Received: 31 July 2020 | Revised: 8 January 2021 | Accepted: 31 January 2021

DOI: 10.1002/osp4.489

SHORT COMMUNICATION

Obesity Science and Practice Open Access WILEY

Using measured resting metabolic rate to derive calorie prescriptions in a behavioral weight loss program

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Funding information
National Institute of Diabetes and Digestive and Kidney Diseases, Grant/Award Number: R01DK103668

Abstract

Objective: Within behavioral weight loss (BWL) programs, using measured resting metabolic rate (RMR) is a more accurate—yet costlier—alternative to the standard method of assigning calorie prescriptions using baseline weight. This investigation aimed to assess differences between calorie goals prescribed using each method including demographic predictors and associations with weight loss.

Methods: This is an ancillary study to a trial comparing approaches to motivational enhancement in a 6-months BWL program designed for emerging adults age 18–25 (N = 308). RMR was measured at baseline and used to derive calorie prescriptions; standard calorie goals were retrospectively assigned for the purpose of these analyses.

Results: Standard calorie prescriptions were significantly higher than those derived from RMR. Sex and race were significant predictors of calorie prescription discrepancies: using the standard method, women and Black participants were assigned higher calorie goals than their RMR would indicate. Calorie goal discrepancy did not predict 6-months weight change.

Conclusions: Differences in calorie prescriptions between approaches were significant; however, it remains to be determined whether measuring RMR is worth the cost, time, and participant burden. It may be the case that this consideration has greater impact for certain subgroups—namely, women and Black participants.

KEYWORDS
behavioral weight loss, dietary prescriptions, indirect calorimetry

1 | INTRODUCTION

Dietary prescriptions are a core tenant of behavioral weight loss programs; most often, these are provided in terms of a daily caloric intake goal.[1] These goals are intended to produce a safe and realistic weight loss of 1–2 pounds/week throughout the duration of the intervention. The standard calorie prescription criteria most commonly used in standard adult behavioral weight loss trials[2,3] was established in the Diabetes Prevention Program,[4] which assigned caloric prescriptions in accordance with participants' baseline weight (Table 1). However, this is a relatively crude method and does not take into account other factors that could influence resting metabolic rate—and therefore calorie needs—such as age, sex, or body composition. An accurate caloric intake goal is critical in shaping participants' early treatment response, which is predictive of overall performance in behavioral weight loss programs.[5-7]

TABLE 1 Calorie prescription in the diabetes prevention program

Baseline weight	Daily caloric intake goal
120–170 pounds	≤1200
175–215 pounds	≤1500
220–245 pounds	≤1800
>250 pounds	≤2000

Measuring resting metabolic rate via indirect calorimetry (i.e., continuous measurement of oxygen consumption and carbon dioxide production) provides an opportunity to assign more accurate calorie prescriptions for individual participants. This more personalized approach might facilitate better early weight loss treatment response, which evidence suggests is critical for overall success.[5-7] In fact, calls for personalized calorie prescriptions in the clinical treatment of obesity emerged 30 years ago[8]; however, this practice has not been adopted by behavioral weight loss clinical trials. This may be due in part to the added burden for both participants and staff associated with measuring resting metabolic rate: participants must fast for 12 h and lay still for approximately 30 min during the measurement. Staff must attend closely to the procedure and make adjustments as needed in order to ensure the accuracy of the measurement, which requires ongoing training. These factors add to project costs and reduce potential for dissemination, raising the question of whether measured resting metabolic rate is worth the investment in time and expense.

The current study is ancillary to a behavioral weight loss trial targeting emerging adults (REACH Trial, NCT02736981) that used objectively measured resting metabolic rate to assign personalized calorie goals for program participants. Aims of the current study are to (1) assess differences between calorie goals prescribed based on measured resting metabolic rate compared to those that would have been assigned in a standard behavioral weight loss program; (2) determine whether there were demographic factors associated with discrepancy between methods; and (3) assess whether discrepancy between methods was predictive of weight loss outcomes.

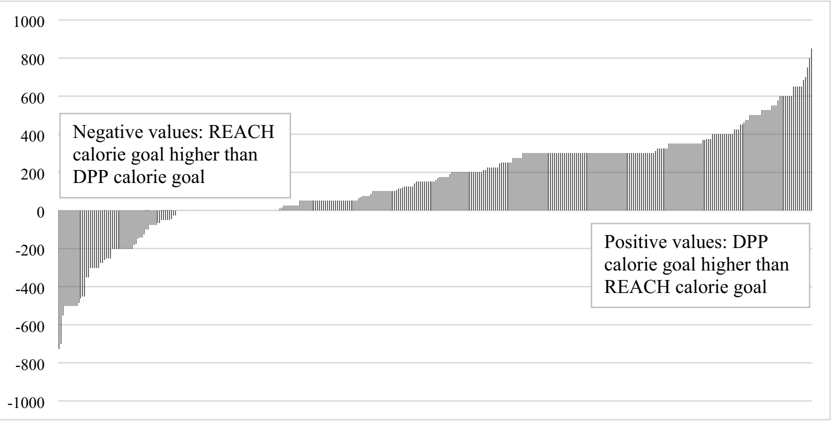
2 | METHODS

Eligible participants were between 18 and 25 years of age with body mass index (BMI) 25–45 kg/m^2; exclusion criteria were comparable to other behavioral weight loss programs[3,9] and included inability to safely participate in unsupervized exercise; history of anorexia nervosa/bulimia nervosa or compensatory behaviors; and medications/medical conditions that could interfere with weight loss. Consenting and eligible participants were randomized to one of three technology-mediated 6-months behavioral weight loss treatments. Intervention in all arms consisted of weekly web-hosted lesson content and weekly e-coaching in addition to one in-person group session in Week 1 and one in-person individual session in Week 2; motivational enhancement techniques differed between arms. Intervention content consisted of evidence-based strategies to help participants adhere to their individual daily caloric intake goal and to gradually shape behavior in order to achieve 250 min of moderate-to-vigorous physical activity per week. Resting metabolic rate was measured at baseline using a portable indirect calorimeter (Fitmate GS, Cosmed USA Inc.) with canopy hood. Weight (kg) was measured at baseline and posttreatment (6 months) by masked assessors. All measurements took place following a 12-h fast. Daily caloric intake goals in the parent trial were assigned using the following formula: Caloric intake (kcals) = ([measured resting metabolic rate] × 1.3) −750 kcals. This formula accounts for calories expended through the thermogenic effect of food and minimal movement (multiplier of 1.3)[10] and is designed to yield an approximate weight loss rate of 1.5 pounds/week (subtracting 750 kcals).[1] These daily caloric intake goals ranged from 1100 to 2550. For the purposes of the current analysis, each participant was also retrospectively assigned a daily caloric intake goal using their baseline weight as is standard in typical behavioral weight loss programs (Table 1). The difference in calorie goals was calculated as (standard calorie goal assigned based on weight - calorie goal assigned based on measured resting metabolic rate). Analysis of variances were conducted in order to assess demographic predictors of discrepancies in calorie goal prescriptions and to assess whether those discrepancies were associated with weight loss outcomes. Significant demographic variables and intervention treatment arm were controlled for in the analysis predicting weight loss outcomes.

3 | RESULTS

Participants (N = 308) were mostly female (82.5%) and of racial/ethnic minority background (58.6%) with a mean age of 22.1 (SD = 2.1) and a mean BMI of 33.7 kg/m^2 (SD = 5.0). The mean difference between calorie goal assignment methods was 172.2 calories/day (SD = 252.9), creating an average discrepancy of approximately 1200 calories over the course of a week. 1 depicts individual differences in calorie goals for each of the 308 participants. Calorie goals prescribed through each approach were strongly and significantly correlated (r = 0.57, p < 0.001). After controlling for baseline weight, sex, race/ethnicity, and baseline BMI were significant predictors of discrepancies in calorie goal prescriptions. The mean difference in calorie goals for men was −30.7 (SE = 32.5) and the mean difference in calorie goals for women was 215.3 (SE = 14.5), F = 46.64, p < 0.001. Thus, women would be prescribed higher caloric intake goals in standard behavioral weight loss programs than their resting metabolic rate would indicate, while men would be prescribed lower caloric intake goals in standard behavioral weight loss programs than their resting metabolic rate would indicate. With respect to race/ethnicity, there was a greater difference in calorie goals for non-Hispanic Black compared to non-Hispanic White participants: 239.7 (SE = 25.5) versus 151.2 (SE = 20.9), respectively, F = 7.15,

FIGURE 1 Difference in daily calorie goals between methods



$p = 0.008$. Black participants would be prescribed significantly higher caloric intake goals in standard behavioral weight loss programs than their resting metabolic rate would indicate. With respect to baseline BMI, those with a BMI > 30 (obesity) had a greater calorie goal discrepancy than those with a BMI < 30 (overweight): 216.0 ($SE = 16.9$) versus 55.5 ($SE = 30.2$), $F = 18.8$, $p < 0.001$. After controlling for treatment arm, sex, race and baseline BMI, the discrepancy between calorie goal prescription methods was not associated with 6-months weight loss outcomes, $\beta = -0.02$, $t = -0.34$, $p = 0.74$.

4 | DISCUSSION

The results of this investigation reflect a discrepancy between calorie prescription methods. In general, calorie goals prescribed in accordance with the standard method are higher than those prescribed based on indirect calorimetry. This could help to promote early dietary adherence, as a higher calorie goal likely represents a less drastic change from participants' baseline caloric intake. Alternatively, these higher calorie goals could result in early program disengagement due to weight loss below expectations—especially in the critical early weeks of treatment. The average participant would lose only 77.1% of the expected ~1.5 pounds/week, getting them off to a slower start even if calorie goals are later revised based on weight loss progress. Furthermore, the average Black participant would lose only 68.0% of the expected ~1.5 pounds/week and the average woman would lose only 71.3% of this goal. It is a consistent finding that women and Black participants fare poorer compared to men and White participants in standard behavioral weight loss programs[11,12]; thus, it is possible that prescribing calorie goals based on baseline weight alone could contribute to these existing disparities.

Of note, the discrepancy between calorie goal assignment methods did not predict participants' 6-months weight loss in the current study. Furthermore, there was a significant and strong positive correlation between the goals assigned using each method. Thus, measuring resting metabolic rate using indirect calorimetry may represent unwarranted burden for both participants and staff with respect to setting calorie goals. In addition, it is unknown how often resting metabolic rate would need to be measured throughout the intervention as a result of changes in body weight and composition. Instead, the value of measuring resting metabolic rate may lie in providing personalized participant feedback and underscoring individual tailoring of an otherwise standardized program, which is an important consideration among emerging adults—a high-risk yet difficult-to-recruit population.[13] An alternative middle-ground is to use an established formula to estimate basal metabolic rate such as the Harris–Benedict Equation[14] or the Mifflin-St. Jeor Equation,[15] both of which take into account not only weight, but also sex, age, and height—however, such equations are more appropriate for population-based estimates rather than individual estimates due to the potential for large errors.[16] Thus, their use should be carefully considered in the context of the research question and population of interest; it is unlikely that the same equation would be the most accurate equation for every individual enrolled in a clinical trial.

Limitations of the current study include its retrospective nature and lack of data regarding participant adherence to calorie goal throughout the program; however, dietary adherence cannot be objectively assessed without the use of doubly labeled water, which is cost-prohibitive in the context of a large-scale behavioral weight loss trial. Given that this study focused on emerging adults, another limitation is the restricted age range; future studies should seek to replicate these findings in a sample with a broader age range. Strengths of the current study include objective measurement of resting metabolic rate and a large racially diverse sample. In order to better understand the impact of accurate calorie prescriptions on program outcomes, future studies should prospectively investigate differences in weight loss and dietary adherence with random assignment to differing calorie prescription methods. Of particular interest is the extent to which the systematic differences in calorie assignment between men versus women and Black versus White participants contribute to the disparities seen in weight loss outcomes among women and Black participants. Thus, this investigation serves not only as a methodological inquiry, but as a potential consideration when designing weight control trials that aim to minimize disparities.

4.1 | Clinical implications

The standard method used in behavioral weight loss trials to prescribe daily caloric intake goals uses a crude weight-based cut-off and may lead to systematic differences in dietary goals—and subsequent weight loss—based on race and sex. Measured resting metabolic rate yields more accurate caloric intake goals; however, prospective research is needed in order to determine whether the trade-off between accuracy and measurement burden is justified with respect to adiposity outcomes.

ACKNOWLEDGMENTS

This study was funded by NIDDK award R01DK103668 to Jessica G. LaRose for the parent trial.

CONFLICT OF INTERESTS

The authors have no conflict of interest to declare.

AUTHOR CONTRIBUTIONS

All authors contributed to the conceptualization and design of this study. Autumn Lanoye conducted the analyses and developed the first draft of the manuscript; Ronald K. Evans, Tricia M. Leahey, and Jessica G. LaRose provided feedback and edits. All authors had final approval of the submitted version.

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How to cite this article: Lanoye A, Evans RK, Leahey TM, LaRose JG. Using measured resting metabolic rate to derive calorie prescriptions in a behavioral weight loss program. *Obes Sci Pract*. 2021;7:335–338. https://doi.org/10.1002/osp4.489