CLINICAL RESEARCH STUDY

THE AMERICAN JOURNAL of MEDICINE®

Low Fitness Partially Explains Resting Metabolic Rate Differences Between African American and White Women

Robin P. Shook, PhD,[a] Gregory A. Hand, PhD, MPH,[a] Xuewen Wang, PhD,[a] Amanda E. Paluch, MS,[a] Robert Moran, PhD,[b] James R. Hébert, ScD,[b,c,d] Damon L. Swift, PhD,[e] Carl J. Lavie, MD,[f,g] Steven N. Blair, PED[a,b]

[a]Department of Exercise Science and [b]Department of Epidemiology and Biostatistics, Arnold School of Public Health, University of South Carolina, Columbia; [c]Department of Family and Preventive Medicine, University of South Carolina, Columbia; [d]South Carolina Cancer Prevention and Control Program, Arnold School of Public Health, University of South Carolina, Columbia; [e]Department of Kinesiology, Center for Health Disparities, East Carolina University, Greenville, NC; [f]John Ochsner Heart and Vascular Institute, Ochsner Clinical School, University of Queensland School of Medicine, New Orleans, La; [g]Department of Preventive Medicine, Pennington Biomedical Research Center, Louisiana State University System, Baton Rouge, La.

ABSTRACT

BACKGROUND: High levels of obesity among African American women have been hypothesized to be partially resultant from a lower resting metabolic rate compared with white women. The aim of the current study was to determine if differences in cardiorespiratory fitness and moderate-to-vigorous physical activity are associated with differences in resting metabolic rate among free-living young adult African American women and white women.

METHODS: Participants were 179 women (white women n = 141, African American women n = 38, mean age = 27.7 years). Resting metabolic rate was measured using indirect calorimetry, body composition using dual energy x-ray absorptiometry, cardiorespiratory fitness via maximal treadmill test, and moderate-to-vigorous physical activity using an activity monitor.

RESULTS: African American women had higher body mass index, fat mass, and fat-free mass compared with white women but lower levels of cardiorespiratory fitness. No differences were observed between African American and white women in resting metabolic rate when expressed as kcal/day (1390.8 ± 197.5 vs 1375.7 ± 173.6 kcal/day, $P = .64$), but African American women had a lower resting metabolic rate when expressed relative to body weight (2.56 ± 0.30 vs 2.95 ± 0.33 mL/kg/min, $P < .001$). After statistical adjustment for differences in body composition between groups using linear regression models, African American women had a lower resting metabolic rate compared with white women (1299.4 ± 19.2 vs 1400.4 ± 9.2 kcal/day, $P < .001$). The addition of cardiorespiratory fitness reduced the differences among groups by 25%. The addition of moderate-to-vigorous physical activity did not improve the model.

CONCLUSIONS: The present study confirms that African American women have a lower resting metabolic rate compared with their white peers, and low cardiorespiratory fitness explained 25% of this difference. Variables associated with resting metabolic rate, such as cardiorespiratory fitness, represent possible points of tailored interventions designed to address high levels of obesity seen in certain demographic groups.

 • *The American Journal of Medicine (2014) 127, 436-442*

KEYWORDS: Fitness; Physical activity; Race; Resting metabolic rate; Women

African American females have the highest prevalence of overweight (82.1%) and obesity (58.6%) of any racial group in the US,[1] are more likely to gain weight,[2] have a harder time losing and maintaining weight loss,[3] and are more likely to regain weight[4] compared with white women. A majority of studies have reported lower levels of resting metabolic rate in African American women compared with white women, ranging from 81 to 274 kcal/day.[5,6] While these values may seem trivial, small differences in energy balance (eg, a positive energy balance due to insufficient levels of energy expenditure) may result in long-term clinically relevant changes in energy storage (eg, adiposity).[7]

Funding: See last page of article.

Conflict of Interest: See last page of article.

Authorship: See last page of article.

Requests for reprints should be addressed to Robin P. Shook, PhD, Public Health Research Center, 921 Assembly St., Columbia, SC 29201.

E-mail address: shookr@mailbox.sc.edu

0002-9343/$ -see front matter
http://dx.doi.org/10.1016/j.amjmed.2014.02.003

Many,[8-12] but not all,[13-15] studies have found a low resting metabolic rate to be predictive of subsequent weight gain.

The primary cause of lower resting metabolic rate appears to be due to individual differences in fat-free mass compartments, with African American women possessing larger levels of skeletal muscle mass and bone mass and lower levels of residual mass (including the brain, liver, heart, and kidneys) compared with white women.[16-21] Fat-free mass is not energetically homogenous; for example, the metabolic rate of bone and skeletal muscle (approximately 2.3 and 13 kcal/kg of tissue/day, respectively) are drastically lower compared with other organs, including the brain, kidneys, heart, and liver (approximately 330 kcal/kg of tissue/day).[22-24] Most analyses only measure fat-free mass, rather than the individual compartments described above, and may not accurately identify sources of variation in resting metabolic rate among groups.[5,18,25]

Another potential cause of low resting metabolic rate levels in African American women may be low cardiorespiratory fitness, as unfit sedentary individuals often have a 5%-20% lower resting metabolic rate compared with those with high levels of cardiorespiratory fitness and moderate-to-vigorous physical activity.[26-28] Indeed, previous analyses from the National Health and Nutrition Examination Survey (NHANES) and elsewhere indicate that African Americans have lower levels of cardiorespiratory fitness compared with Whites, by 5%-10%, particularly among women.[29-31] It is possible that the low levels of cardiorespiratory fitness in African American women may augment existing low levels of resting metabolic rate due to differences in metabolically active tissues.

The aim of the current study was to compare resting metabolic rate between African American and white women, adjusting for differences in body compartments and levels of cardiorespiratory fitness and moderate-to-vigorous physical activity.

CLINICAL SIGNIFICANCE

- African American young women have a lower resting metabolic rate than white young women.
- Low cardiorespiratory fitness levels among African American women explain approximately 25% of this difference in resting metabolic rate.
- Low levels of moderate to vigorous physical activity did not explain any additional difference in resting metabolic rate between groups.
- Variables associated with resting metabolic rate (eg, cardiorespiratory fitness), represent possible points of tailored interventions designed to address the obesity epidemic.

METHODS

The design and rationale for this study have been described in detail.[32] All study protocols were approved by the University of South Carolina Institutional Review Board, and informed consent was obtained from each participant before data collection. Individuals were excluded if they had a major medical condition (eg, diabetes, hypertension, thyroid condition). All women were eumenorrheic. Given that no widely accepted nomenclature exists for classification of race in academic and journalistic writing, we have adopted the categories utilized in the 2010 US Census, "Black or African American" and "White,"[33] (self-identified by participants, and only one category could be selected).

Dual-energy x-ray absorptiometry (DXA) provided measurements on bone mineral density, fat mass, and fat-free mass, both whole body and various regions (eg, arms, legs) using a Lunar DPX system (version 3.6; Lunar Radiation Corp, Madison, Wis). Skeletal muscle mass was estimated from appendicular lean soft tissue mass using the following linear regression equation:

$$\text{Skeletal mass} = (1.13 \times \text{appendicular lean soft tissue}) - (0.02 \times \text{age}) + (0.61 \times \text{sex}) + 0.97$$

where sex = 0 for females.[34] This equation was developed (n = 321) and validated (n = 93), with ethnically diverse men and women using magnetic resonance imaging (MRI) and DXA. Correlation between skeletal mass derived from the equation and MRI were high (r = 0.96, $P < .0001$).[34] Residual mass, representing brain, liver, kidneys, heart, gastrointestinal tract, and other organs and tissues, was then calculated using the following equation[21]:

$$\text{Residual mass} = \text{body weight} - \text{fat mass} - \text{skeletal mass} - \text{bone mass}$$

Cardiorespiratory fitness was assessed by maximal treadmill test (Modified Bruce protocol) with respiratory gases sampled using a TrueOne 2400 Metabolic Measurement Cart (Parvo Medics, Salt Lake City, Utah). Resting metabolic rate was measured via indirect calorimetry using a ventilated hood and an open-circuit system (also the TrueOne 2400 Metabolic Measurement Cart). An initial stabilization period of 15 minutes was followed by a 30-minute data collection period. Participants arrived for a morning visit (<9:00 AM) following a 12-hour dietary fast and at least 24 hours after the last bout of structured exercise.

Total daily energy expenditure was measured using a validated arm-based activity monitor (SenseWear Mini Armband; BodyMedia Inc., Pittsburgh, Pa).[35] The participants wore the armband for 10 consecutive days, and compliance criteria for adequate wear time were set at 7 days, with at least 23 hours of daily wear time. Time spent in physical activity was classified by intensity according to the estimated metabolic equivalent of task (MET) based on the following criteria: Sedentary, 1.0 to ≤1.5 METs; Light, >1.5 to ≤3.0 METs; Moderate, >3.0 to ≤6.0 METs; Vigorous,