VALIDITY OF A GENERALIZED EQUATION FOR SETTING TARGET BODY WEIGHT

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Exercise training produces changes in lean and fat weight, yet the original equation that computes target body weight (TBW) assumes that all weight loss is fat. We developed a generalized equation (GTBW) that accounts for various percentages of weight loss due to fat (WF%). G T B W = (C F − W F % × C B W ) / (D F % − W F % ), where CF is current fat weight, CBW is current BW, and DF% is the desired percent of body fat. We studied the validity of G T B W and original TBW (OTBW) in 38 fitness participants who exercised 3 days a week, with 20 minutes of aerobic and 20 minutes of strength training, for 10 weeks. Final post weight (PW) was the criterion measure. Percent fat was computed from three sex-specific skinfold sites, age and weight. WF% (191 ± 242%) from a separate group (n = 46) was used in both estimates. WF% greater than 100% reflects increased lean weight that was greater than the decrease in fat. DF% (2.6 ± 1.9%) was the %fat loss from this same group and was used in the OTBW and G T B W . Correlations between OTBW (r = 0.97) and G T B W (r = 0.99) versus PW were significant (p < 0.05). Residual plots for OTBW (r = 0.31) and G T B W (r = 0.17) were not significant. Mean differences showed that OTBW was significantly smaller (p < 0.01) than PW, while G T B W and PW were not different. Subjects increased (p < 0.05) lean mass by 0.82 ± 1.56 kg. The increase in lean mass violated the basic assumption for setting target weights using the OTBW formula. OTBW estimate produced significantly lower TBW and may have negative motivational outcomes. We conclude that the G T B W formula should be used when setting TBW. [J Exerc Sci Fit • Vol 8 • No 2 • 85–88 • 2010]

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Introduction

The setting of realistic target body weights (TBW) in weight loss programs is important in goal setting for fitness and weight loss programs. Weight loss programs that include diet and exercise have significant impact on body composition. Most (Lockwood et al. 2008; Nakater et al. 2008; Yu et al. 2008; Sigal et al. 2007; Strasser et al. 2007; Tarnopolsky et al. 2007; Daly et al. 2005) but not all research studies that combine diet with either aerobic, resistance or both types of training showed significant decreases in body fat or maintenance of lean mass. Heyman et al. (2007) showed no significant change in body fat of post menarcheal girls with type I diabetes who completed 6 months of aerobic and resistance training. The majority of these results are not congruent with the assumption used to estimate TBW. The assumptions are that 100% of the weight loss is fat weight and that lean body weight does not change during weight loss programs. Use of the standard equation (Golding 2000; Noble 1986) to estimate TBW requires a client to be reassessed and new target weights provided. This trial by error approach does not consider the differences in the change in body composition that are observed with weight control programs that utilize diet alone or in combination with exercise programs that include aerobic and/or strength training. For example, Daly et al.’s (2005) study on type II diabetics showed that subjects who dieted and exercised had a decrease in weight and fat with an increase in lean body mass...
relative to the diet-only group. The 1.8% increase in lean mass violated the assumption of a stable lean body mass and that all weight loss is due to fat. In actuality, some studies show a greater fat loss than weight loss because of an increase in lean body mass (Lockwood et al. 2008; Yu et al. 2008; Sigal et al. 2007; Tarnopolsky et al. 2007; Daly et al. 2005).

Siconolfi (2003) developed a generalized formula that could account for the changes in body fat and lean mass specific to a weight loss program. The generalized formula is:

\[
GTBW = \frac{(CF - WF\% \times CBW)}{(DF\% - WF\%)} \tag{1}
\]

where GTBW is general target weight, CF is current fat weight, WF\% is weight loss due to fat, CBW is current body weight, and DF\% is the desired percent of body fat.

The original TBW (OTBW) formula can be shown as a special case of the generalized formula with the assumption that WF\% = 100\% (expressed as a decimal):

\[
OTBW = \frac{(CF - WF\% \times CBW)}{(DF\% - WF\%)}
\]

From this, we can get:

\[
OTBW = \frac{(CF - CBW)}{(DF\% - 1)}
\]

and substituting CF – CBW with -CL (current lean weight)

\[
OTBW = \frac{-CL}{(DF\% - 1)}
\]

and removing the negative signs by multiplying by -1

\[
OTBW = \frac{CL}{(1 - DF\%)} \tag{2}
\]

Siconolfi (2003) presented an abstract at the American College of Sports Medicine that showed a theoretical improvement in setting the TBW (10–20 pounds for obese individuals) for the GTBW over the OTBW. He compared the target weights computed using 100\% and 80\% of weight loss due to fat to post weights (at 16\% body fat for men and 21\% body fat for women), assuming that weight loss consisted of 60–86\% fat loss in five virtual males and five virtual females. The 80\% of weight loss due to fat was chosen for the diet and exercise comparison since it was about the average percentage of weight loss (with a range of 66–92\%) due to diet and exercise reported in the literature (Borg et al. 2002; Brill et al. 2002; Janssen et al. 2002; Evans et al. 1999). Assuming that 80\% of weight loss is fat, the GTBW becomes:

\[
GTBW = \frac{(CF - 0.80 \times CBW)}{(DF\% - 0.80)} \tag{3}
\]

From the Table, Siconolfi (2003) concluded that the generalized target weight formula is more accurate than the traditional formula.

The purpose of this paper was to further evaluate the validity of the GTBW formula using 84 participants in a YMCA exercise program.

**Methods**

The fitness participants exercised 3 days a week at the South Shore YMCA (Quincy, MA, USA), with 20 minutes of aerobic and 20 minutes of strength training, for

\[
\begin{array}{|c|c|c|c|c|c|c|c|c|}
\hline
\text{Sex} & \text{Before weight} & \text{Before \% body fat} & \text{After \% body fat} & \text{\%WF} & \text{After weight} & \text{OTBW 100\%} & \text{GTBW 80\%} \\
\hline
M & 160 & 20 & 16 & 60 & 145 & 152 & 150 \\
M & 180 & 24 & 16 & 66 & 151 & 163 & 158 \\
M & 200 & 26 & 16 & 72 & 164 & 176 & 169 \\
M & 220 & 28 & 16 & 78 & 177 & 189 & 179 \\
M & 240 & 30 & 16 & 84 & 191 & 200 & 188 \\
F & 130 & 30 & 21 & 62 & 101 & 115 & 110 \\
F & 140 & 32 & 21 & 68 & 107 & 121 & 114 \\
F & 150 & 34 & 21 & 74 & 113 & 125 & 117 \\
F & 160 & 38 & 21 & 80 & 114 & 126 & 114 \\
F & 170 & 40 & 21 & 86 & 120 & 129 & 115 \\
\text{Mean} & 175 & 30 & 19 & 73 & 138^* & 150 & 141 \\
\text{SD} & 35.4 & 6 & 3 & 9 & 31.8 & 30.9 & 30.7 \\
\hline
\end{array}
\]

*p < 0.001 lower than traditional target weight, but not different from the target weight from the generalized equation.
10 weeks. The training program followed the American College of Sports Medicine (1995) exercise guidelines for both strength and endurance training. The criterion measure was the participants’ final post weight (PW).

Subjects (n = 84) were randomly divided into two groups. The average changes in body composition of the first group defined the average weight loss due to fat (WF%) and the desired % body fat (DF%) associated with this training program and then used in OTBW and GTBW. The average WF% (191 ± 242%) from the first group (n = 46) was greater than 100% since subjects gained a significant amount of lean mass, thereby creating an overall weight loss that was smaller than fat loss. Kraemer et al. (2007, 1997) and Sigel et al. (2007) showed greater fat loss than weight loss with a range of 118–123% for different aerobic and aerobic combined with strength training programs. (These percentages were computed from the averaged data from tables in the articles. If we compute the percentage of weight loss due to fat loss for group one using the averaged data, we get a similar percentage of 123%. However, when computing the WF% for a program for use in the GTBW, it should reflect the average of the individuals.)

The second group (n = 38) of participants served as the validity group. Validity was assessed using Pearson’s product moment correlation of OTBW and GTBW versus PW. A plot of residuals (OTBW – PW and GTBW – PW) versus averaged values (average of OTBW and PW and average of GTBW and PW) was computed to evaluate systematic error. Mean differences were analyzed with repeated measures ANOVA and a Bonferroni post hoc test.

Results

The correlations between OTBW (Figure 1) and GTBW (Figure 2) versus PW were significant (r = 0.97 and r = 0.99, respectively). The plot of residuals showed no significant (p > 0.05) correlations for OTBW (r = 0.31) and GTBW (r = 0.17). There were three individual differences for the OTBW residuals that were outside the 95% level of confidence. For the GTBW, only one subject’s difference was outside the limits. The evaluation of differences between the means showed that OTBW (176 ± 58 lbs) was significantly smaller (p < 0.01) than PW (179 ± 40 lbs), while no significant difference (p > 0.05) was found between the GTBW (180 ± 40 lbs) and PW.

Discussion

When fitness programs include a significant strength training component, one can expect to see increases in lean mass (Lockwood et al. 2008; Yu et al. 2008; Sigal et al. 2007; Tarnopolsky et al. 2007; Daly et al. 2005; Kraemer et al. 1997). Our subjects also exhibited a significant (p < 0.05) increase in lean mass by 1.8 ± 3.4 lbs. The increase or change in lean mass violated the basic assumption for setting target weights using the OTBW equation. The OTBW estimate produced a significantly lower TBW and may have negative motivational outcomes.

The initial average percent body fat of the subjects in the current study was 30.8%; after 10 weeks of

Fig. 1 Correlation between original target body weight (OTBW) and participants’ post-training body weight. The thin black line is the line of identity.

Fig. 2 Correlation between general target body weight (GTBW) and participants’ post-training body weight. The thin black line is the line of identity.
exercise training, this had only decreased to 28.2%. This small change in body fat (~6 lbs) had created a very small difference (3 lbs) in body weight, and it could be argued that the extra information needed to increase the accuracy is not worth the effort. However, the current study was designed to evaluate the validity given a 2.6% decrease in percent body fat. If we plot (Figure 3) the ideal weights (based on 16% for men and 21% for females) computed from the OTBW and GTBW, we can gauge the magnitude of the difference. The OTBW would produce a target weight of ~180 lbs while the GTBW target would be 200 lbs. Given the difficulty of losing the final amount weight for most participants, the more realistic (20 lbs higher) GTBW should help participants maintain motivation to reach their true ideal weight.

One of the strengths of this study was the population used to evaluate the validity. The use of YMCA participants and the YMCA’s fitness testing battery help demonstrate the robustness of the validity. We conclude that the GTBW formula is one that should be used when setting TBW.

References


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