Predicted vs. Actual Resting Energy Expenditure and Activity Coefficients: Post-Gastric Bypass, Lean and Obese Women

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Abstract

Total Energy Expenditure (TEE) and energy requirements are commonly estimated from equations predicting Resting Energy Expenditure (REE) multiplied by a Physical Activity (PA) coefficient that accounts for both PA energy expenditure and the thermogenic effect of food. PA coefficients based on PA self-reports are a potential source of error that has not been evaluated. Therefore, in this study we compared: 1) the Harris-Benedict (HB), Mifflin-St. Jeor (MSJ), and the Food and Agriculture Organization/World Health Organization/United Nations University (FAO/WHO/UNU) REE equations with REE measured (REE-m) with indirect calorimetry; 2) PA coefficients determined with PA self-reports vs. objectively assessed PA; and 3) TEE estimates in post-Gastric Bypass (GB = 13), lean (LE = 7), and obese (OB = 12) women. REE was measured in the morning after an overnight fast with participants resting supine for 30 min. Self-reported PA was evaluated with a questionnaire and objectively measured with accelerometers worn for 5-7 days. Nutritional intake was evaluated with a food frequency questionnaire. Anthropometry included DEXA, and abdominal CT scans. Eligible GB had surgery ≥ 12 months before the study, and had ≥ 10 kg of body weight loss. All participants were 18-45 years of age, able to engage in ambulatory activities, and not taking part in exercise training programs. One-way ANOVA was used to detect differences in REE and TEE. Accuracy of REE prediction equations were determined by cases within 10% of REE-m, and agreement analyses. REE predictions were not different than REE-m, but agreements were better with HB and MSJ, particularly in the GB and LE groups. Discrepancies in the PA coefficients determined with self-report vs. objectively assessed PA resulted in TEE overestimates (approximately 200-300 Kcal/day) using HB and MSJ equations. FAO/WHO/UNU overestimated TEE in all groups regardless of the PA assessment method (approximately 300-900 kcal/day). These results suggest that: 1) HB and MSJ equations are good predictors of REE among GB and LE, but not among OB women, 2) PA coefficients used to estimate TEE must be determined with objective PA assessment, and 3) TEE estimates using PA coefficients with the FAO/WHO/UNU equation must be used with caution.

Keywords: Energy requirements; Bariatric; Accelerometer; Indirect calorimetry

Introduction

Determining daily energy requirements to help guide weight control involves all components of Total Energy Expenditure (TEE): Resting Energy Expenditure (REE), Physical Activity Energy Expenditure (PAEE), and the Thermogenic Effect of Food (TEF). However, precise measurement of TEE mandates sophisticated equipment not readily available outside research or clinical settings.

The Harris-Benedict (HB), [1] Mifflin St. Jeor (MSJ), [2] and the Food and Agriculture Organization/World Health Organization/United Nations University (FAO/WHO/UNU) [3] are REE predicting equations widely used in different populations [4-6]. These equations consider factors such as weight, height, age, and gender. The predicted REE is then multiplied by a PA coefficient for an estimate of TEE (Table 1). These coefficients have been derived by subtracting REE measured with indirect calorimetry from the TEE measured with the doubly labelled water technique [3,7,8]. Therefore, PA coefficients account not only for PAEE but also the TEF. However, there are inconsistencies in the selection and recommendation of PA coefficients for different equations (Table 1). Specific PA coefficients are based on the PA level of each participant, usually determined by self-reports and dietitian's experience. Because PAEE is the most variable component of TEE, the impact of PA coefficients based on self-report vs. objective PA assessment must be evaluated.

After gastric bypass surgery REE declines in direct association with weight loss [9-11], and REE prediction equations remain well correlated with measured REE (REE-m) in this population. Flancbaum et al. [12] showed that HB equation predicted 90-101% of the REE-m by indirect calorimetry from pre- to 6-months post-surgery and 107-111% from 12-24 months post-surgery; during which gastric bypass patient's weight decreased 96 to 146 kg. Among obese individuals, Prado-de Oliveira et al. [13] reported that HB equation predicted REE-m; however, prediction was 8% lower. More recently, Ullah et al. [14] observed that HB equation overestimated REE by 10% in morbidly obese adults,

but after gastric bypass surgery the difference was reduced to 1%. Other studies have supported HB and MSJ equations to predict REE in non-obese to morbidly obese women [5,15], while the FAO/WHO/UNU equation have been supported by some [16] but criticized by others [15].

The HB, MSJ, and FAO/WHO/UNU equations to predict TEE using recommended PA coefficients in post-Gastric Bypass (GB), Lean (LE), and Obese (OB) adults have not been reported. Because the significant weight reduction after gastric bypass surgery represents a metabolic challenge not fully understood, and because over reporting PA behavior is common, particularly among overweight and obese adults [17,18], we hypothesized that 1) predicted REE will be similar to REE-m using all equations, but 2) differences in PA coefficients determined with self-report vs. objectively assessed PA behavior will be present among GB, LE, and OB women.

Methods

A sub-group of non-diabetic female adults were recruited from a larger study [4]: GB (n=13), LE (n=7), and OB (n=12). GB participants were contacted from a database of patients that had undergone open or laparoscopic proximal Roux-en-Y gastric bypass surgery at Mayo Clinic, Rochester, MN. The eligibility criteria were: 18-45 years of age, surgery ≥ 12 months prior to the study, ≥ 10 kg of body weight loss, and able to engage in ambulatory activities. Women were specifically targeted in the present study due to the fact that more than 80% of bariatric surgery patients are women [19]. Participants in the OB and LE groups were recruited from the surrounding Rochester, MN, area through advertisements. All participants underwent a medical history and physical exam by a study physician, had a confirmed negative pregnancy test, and were evaluated during the early follicular phase of the menstrual cycle or during days 3-7 of the

placebo phase of oral contraceptive therapy. Participants taking part in exercise training programs were excluded. The Mayo Institutional Review Board approved the study and participants gave informed consent after all their questions were answered. All testing were conducted at the Clinical Research Unit of the Mayo Clinic Center for Translational Science Activities.

REE

REE was measured over 30 min using indirect calorimetry (Deltatrack, Sensormedics, Yorba Linda, CA). Measurements were taken during the same time of the day (starting at 7:00 am) with participants in fasting state lying in a supine position with care taken to minimize distractions. Heart rate was measured from a 3-lead ECG. Predicted REE was determined using the HB, MSJ and FAO/WHO/UNU equations (Table 1).

Physical activity and sedentary behavior

Self-reported PA was assessed through personal interviews using the International PA Questionnaire (IPAQ), where min/week of Moderate to Vigorous Physical Activities (MVPA) and sitting or sedentary time were determined. Objective PA and sedentary time was obtained using the ActiGraph GT1M accelerometer attached to an elastic belt and worn at the hip level for 5-7 consecutive days including at least one weekend day. Participants were instructed to remove the accelerometer only when showering, sleeping at night, or engaging in aquatic activities. Daily phone calls helped ensure proper use of accelerometers, which were fully charged and set for 60 second epoch of activity count and steps measurements. Participants were scheduled for a visit to complete the IPAQ and return the accelerometer for downloading (ActiLife v4.4.1, The ActiGraph, Pensacola, Florida) and assessment of MVPA, sedentary time, and steps/day using previously reported protocols [20-22].

Physical activity level and coefficient

PA levels were determined using the following categories: 0 = little or no exercise, 1 = light, 2 = moderate, 3 = heavy and 4 = very heavy exercise; in accordance to PA categories recommended for the HB equation [7]. A PA level was assigned to each participant based on their self-reported and accelerometer determined MVPA in min/day and steps/day using previously described thresholds [20-22]: 0 ≤ 100 min/week or < 5,000 steps/day, 1 = 100-149 min/week or 5,000-7,499 steps/day, 2 = 150 - 299 min/week or 7,500-9,999 steps/day, 3 = 300-449 min/week or 10,000-12,000 steps/day, and 4 ≥ 450 min/week or ≥ 12,500 steps/day.

The recommended PA coefficient [7] for each PA level (Table 1) was multiplied by the REE predicted with HB and MSJ equations for an estimate of TEE. The FAO/WHO/UNU equation presents a different set of PA levels and coefficient (FAO/WHO/UNU, 1985) which were determined according to the following criteria: 0 (light activity) < 150 min/week or < 7,500 steps/day, 1 (moderate activity) = 150-299 min/week or 7,500-10,000 steps/day, and 2 (heavy activity) ≥ 300 min/week or ≥ 10,000 steps/day. We also determined TEE for each participant using the REE-m, the accelerometer determined PAEE, and 10% for the TEF. Then, we determined a PA coefficient by dividing our determined TEE by the REE-m (Table 2).

Table 1: Equations to predict Resting Energy Expenditure and recommended Physical Activity (PA) coefficients for each PA level.

Equation		PA Level: PA Coefficient
HB (1984)	Women (REE) = 447.593 × (9.247 × weight) + (3.098 × height) - (4.330 × age)	0:1.2 1:1.375 2:1.55 3:1.725 4:1.9
MSJ (2005)	Women (REE) = (9.99 × weight) + 6.25 × height - (4.92 × age) - 161	
FAO/ WHO/ UNU (1985)	Women - (REE by age group) 18-30 yr. of age: (13.3 × weight) + (334 × height) + 35 31-60 yr. of age: (8.7 × weight) - (25 × height) + 885 > 60 yr. of age: (9.2 × weight) + (637 × height) - 302	0:1.56 1:1.64 2:1.82

HB = Harris-Benedict, MSJ = Mifflin-St. Jeor, FAO/WHO/UNU = World Health Organization/Food and Agriculture Organization/United Nations University. Weight in kg, Height in cm (m for FAO/WHO/UNU), and Age in years.
PA level for HB and MSJ: 0= little or no exercise, 1 = light exercise, 2 = moderate exercise, 3 = heavy exercise, 4 = very heavy exercise. PA level in FAO/WHO/UNU is based on occupational activity: 0 = light activity, 1 = moderate activity, and 2 = heavy activity.

Body composition

Body composition was determined with DEXA (DPX-IQ, GE Medical Systems Lunar Corporation, Madison, WI). Abdominal (L2 vertebrae level) 6-10 mm sectional slices were obtained from CT scans; and the amount of adipose tissue determined automatically using a seeding program as previously described [23]. Body mass index (BMI: kg/m²) was calculated from height (cm) and weight (kg) using a Cardinal/Detecto scale (Webb City, Missouri). A registered nurse took all measurements.

Nutritional intake

The general Viocare Technologies electronic food frequency questionnaire (Vio-FFQ) was administered by interview. This instrument capture the previous 30-day average nutritional intake employing the Minnesota nutritional database for analyses, and has been validated against 4-day food records and 24-hr dietary recalls [24].

Data analyses

Statistical analyses included means and standard errors for all study variables. A one-way ANOVA was used to determine differences between REE-m and predicted with HB, MSJ, and FAO/WHO/UNU equations, and agreements between REE-m and predicted were evaluated with Bland & Altman's plots [25]. In addition, the concordance correlation coefficient and mean difference for each group were obtained to further test the agreement between the REE-m and predicted [26]. The percent REE predicted with each equation was also determined. One-way ANOVAs were used to determine differences in PA coefficients within each group based on self-reported and objectively assessed PA behavior, and differences in TEE estimated with self-reported and objectively assessed PA coefficients. Statistical significance was interpreted from a $p < 0.05$ using STATA (version 11, 2009, STATA Corp LP, College Station, TX).

Results

Average BMI for GB participants at the time of surgery was 44.7 ± 1.0 kg/m², and time from surgery to the study was 38 ± 5 months, with an average loss of $33 \pm 2\%$ of pre-surgical weight. General physical and nutritional characteristics are presented in Table 3. Groups were similar in age, fat free mass, REE relative to fat free mass, MVPA, and sedentary time. Resting oxygen consumption relative to body weight was lower and PAEE higher in OB compared with GB and LE groups. BMI was different between groups with OB having the highest and LE having the lowest values. Nutritional intakes were similar between groups.

No within group differences were observed for REE-m and predicted with the three equations, but between group differences were detected. REE-m was lower in LE compared with the GB and OB groups, and predicted REE were different between the three groups (Figure 1A), with the highest predicted REE observed in the OB and the lowest in the LE group. The percent of REE predicted with all equations was higher in the OB compared with the GB group (Figure 1B). Moreover, the agreement and concordance between the REE-m and predicted with HB, MSJ, and FAO/WHO/UNU equations (Figure 2A, 2B, 2C, respectively)

Table 2: General physical and nutrition characteristics of study participants (Mean $\pm$ SE).

Variable	GB (n = 13)	LE (n = 7)	OB (n = 12)	P
Age (yrs.)	37.6 $\pm$ 1.7	36.6 $\pm$ 2.7	32.0 $\pm$ 2.3	0.14
BMI (kg/m ²)	30.2 $\pm$ 1.4*	22.4 $\pm$ 0.8*	37.9 $\pm$ 1.0*	< 0.001
Visceral fat (cm ²)	58.8 $\pm$ 10.5	31.4 $\pm$ 8.7	127.4 $\pm$ 11.0*	0.005
Fat Free Mass (kg)	46.2 $\pm$ 1.7	42.4 $\pm$ 2.4	49.8 $\pm$ 1.8	0.06
Resting VO ₂ (ml·kg ⁻¹ ·min ⁻¹)	2.24 $\pm$ 0.1	2.44 $\pm$ 0.1	1.95 $\pm$ 0.1*	0.002
Relative REE (kcal/kg FFM)	35.6 $\pm$ 1.2	32.7 $\pm$ 1.8	35.1 $\pm$ 1.6	0.45
Accelerometer Total MVPA (min/week)	185.9 $\pm$ 33.0	322.6 $\pm$ 136.3	124.0 $\pm$ 22.1	0.09
MVPA in 10 min bouts (min/week)	22.9 $\pm$ 11.4	174.4 $\pm$ 133.2	21.6 $\pm$ 7.3	0.10
Accelerometer PAEE (kcal)	268.8 $\pm$ 19.4	179.4 $\pm$ 26.8	350.4 $\pm$ 24.2*	0.002
Accelerometer Sedentary Time (hrs./day)	9.7 $\pm$ 0.5	9.3 $\pm$ 0.7	9.9 $\pm$ 0.5	0.78
IPAQ MVPA (min/week)	497.7 $\pm$ 248.6	541.4 $\pm$ 263.7	828.6 $\pm$ 261.7	0.61
IPAQ Sedentary Time (hrs./day)	7.9 $\pm$ 1.4	6.7 $\pm$ 1.1	7.7 $\pm$ 0.9	0.81
Energy Intake (kcal/day)	1878 $\pm$ 215.7	1697 $\pm$ 335.1	2119 $\pm$ 476.0	0.75
Carbohydrate Intake (g)	225.6 $\pm$ 27.3	208.7 $\pm$ 47.8	244.6 $\pm$ 48.8	0.85
Fat Intake (g)	77.0 $\pm$ 10.8	59.4 $\pm$ 9.4	83.5 $\pm$ 19.9	0.61
Protein Intake (g)	76.5 $\pm$ 7.7	78.1 $\pm$ 19.1	94.0 $\pm$ 19.2	0.66

* Values significantly different from each other (BMI = Body Mass Index, MVPA = Moderate to Vigorous PA, REE = Resting Energy Expenditure, PAEE = PA Energy Expenditure, IPAQ = International PA Questionnaire)

was similar for all groups combined (coefficient of concordance: 0.75, 0.75, and 0.72, respectively; $p < 0.001$ for all). However, when groups were analyzed individually (dashed lines in Figure 2), the coefficient of concordance remained significant with all equations for the GB and LE groups, but not significant for the OB group. Figure 2 also shows a tendency for REE predicted to be higher at higher levels and lower at lower levels of REE-m. This tendency disappeared when all groups were combined.

PA coefficients using objective vs. self-reported PA level are presented in Table 3. Values were higher using the FAO/WHO/UNU classification and, as expected, values were also higher when using self-reports to classify PA level. Our determined PA coefficient was similar to PA coefficients estimated with objectively assessed PA level. Although the differences between PA coefficients appeared small, when values were used to predict TEE, differences in energy requirements were magnified. The comparison between our determined TEE and TEE predicted with each equation is presented in Figure 3. No differences were observed between these two values in GB and OB groups when objective PA level and coefficients were used, but predicted TEE was higher with self-reported PA level (approximately

200-300 Kcal/day). In the LE group, TEE predicted with HB was higher (approximately 300 Kcal/day) with both objectively and subjectively determined PA level. Predicted TEE with MSJ equation was similar to our determined TEE in all groups when using objectively and subjectively determined PA level. With the FAO/WHO/UNU equation, the predicted TEE was significantly higher (approximately 300-900 kcal/day) in all groups regardless of how PA level was determined.

Discussion

In this study we compared 1) REE measured and predicted with HB, MSJ, and FAO/WHO/UNU equations, and 2) our determined PA coefficient with those commonly used for HB, MSL, and FAO/WHO/UNU equations, and 3) our determined TEE and TEE predicted for GB, LE, and OB women. The most important findings are: REE predicted using HB, MSJ, and FAO/WHO/UNU equations were not different than REE-m, and the agreement and concordance between REE-m and predicted was significant for all groups combined. However, the limits of agreement and concordance between REE-m and predicted for each individual group were not acceptable only in the OB group; thus, suggesting that HB and MSJ equations are adequate to predict REE in GB and LE but not in OB women. We also observed that equations tended to overestimate in the lower range and underestimate in the higher range of REE in the GB and LE groups. Another important finding is that PA levels determined with self-reports resulted in elevated PA coefficients that magnified the TEE predicted, particularly with the FAO/WHO/UNU equation. Therefore, the selection of PA coefficients to predict TEE should be based on objective assessments of PA using accelerometers.

Table 3: Mean and range of recommended physical activity (PA) coefficients as determined by individual PA levels obtained by objective assessment (steps/day or accelerometer-MVPA) or self-reported (IPAQ) PA behavior, and determined PA coefficient based on objective measurements in post-gastric bypass (GB), Lean (LE) and Obese (OB) women.

Criteria	Equation	GB	LE	OB
Steps/day	HB, MSJ	1.4 (1.2-1.725)	1.5 (1.2-1.9)	1.4 (1.2-1.55)
	FAO/WHO/UNU	1.6 (1.56-1.64)	1.6 (1.5-1.82)	1.6 (1.56-1.64)
Accelerometer - MVPA (min/week)	HB, MSJ	1.4 (1.2-1.9)	1.5 (1.2-1.9)	1.3 (1.2-1.55)
	FAO/WHO/UNU	1.6 (1.56-1.82)	1.7 (1.56-1.82)	1.6 (1.56-1.64)
IPAQ - MVPA (min/week)	HB, MSJ	1.6 (1.2-1.9)	1.5 (1.2-1.725)	1.5 (1.2-1.725)
	FAO/WHO/UNU	1.7 (1.56-1.82)	1.6 (1.56-1.82)	1.6 (1.56-1.82)
Determined PA coefficient = (REE-m + accelerometer PAEE + TEF)/REE-m		1.4 (1.3-1.5)	1.3 (1.2-1.4)	1.4 (1.3-1.6)

Mean and range of recommended physical activity (PA) coefficients as determined by individual PA levels obtained by objective assessment (steps/day or accelerometer-MVPA) or self-reported (IPAQ) PA behavior, and determined PA coefficient based on objective measurements in post-gastric bypass (GB), Lean (LE) and Obese (OB) women.

Figure 1: Resting energy expenditure (A) and percent of resting energy expenditure predicted (B) by Harris-Benedict (HB), Mifflin St. Jeor (MSJ), and FAO/WHO/UNU equations in post gastric-bypass (GB), Lean (LE) and Obese (OB) women (Between group: bars with same symbols are significantly different from each other, $P < 0.05$).

Previous studies have reported similar REE-m and predicted with HB, MSJ and FAO/WHO/UNU equations [27,28], and a tendency for bias in REE predicted in the extremes of REE-m [28,29]. Although, this bias was not present in our OB group, their predicted REE had poor agreement and concordance with REE-m. Only 33% of the predicted REE in this group were within 10% of the REE-m using the FAO/WHO/UNU equation, and 50% with HB and MSJ equations, which is consistent with Spears et al. [28] observations. However, 78-100% of our GB and LE groups had predicted REE within 10% of the REE-m using all three equations.

A better REE estimate with MSJ compared with HB was reported in a systematic review among non-obese and obese adults [5]. REE predicted with MSJ was within 10% of the REE-m in 82% of non-obese, and 70% of obese participants, contrasting with REE predicted with HB which was accurate in 45-80% of the non-obese, and 38-66% of the obese. FAO/WHO/UNU equation was not included because of lack of evidence at the individual level at that time. However, in a study to determine energy requirements in a controlled feeding trial, Lin et al. [16] reported that HB and FAO/WHO/UNU equations accurately predicted energy requirements to achieve stable weight. In another study, Weijs and Vansant [15] evaluated the accuracy of HB, MSJ, and FAO/WHO/UNU equations among normal weight

to morbidly obese Belgian women. Although the REE predicted and REE-m were similar (Mean $\pm$ SD= 1,687 $\pm$ 219, 1,614 $\pm$ 247, 1,691 $\pm$ 240, and 1,657 $\pm$ 288 Kcal/day, respectively), and the average accuracy was also similar (68, 68, and 61% cases within 10% of REE-m, respectively); at the individual level the accuracy dropped significantly (51% to 29%) with the FAO/WHO/UNU in extremely obese women (≥ 45 Kg/m²). In the range of BMI observed in our study the accuracy of the HB and MSJ equations reported by Weijts and Vansant [15] ranged from 75-80%, which is also consistent with our results. These authors concluded that HB and MSJ can be used to predict REE in normal weight to

Figure 3: Total Energy Expenditure (TEE) as estimated and predicted by different equations using a physical activity coefficient based on self-reported (IPAQ) versus objective (steps/day) assessment of PA behavior in post-gastric bypass (GB), Lean (LE) and Obese (OB) women. (* P < 0.05 compared with determined TEE).

morbidly obese women. The present study is the first to provide these evaluations in women who have undergone gastric bypass surgery, and also the first to compare PA coefficients to estimate TEE based on objective vs. subjective assessment of PA level.

The use of PA coefficients to estimate TEE from REE prediction equations is common among dietitians and nutritionists when assessing energy requirements and nutritional interventions. The difficulties with the accuracy of these coefficients are partially solved when TEE is measured with doubly labelled water under free living conditions, and REE with indirect calorimetry [7]. PA coefficients derived from such measures account not only for the PAEE but also the TEF. Based on these reports, a mean 1.65 PA coefficient was derived, with lower coefficients for individuals classified as sedentary and low active (1.2-1.5), and higher values for individuals classified as heavily active (1.8-2.4) [30]. Other categories of PA and corresponding PA coefficients have been used (Table 1) in different studies. For example, Kien and Ugrasbul [31] used a standard PA coefficient of 1.6 for the estimate of TEE in non-obese adults; while Spears et al. [28] used a PA coefficient of 1.4 for sedentary, 1.5 for low active, and 1.6 for active overweight women. Others have failed to specify how PA level is determined or which PA coefficient is used to estimate TEE [4,6]. However, most studies rely on PA self-reports [6,16,28] which are likely to overestimate PA coefficients because of the usual over-reporting of PA behavior [18]. We recently reported that GB, LE and OB adults overestimate their PA behavior with self-reports compared with objective assessment, and the overestimation is higher in OB compared with GB and LE groups [17]. Light activity and sedentary behavior in the present group of women showed, as expected, that the proportion classified as sedentary to low active was lower with self-report compared with accelerometer (GB: 38 vs. 81%; LE: 57 vs. 71%; OB: 50 vs. 81%), and the level of sedentariness among these participants

was of concern.

Our determined PA coefficients for GB, LE, and OB women were similar to those recommended for HB and MSJ only when using objectively assessed PA level, and were lower than coefficients for the FAO/WHO/UNU equation and coefficients used in previous studies [28,31]. These differences are magnified when coefficients are used to estimate TEE from prediction equations, particularly with the FAO/WHO/UNU, suggesting that their PA coefficients are probably inadequate. Overestimates of daily energy requirements ranging from 200-900 kcal/day when adding an estimated PA coefficient factor to an REE prediction equation could jeopardize any attempt for weight control. It was also interesting to notice that energy intake was not different than our determined TEE in each group (GB= $1,878 \pm 215$ vs. $2,203 \pm 62$ Kcal/day; LE = $1,698 \pm 329$ vs. $1,767 \pm 78$ Kcal/day; OB = $2,199 \pm 481$ vs. $2,370 \pm 63$ Kcal/day, respectively), suggesting that women participants were likely in energy balance.

There are important limitations in the present study. First our small sample size consisting only of women makes our results not generalizable to men. However, our results are comparable to previous studies with women using larger sample sizes. A strength and novelty of this study is the inclusion of GB, LE, and OB groups for comparison. A second limitation is the lack of valid assessment of TEF. Although TEF represents a small amount of the TEE, assuming that it represents 10% of the TEE could be problematic for some individuals. There is limited information regarding TEF among GB, OB and LE individuals. The comparison of TEF before and after gastric bypass surgery have indicated either no change or 200% increase [11].

In conclusion, predictions of REE using HB and MSJ equations appeared adequate for our GB and LE women, but caution is advised for those in the extremes of REE. Among OB women HB and MSJ equations were less appropriate, and the FAO/WHO/UNU equation was the least accurate in all groups. To determine daily energy requirements from estimated TEE, PA coefficients must be based on objectively assessed PA behavior. Future studies must include TEF among GB, LE and OB participants so that TEE prediction equations could be adequately validated.

Disclaimers

The authors have no financial conflicts to disclose. The views expressed in the submitted article are the authors' own and not an official position of the University of Puerto Rico or Mayo Clinic.

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