Metabolism Make-Over: Fact or Fiction?

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CEC Providers

Research: Resting metabolic rate and weight loss questions answered and explained.

A major goal of weight management strategies and programs is to create an imbalance between energy intake (decreasing) and energy expenditure (increasing), in order to facilitate weight loss.

Total 24-hour energy expenditure (TEE, see Figure 1 for its components), is a multifaceted physiological phenomenon that is influenced by a complex interaction of genes (which favor energy conservation and storage for survival) and environment (which in today's developed world increasingly promotes a sedentary lifestyle while providing ready access to food) (Rosenbaum & Leibel 2010). Rosenbaum & Leibel purport that TEE can be separated into resting metabolic rate (RMR), comprising ~60% of TEE; the thermic effect (i.e., heat- and energy-releasing reactions) of exercise and spontaneous physical activity, accounting for ~30% of TEE; and the thermic effect of food (digestion, absorption and metabolism of nutrients), making up 5%–10% of TEE.

Because of its robust role in TEE, RMR has become the target of many substantiated and unsubstantiated weight loss propositions. This column will provide an evidence-based review of seven of the most popular questions on metabolism.

Seven Questions to Consider

1. How much does RMR decrease from diet-only interventions?

Hill (2004) states that basal metabolic rate (BMR; very similar to RMR, but measured using slightly stricter criteria) can be suppressed up to 20% by energy restriction. For example, a person whose BMR is 1,500 calories a day might have an approximate decrease of 300 calories per day in a diet-only program. However, Hill says that physical exercise (aerobic training and resistance exercise) provides a protective effect against such a drop. This can be explained primarily by the fact that people tend to lose a considerable portion of muscle mass

in diet-only programs, whereas one of the key contributions from exercise in weight loss programs is the preservation of muscle—and hence of RMR.

2. How much does RMR change from continuous long-term participation in aerobic exercise?

Potteiger and colleagues (2008) completed a 16-month study on the effect of RMR in adult female (exercise group = 25, control group = 18) and male (exercise group = 16, control group = 15) subjects who did aerobic exercise 3–5 days per week for 20–45 minutes per session at a moderate intensity (60%–75% of their heart rate reserve). There were no RMR changes in the control group, who just maintained their normal exercise and diet patterns for the 16 months. However, the females in the exercise group saw an average increase in RMR of 129 calories per day (meaning they were burning an additional 129 calories daily), while the males in the exercise group experienced an average increase in RMR of 174 calories per day (they were burning an extra 174 calories daily) in this 16-month investigation.

3. How much does RMR change from continuous long-term participation in resistance exercise?

Hunter et al. (2000) conducted a 26-week resistance training study with beginning, sedentary and older (aged 61–77) males (n = 7) and females (n = 8). Subjects completed supervised workouts consisting of 2 sets of 10 repetitions (with 2 minutes of rest between sets). The resistance exercises were elbow flexion, elbow extension, lateral pull-down, seated row, chest press, leg extension, leg curl, seated press, back extension, bent-leg sit-up (15–25 repetitions) and squat or leg press (as determined by the supervising exercise physiologist). The subjects trained at an intensity within 65%–80% of their 1-repetition maximum (1–RM). Hunter and colleagues carefully integrated progressive overload into the program after reviewing daily training logs and after retesting 1-RM every 3 weeks. By the end of the 6-month investigation, male and female subjects had increased their RMR by 7%, which was approximately 100 additional calories per day.

4. What is the best equation for estimating RMR?

Frankenfield, Roth-Yousey and Compher (2005) conducted a review of four population RMR estimation equations. The Mifflin-St. Jeor equation was found to be most accurate (Mifflin et al. 1990). The Mifflin-St. Jeor RMR equation was derived from data collected on males (n = 251) and females (n = 247) aged 19–78. For men and women respectively, the equation is as follows:

Males: RMR = 10 × (weight in kilograms) + 6.25 × (height in centimeters) – 5 × (age in years) + 5

Females: RMR = 10 x (wt in kg) + 6.25 × (ht in cm) − 5 × (age in years) − 161

To determine body weight in kg from pounds, simply divide weight in pounds by 2.205. For instance, a 140-pound woman would calculate body weight in kg as follows: 140 pounds/2.205 = 63.5 kg. Height in cm is easily determined by multiplying a person's height in inches by 2.54. So, for a female who is 5 feet 6 inches (or 66 inches), height in cm would be 66 inches × 2.54 = 167.64 cm. Continuing with this RMR estimation, if a female client weighs 140 pounds, is 5 feet 6 inches tall and is 30 years old, the estimate for her RMR would be calculated as follows:

RMR = 10(63.5) + 6.25(167.64) − 5(30) – 161

= 635 + 1,048 − 150 − 161

= 1,372 calories per day

Now it's your turn: Calculate your estimated RMR!

5. How much does RMR vary person to person?

Lazzer and colleagues (2010) studied the relationship among BMR, gender, age and body composition in 8,780 obese subjects aged 7–74. The data show quite a bit of variability across subjects, which the authors note can be explained by genetics, physical activity, organ mass and hormonal factors. In fact, because of this variability the Mifflin-St. Jeor RMR equation highlighted above has a ±10% margin of error in predicting RMR. In addition, some people have what Rosenbaum and Leibel (2010) refer to as an increased "genetic risk" toward obesity. These people have metabolisms that are appreciably more depressed by "thrifty genes" that strive hard to maintain body fat levels.

6. Does eating more frequently during the day elevate RMR?

As noted above, the thermic effect of food accounts for up to 10% of TEE. Eating more frequently during the day may actually help to maintain this effect (Rosenbaum & Leibel 2010). Of concern to the exercise professional is the tendency of some clients to skip meals. This unwise strategy not only has the potential to lead to inadequate nutrient intake and low blood glucose; it may also be interpreted as a "threat" by the mind, resulting in a series of physiological reactions designed to conserve fat reserves on the body.

7. Are any of the proposed "thermogenic ingredients"--such as teas (green, white and oolong, although green tea has been the primary tea studied), caffeine and capsaicins (the major component in red hot peppers and some spices)--successful in elevating RMR?

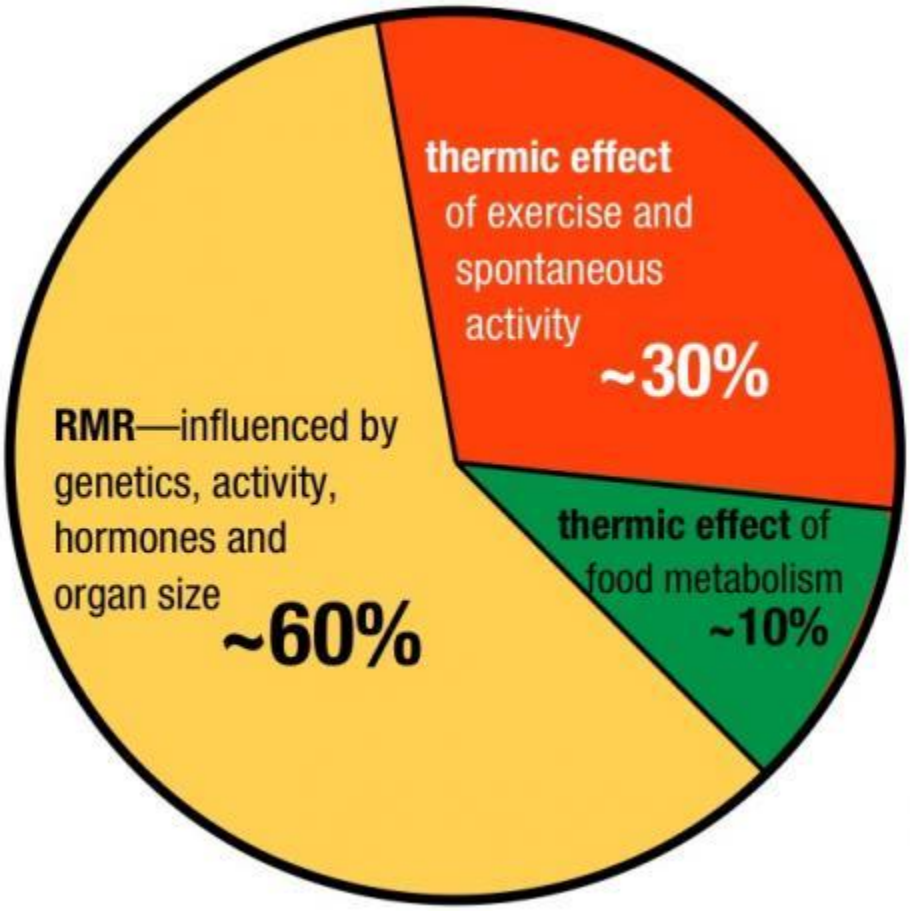
Hursel and Westerterp-Plantenga (2010) conducted an extensive scientific review to determine whether these ingredients could be linked to an increase in thermogenesis (calorie burning via heat production in the body). From this review, the authors concluded that these ingredients might briefly increase RMR (4%–5%) and mildly improve fat oxidation (i.e., fat burning). The investigators explain that, through different physiological pathways, these thermogenic ingredients slightly elevate the sympathetic nervous system, which is very involved in the regulation of RMR.

They suggest that more research is needed to determine what doses and combinations of these bioactive ingredients are optimal for increasing RMR. As an important caution to exercise professionals, the authors state that in some people green tea and caffeine may cause increases in systolic and diastolic blood pressure levels (up to 6 millimeters of mercury) and/or other side effects, including heart palpitations, anxiety, headache, restlessness and dizziness. However, for most individuals the research indicates very little health risk from teas and caffeine (and none from capsaicins).

Metabolism Make-Over Conclusion

Well-controlled, long-term studies show that both aerobic exercise and weight lifting independently increase RMR, thus contributing to the desired energy balance goals of weight management programs. In addition, optimal doses and combinations of some thermogenic agents (teas, caffeine and capsaicins) that mildly elevate RMR are on the horizon. These, too, may ultimately complement a client's serious weight loss efforts.

SIDEBAR: Figure 1. Components of Total 24-Hour Daily Energy Expenditure (TEE)


thermic effect
of exercise and
spontaneous
activity
~30%
RMR—influenced by
genetics, activity,
hormones and
organ size
~60%
thermic effect of
food metabolism
~10%