to

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increase both physical fitness and to decrease weight, rendering it difficult to determine the independent contributions of each to improvement in health outcome. Studies investigating the relative contributions of weight loss and physical fitness on heath risks have reported mixed results. Some health risks, such as type 2 diabetes, seem to be more adversely influenced by excess body weight (Weinstein et al., 2004), whereas others, such as coronary artery disease, appear to be affected more by poor physical fitness (Wessel et al., 2004).

In this study, we addressed this issue in the context of health-related quality of life (HRQL). HRQL provides a general indicator of day-to-day functioning for individuals; thus measuring change in HRQL associated with obesity treatment allowed us to investigate the effects of weight loss and increased physical fitness across several realms of functioning (e.g., general health, physical functioning, and vitality) rather than concentrate on a single health risk. HRQL has further been shown to be a predictor of mortality, such that decreases in HRQL corresponded with an increased risk of mortality while increases in HRQL were associated with a decreased risk (Kroenke, Kubansky, Adler, & Kawachi, 2008).

Obesity impacts a variety of dimensions of quality of life, including vitality, bodily pain, and even social functioning. Obese individuals report significantly lower HRQL than normal-weight individuals (Han, Tijhuis, Lean, & Seidell, 1998; Kolotkin, 1995; Kruger, Bowles, Jones, Ainsworth, & Kohl, 2007). This decrement is most pronounced within physical dimensions of HRQL, such as bodily pain, physical functioning, and vitality than within emotional dimensions such as social functioning, role functioning: emotional and mental health (Doll, Petersen, & Stewart-Brown, 2000; Fontaine & Barofsky, 2001; Larsson, Karlsson, & Sullivan, 2002).

Significant improvements in HRQL have been observed following weight loss in obese individuals (Karlsson, Sjötrö, & Sullivan, 1998). This association has been shown both in studies reporting moderate weight losses of 4 to 8 kg (Fontaine et al., 1999; Jensen, Roy, Buchanan, & Berg, 2004) and studies observing larger weight losses of 20 kg or more (Kral, 1992; Weiner, Datz, Wagner, & Bockhorn, 1999).

Physical inactivity has been identified as a significant health risk independent of obesity (Andersen, Schnohr, Schroll, & Hein, 2000; Blair et al., 1996; Villeneuve, Morrison, Craig, & Schaubel, 1998). For example, Kruger et al. (2007) found that inactive adults were three times more likely than active adults to report poor or fair self-rated health regardless of body mass index (BMI) category. Furthermore, increases in physical activity have been associated with increases in HRQL (Elavsky et al., 2005). Research suggests that both weight loss and increased fitness lead to increases in HRQL; however, the individual contributions of each have not been examined. It is unknown whether weight loss or increases in physical fitness produce greater improvements in HRQL for obese individuals.

1.1 Current Study

This study investigated the relative contributions of weight loss and increased physical fitness to changes in HRQL following lifestyle treatment for obesity. We expected that both weight loss and increased fitness would be independently associated with improvements in HRQL. Moreover, we hypothesized an “additive effect” for weight loss and increased fitness such that each would uniquely enhance HRQL for obese persons. We also examined whether having large weight losses coupled with small improvements in physical fitness led to larger increases in HRQL than having smaller weight loss paired with large increases in physical fitness.

2. Method

2.1 Participants

Participants were 298 women from rural counties who took part in a 6-month lifestyle intervention for obesity (Perri et al., 2008). Of the 298 participants, 274 provided data at both baseline and six months. This sample of 274 participants was used for all analyses. Participants were 50–75 years old (mean age = 59.0 years, *SD* = 6.2), with BMIs between 30 and 50 kg/m^2 (mean BMI at baseline was 36.8 kg/m^2, *SD* = 4.8). Potential participants were excluded if they weighed over 158.8 kg, had a history of heart attack or stroke, metabolic abnormalities, any musculo-skeletal conditions that limited walking, any major psychiatric disorders, or experienced significant weight loss (i.e., ≥ 4.5 kg) in the six months prior to the study. In terms of race and ethnicity, 76.6% of participants were Caucasian, 19.0% were African American, 1.8% were Hispanic, and 2.6% were Asian, Native American, or Pacific Islander. For details regarding recruitment, screening, and attrition, see Perri et al. (2008).

2.2 Measures

2.2.1 Weigh—Participants were weighed at baseline and six months. Weight was measured to the nearest 0.1 kilogram using a calibrated and certified balance beam scale. For each weighing, participants wore light indoor clothing with no shoes. At the time of weighing, each participant's height was also measured and recorded. These weights and heights were used to compute each participant's BMI.

2.2.2 Fitness—Physical fitness was measured at baseline and six month assessments using the 6 Minute Walk Test (6MWT; Butland, Pang, Gross, Woodcock, & Geddes, 1982). For this test participants were given the instructions to walk as quickly as possible, without jogging or running, around two cones placed 40 m. apart. Participants were also told they could stop if they became too tired, but should resume walking as soon as they were able to continue. To adjust for practice effects, at baseline participants were given two trials, on different days, of the 6MWT; only the data from the second trial were used. When testing the validity of the 6MWT, researchers found that distances from the 6MWT were significantly correlated to peak oxygen intake (VO2) values from a cycle ergometer test $r = 0.73$, $p < .001$ (Turner, Eastwood, Cecins, Hillman, & Jenkins, 2004). Further, Larsson and Reynisdottir (2008) found that with an obese sample, the 6MWT was reliable ($r = 0.94$ between two trials) and that BMI explained 38% of the variance in distance walked.

2.2.3 Health-Related Quality of Life—We used the Medical Outcomes Study Short-Form, referred to as the SF-36 (Ware, Kosinski, & Gandek, 2000) as a measure of HRQL. The SF-36 includes eight subscales: Vitality, Bodily Pain, General Health, Physical Functioning, Social Functioning, Physical Role Functioning, Emotional Role Functioning, and Mental Health. In addition to these subscales, the SF-36 also included a question asking participants to report the amount of change in their general health over the past year (referred to as "Health Transition"). The internal consistency of the SF-36 ranged from .63 to .96 and the test-retest reliability ranged from .60 to .81 (Ware et al., 2000).

2.3 Procedure

Participants underwent a six-month lifestyle obesity intervention modeled after the Diabetes Prevention Program (Knowler et al., 2002) consisting of three parts: a low-calorie eating plan, weekly aerobic exercise goals, and behavior modification. The intervention involved weekly 90-minute group-based sessions delivered via Cooperative Extension Service offices, led by a group leader with a bachelors or masters degree in a relevant discipline. Participants were guided in making gradual changes in their eating and physical activity habits. Caloric goals included adherence to a 1200 kcal per day eating plan, reduction in total fats, and increased

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consumption of whole grains, fruits, and vegetables. Participants were also encouraged to increase their physical activity by 3000 steps above baseline, or 30 minutes per day of brisk walking, 6 days per week. At the beginning of each session, participants were asked to detail their success in meeting their daily eating and physical activity goals; at the end of each sessions, they were asked to identify new goals for the next week. The eating and physical activity goals were given approximately equal attention during these discussions. Group leaders were trained in problem solving therapy and assisted participants with overcoming obstacles encountered during the program. Further information on this intervention can be found in a previously published paper (Perri et al., 2008).

2.4 Statistical analyses

Pearson product-moment correlations were used to assess the associations between changes in body weight, physical fitness, and HRQL, and hierarchical regressions were used to examine the individual contributions of weight loss and physical fitness to HRQL. Potential issues with collinearity between weight loss and change in physical fitness were addressed by examining the variance inflation factor (VIF), and a commonality analysis was used to investigate the variance explained due to the combined effects of weight loss and physical fitness. A pre- and post-test longitudinal model was used. Baseline values for BMI, physical fitness, and HRQL were entered as Step 1 in the hierarchical regressions. A change score from pre- to post-test for each SF-36 domain was created. This involved saving the residual from a regression using the baseline and post-test scores as the independent and dependent variables, respectively. The residualized change scores for body weight and physical fitness were entered as Step 2 and Step 3, respectively. These residualized change scores were also used in the mediation analyses.

After examining the individual contributions of weight loss and increased fitness to changes in HRQL, a series of regressions were implemented, in accord with Baron and Kenny's (1986) mediation method, to assess whether change in weight mediated the association between increased fitness and increases in HRQL. In this analysis, we only included subscales that initially showed a relation between physical fitness and HRQL but did not show a unique effect of physical fitness above and beyond the effect of weight change.

Finally, an independent-samples t-test was used to examine mean differences in Health Transition scores between participants in the top tertile for weight loss and the bottom tertile for increased fitness (Group 1) and participants in the bottom tertile for weight loss and the top tertile for increased fitness (Group 2). The Health Transition item was used as the outcome measure for this analysis because it functioned as a general health-change indicator, and thus it provided the clearest view of the change in HRQL due to the intervention.

3. Results

Of the 274 participants who provided data at baseline and six-months, 234 completed treatment. These individuals lost a mean of 10 kg (unadjusted for attrition; for additional details see Perri et al., 2008). Means for each variable (e.g., body weight, physical fitness, and SF-36 scores) at baseline and six months for all 274 participants who provided data at baseline and six-months are presented in Table 1. On average, participants completed 130 daily food and activity records out of 161 possible records. From baseline to six-months, weight loss (as measured by change in BMI) was significantly correlated with all SF-36 subscales except the Physical Role Functioning and Emotional Role Functioning subscales (see Table 2). Specifically, decreases in weight were associated with improvements in Health Transition, Physical Functioning, Bodily Pain, General Health, Vitality, Social Functioning, and Mental Health scores (all $ps < .05$).

For all analyzed regression models, the VIF values ranged from 1.0 to 1.3, well below the recommended cut-off of ≤ 10 (Bowerman & O'Connell, 1990; Myers, 1990), suggesting collinearity was not an issue with the variables used in this study. Further, commonality analyses run for each regression found that variance explained by the combination of weight loss and physical fitness was not significant.

A series of hierarchical regressions, controlling for baseline BMI, physical fitness, and HRQL subscale scores, were conducted to examine the individual contributions of weight loss and increased physical fitness to change in HRQL. Results are presented in Table 3. Baseline values (entered as Step 1 of the regression) were not significantly related to changes across any SF-36 subscale scores except Physical Functioning, $F(3,259) = 3.49$, $r^2 = .039$, $p < .05$, therefore the results for this step of the regression are not reported. Further, the results for the Physical Role Functioning and Emotional Role Functioning subscales are not displayed in the table because no significant contributions of either weight loss or increased physical fitness were found for either.

Weight loss was significantly associated with improvements in Health Transition, Physical Functioning, Bodily Pain, General Health, Vitality, and Mental Health (see Table 2), but was not associated with increased Physical Role Functioning, $p = .09$, or Emotional Role Functioning, $p = .13$. Whereas improvement in physical fitness significantly predicted improvement in Physical Functioning, it did not significantly contribute beyond the effects of weight loss to the variance explained for any other of the subscales.

Increased physical fitness was correlated with improvements in several HRQL subscales yet this association became non-significant after controlling for weight loss. Therefore, we investigated possible mediation by weight loss. This mediation hypothesis was applicable to the relationships between increased physical fitness and increases in Health Transition, General Health, and Vitality. Mediation was not investigated for Physical Role Functioning because neither weight loss nor physical fitness were related after controlling for baseline data, nor for Physical Functioning because physical fitness remained a significant contributor to change above and beyond the effect of weight loss.

Improvements in physical fitness were found to be significantly associated with improvements in Health Transition, $B = -.001$, $SE = .000$, $p < .01$, General Health, $B = .012$, $SE = .005$, $p < .05$, and Vitality scores, $B = .014$, $SE = .007$, $p < .05$, and with weight loss, $B = -.005$, $SE = .001$, $p < .001$. After controlling for physical fitness, weight loss was significantly associated with improvements in Health Transition , $B = .172$, $SE = .024$, $p < .001$, General Health, $B = -1.613$, $SE = .358$, $p < .001$, and Vitality, $B = -2.267$, $SE = .474$, $p < .001$ scores. Finally, after controlling for weight loss, the association between improvements in physical fitness and improvements in Health Transition, $B = .000$, $SE = .000$, $p = .35$, General Health, $B = .007$, $SE = .010$, $p = .52$, and Vitality, $B = .002$, $SE = .007$, $p = .77$ scores became non-significant. This suggested that weight loss acted as a full mediator for the association between change in physical fitness and change in Health Transition, General Health, and Vitality. Sobel tests confirmed that this mediation was significant for each subscale, $z = -4.10$, z = 3.35, z = 3.46, respectively, $p < .001$.

A t-test was used to detect significant differences between mean scores on the Health Transition domain between participants who lost a large amount of weight but had minor increases in physical fitness (Group 1) and participants who lost smaller amounts of weight but had large increases in physical fitness (Group 2). There were significantly greater improvements in the Health Transition, $t(36) = -3.79$, $p = .001$, for the participants in Group 1 compared to participants in Group 2. Thus, large decreases in weight accompanied by small increases in fitness produced greater improvements in a global HRQL change indicator than large increases in fitness coupled with small weight losses.

4. Discussion

In this study, we investigated the relative contributions of weight loss and physical fitness to improvements in health-related quality of life (HRQL). We hypothesized that both weight loss and physical fitness would provide unique contributions to improvements in HRQL. We also predicted that participants with large weight losses but modest increases in physical fitness would experience significantly greater improvements in HRQL than participants with small weight losses and large increases in physical fitness.

The major finding in this study was that weight loss contributed significantly to improvements in seven of the nine key domains of HRQL (i.e., Health Transition, Vitality, Bodily Pain, General Health, Social Functioning, Emotional Role Functioning, and Mental Health). For these seven domains, increases in fitness did not contribute significantly to enhanced HRQL beyond the effects of weight loss. Further, weight loss was found to mediate the relation between physical fitness and increases for two of the HRQL subscales (i.e., General Health, Vitality) and Health Transition. Finally, participants who lost large amounts of weight with little change in physical fitness had significantly greater improvements in HRQL (measured by Health Transition) than participants who had smaller weight losses but greater increases in physical fitness.

These results suggest that for obese persons, increased fitness in the absence of significant weight loss may not improve health-related quality of life. This finding differs from results of several previous studies (Brown et al., 2004; Elavsky et al., 2005; Kruger et al., 2007) which demonstrated that higher levels of physical fitness and physical activity were significantly associated with increased HRQL. Several factors could have contributed to this discrepancy. The study by Elavsky et al. (2005) did not correct for body weight, and there may be an interaction effect between physical fitness and obesity status in regards to HRQL. It is possible that changes in fitness may be more highly valued by normal weight and overweight individuals than obese individuals. Although the studies by Brown et al. (2004) and Kruger et al. (2007) did control for BMI, both utilized cross-sectional data gathered from phone interviews. Thus, no conclusions could be drawn about the association between change in physical activity levels and HRQL; these studies found that individuals who already participated in physical activity had higher HRQL than those who did not.

The self-report nature of the SF-36 allowed us to investigate how participants percieved their improvements in health and daily functioning. Compared to weight loss, the changes in fitness experienced by participants may have been subtle, particularly because participants in the current study were healthy and free of chronic disease and physical impairment. As it is easier to observe weight loss than increases in fitness, participants may attribute improvements in mobility and daily functioning to reduced weight rather than to increased aerobic fitness.

The observed changes in HRQL may have been influenced by participants' expectations upon entering the program. The sample was comprised of individuals who volunteered to take part in a weight management program. Participants in such interventions are likely more interested in achieving weight loss than in improving their cardiorespiratory fitness (Foster, Wadden, Vogt, & Brewer, 1997). Thus, the strength of the association between weight loss and improved HRQL observed in this study may be due, in part, to participants' focus on their weight.

Beyond participant expectations, changes in physical fitness may be less salient for participants because obesity treatment programs primarily focus on weight loss and typically assess participants' weight on a weekly basis (Wing, Tate, Gorin, Raynor, & Fava, 2006). Moreover, participants receive reinforcement from their interventionist, group members, family and friends for their weight loss. In contrast, feedback on changes in physical fitness is less frequently provided. One goal of future interventions could be to increase the emphasis on changes in physical activity and fitness in an attempt to increase the positive valence associated with improvements in physical fitness. For example, the provision of more frequent fitness testing and feedback would likely enhance participant attentiveness to their improved physical functioning. Heightened awareness of such improvements may enhance participants' HRQL.

There were several potential limitations to the current study. First, the sample was comprised of healthy women ages 50–75; the findings may not be generalizable to men, younger adults, and obese individuals in poor health. Second, although participants were followed for six months and assessed pre- and post treatment, the design of the study was nonetheless correlational. Because participants were not randomly assigned to weight loss and physical fitness conditions, caution should be used in interpreting cause and effect with respect to the relationship between weight loss, physical fitness, and HRQL.

This study contributes significantly to the literature on weight loss, physical fitness, and HRQL in several important ways. To our knowledge, this study is the first to examine the unique contributions of weight loss and increases in fitness on HRQL in obese individuals. Our findings demonstrated that, with respect to middle age and older obese women, weight loss rather than increased fitness is a more significant contributor to improvements in quality of life.

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Table 1

Weight, BMI, Physical Fitness, and SF-36 Subscale Scores at Baseline and Six Months

	Baseline		**Six Months**	
Variable	***M***	***SD***	***M***	***SD***
Weight (kg)	96.3	14.8	87.2	14.6
BMI	36.7	4.9	33.2	4.9
Physical Fitness (steps walked)	1414.0	184.3	1492.4	195.0
SF-36: Health Transition	2.9	0.7	1.9	0.8
SF-36: Physical Functioning	76	18.8	82.5	17.0
SF-36: Role Functioning: Physical	83.5	29.6	83.1	31.5
SF-36: Bodily Pain	71.3	18.9	71	22.7
SF-36: General Health	75.1	15.6	78.8	15.4
SF-36: Vitality	58.5	18.8	66.2	19.0
SF-36: Social Functioning	90.3	15.7	90.4	17.1
SF-36: Role Functioning: Emotional	90	22.8	87.9	26.6
SF-36: Mental Health	82.9	12.4	82.4	14.7

Table 2

Pearson correlations between weight loss (decrease in body mass index), increased physical fitness, and improvements in health-related quality of life.

Health-Related Quality of Life Domain[a]	Body Mass Index		Physical Fitness	
	r	*p*	*r*	*p*
Health Transition	.45	.001	−.21	.001
Physical Functioning	−.21	.001	.21	.001
Role Functioning: Physical	−.11	.060	.12	.057
Bodily Pain	−.14	.021	.09	.132
General Health	−.27	.001	.15	.018
Vitality	−.27	.001	.13	.037
Social Functioning	−.14	.019	−.01	.887
Role Functioning: Emotional	.01	.176	.01	.921
Mental Health	.02	.016	.02	.808

[a]Domains derived from the Medical Outcomes Study Short Form (SF-36).

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Table 3

The individual contributions of decreased BMI and increased physical fitness to improvements in SF-36 domains of health-related quality of life.

Domain	Variable	β	R^2	R^2_{Change}	p
Health Transition	Step 2		.210	.207	.000
	BMI	.457			
	Step 3		.212	.002	.432
	BMI	.440			
	Physical Fitness	−.048			
Physical Functioning	Step 2		.086	.048	.000
	BMI	−.218			
	Step 3		.104	.017	.026
	BMI	−.166			
	Physical Fitness	.145			
Bodily Pain	Step 2		.030	.020	.021
	BMI	−.142			
	Step 3		.030	.001	.700
	BMI	−.133			
	Physical Fitness	.026			
General Health	Step 2		.103	.087	.000
	BMI	−.297			
	Step 3		.103	.000	.737
	BMI	−.289			
	Physical Fitness	.022			
Vitality	Step 2		.098	.095	.000
	BMI	−.308			
	Step 3		.098	.000	.828
	BMI	−.303			
	Physical Fitness	.014			

Domain	Variable	β	R^2	R^2_{Change}	p
Social Functioning	Step 2		.034	.032	.004
	BMI	−.178			
	Step 3		.039	.005	.275
	BMI	−.203			
	Physical Fitness	−.074			
Mental Health	Step 2		.036	.029	.006
	BMI	−.171			
	Step 3		.037	.001	.546
	BMI	−.186			
	Physical Fitness	−.041			

Note. Baseline values for Body Mass Index, Physical Fitness, and each subscale score (respectively) were included as covariates in Step 1. Step 1 was not significant for any of the above regressions except for Physical Functioning.