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Energy Prediction Equations Are Inadequate for Obese Hispanic Youth

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ABSTRACT

Assessing energy requirements is a fundamental activity in clinical dietetics practice. A study was designed to determine whether published linear regression equations were accurate for predicting resting energy expenditure (REE) in fasted Hispanic children with obesity (aged 7 to 15 years). REE was measured using indirect calorimetry; body composition was estimated with whole-body air displacement plethysmography. REE was predicted using four equations: Institute of Medicine for healthy-weight children (IOM-HW), IOM for overweight and obese children (IOM-OS), Harris-Benedict, and Schofield. Accuracy of the prediction was calculated as the absolute value of the difference between the measured and predicted REE divided by the measured REE, expressed as a percentage. Predicted values within 85% to 115% of measured were defined as accurate. Participants (n=58; 53% boys) were mean age 11.8±2.1 years, had 43.5%±5.1% body fat, and had a body mass index of 31.5±5.8 (98.6±1.1 body mass index percentile). Measured REE was 2,339±680 kcal/day; predicted REE was 1,815±401 kcal/day (IOM-HW), 1,794±311 kcal/day (IOM-OS), 1,151±300 kcal/day (Harris-Benedict), and, 1,771±316 kcal/day (Schofield). Measured REE adjusted for body weight averaged 32.0±8.4 kcal/kg/day (95% confidence interval 29.8 to 34.2). Published equations predicted REE within 15% accuracy for only 36% to 40% of 58 participants, except for Harris-Benedict, which did not achieve accuracy for any participant. The most frequently accurate values were obtained using IOM-HW, which predicted REE within 15% accuracy for 55% (17/31) of boys. Published equations did not accurately predict REE for youth in the study sample. Further studies are warranted to formulate accurate energy prediction equations for this population.

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The assessment of energy requirements is a fundamental activity in clinical dietetics practice. Basal energy represents the minimal energy supporting vital organ functions, which is estimated from indirect calorimetry measures of resting energy expenditure (REE) (1). REE is used along with assessment of physical activity to plan diet therapy. REE is especially poignant in the care of those with limited tolerance or capacity to self-correct overfeeding or underfeeding (eg, mechanically ventilated patients) (2). Because measuring REE requires specialized and expensive equipment, REE is often predicted using linear regression equations (1,3,4).

The Harris-Benedict equations (HBEE) (3) were generated from REE measures of mostly college students and faculty of unreported race and ethnicity (Table 1). Only 19 participants enrolled by Harris and Benedict (3) were overweight or obese (5). Although few young children were included in the dataset and despite lack of agreement with pediatric measures (6,7), HBEE continues to be used in pediatric practice (8). The Schofield equations (4) were generated from data published during a 60-year period in the scientific literature of mostly European and North American children (Table 1). According to the Institute of Medicine (IOM) (1), the pediatric Schofield equations (4) were validated in British (9) and Dutch (10) children. More recently, IOM (1) generated prediction equations for healthy-weight children (IOM-HW) and for overweight and obese children (IOM-OS). These equations are intended for use with children aged 3 to 18 years, although the data sample used to derive equations was young, averaging 7 to 9 years old. The racial composition of the volunteers was mostly white in the IOM-HW data set but predominantly

Table 1. Characteristics of the study sample of obese Hispanic youth (N=58), grouped by sex, and comparison to participants in other studies that predicted resting energy expenditure

Characteristic	Boys				Girls			
Study sample	n=31				n=27			
	Mean±SD[a]		*Range*		*Mean±SD*		*Range*	
Age (y)	11.5±2.2		7.1-15.7		12.0±1.9		8.6-15.3	
Weight (kg)	72.2±20.4		43.7-119.6		78.2±21.5		44.3-137.3	
Body mass index	30.2±4.6		23.5-41.2		33.0±6.7		24.2-49.7	
Harris-Benedict[b] sample	n=136				n=103			
Age (y)	26.9±8.8		16.0-63.0		31.1±13.9		15.0-74.0	
Weight (kg)	64.1±10.3		33.2-108.9		56.4±11.4		35.6-94.1	
Body mass index	21.4±2.9		15.2-32.5		21.5±4.1		12.3-34.6	
IOM-HW[c] sample	n=154				n=397			
Age (y)	7.8±3.0		3.0-18.0		9.3±3.1		3.9-18.0	
Weight (kg)	27.3±11.0		15.4-70.6		31.4±11.6		14.6-67.3	
Body mass index	16.1±1.6		13.8-22.2		16.8±2.1		13.6-23.4	
IOM-OS[d] sample	n=157				n=249			
Age (y)	7.5±2.5		4.0-18.8		8.9±3.2		4.0-16.3	
Weight (kg)	39.3±16.1		18.1-83.9		45.0±19.6		16.7-128.2	
Body mass index	22.1±4.6		14.9-38.2		22.9±4.9		16.8-44.6	
Schofield[e] sample	n=1,072				n=988			
Age category (y)	**3-10**		**11-18**		**3-10**		**11-18**	
	Mean±SD[a]	*Range*	*Mean±SD*	*Range*	*Mean±SD*[a]	*Range*	*Mean±SD*	*Range*
Age (y)	7.5±1.8	3.1-10.6	13.7±2.4	11.1-18.6	7.6±1.7	3.4-10.7	12.8±2.3	11.2-18.3
Weight (kg)	21.5±4.4	15.7-33.9	41.8±14.6	28.6-77.1	21.4±4.7	14.2-34.0	38.5±11.2	25.5-72.4
Body mass index	15.3±1.3	11.7-18.8	18.1±2.7	10.5-25.9	15.3±1.5	11.3-19.4	17.6±2.6	11.1-24.1

[a]SD=standard deviation.
[b]Harris-Benedict equation (3).
[c]IOM-HW=Institute of Medicine equation for healthy-weight children (1).
[d]IOM-OS: Institute of Medicine equation for overweight and obese children (1).
[e]Schofield equation (4).

American Indian in the IOM-OS data set, and the ethnicity in both data sets was <7% Hispanic (1). The IOM equations have yet to be validated.

Obesity and its complications are highly prevalent among Hispanic American youth. In the 2007-2008 National Health and Nutrition Examination Survey, 23% of Hispanic American children and adolescents were reported as having body mass index (BMI) clinical growth curves at ≥95th percentile, an 80% higher prevalence compared to non-Hispanic white children and adolescents (11). Obese Hispanic Americans also have a high prevalence of obesity-associated comorbidities, including hyperinsulinemia and impaired glucose tolerance (12,13). For these reasons, the investigative team undertook research in Hispanic children. REE equations were of interest for use in planning meal studies, but the accuracy of various equations was not known for US children. The primary hypothesis tested whether there was a significant difference between an individual's measured REE value and the REE predicted by each of four equations: IOM-HW (1), IOM-OS (1), HBEE (3), and Schofield (4).

METHODS

Participants

The data were derived from baseline measures of participants enrolled in a weight loss trial, whose procedures were approved by the Children's National Medical Center Institutional Review Board. Participants were recruited at a hospital-affiliated clinic located in a predominantly Hispanic neighborhood in Washington, DC. Inclusion criteria included obesity, Hispanic ethnicity, age 7 to 15 years, and ambulatory. Children with type 2 diabetes, pervasive development delay, cerebral palsy, severe asthma, Cushing syndrome, Prader-Willi syndrome, or untreated hypothyroidism were excluded. Consent and assent were obtained from parents and children, respectively.

Procedures

Participants arrived at the Clinical Research Center at 7:00 AM after a 12-hour fast. The study physician conducted a medical history, physical examination, and screened participants for exclusionary conditions. Compliance with fasting procedures was confirmed from a 24-hour dietary recall. The child was asked to void and change into a hospital gown. Height and weight were measured in triplicate using a wall-mounted stadiometer (SECA 216, Hanover, MD) and digital scale (Healthometer, Bridgeview, IL), respectively. BMI was calculated as kg/m^2, BMI percentiles for age and sex were determined (14), and obesity was defined as BMI ≥95th percentile (15). Body composition was assessed in spandex clothes