BTN academy

ENERGY BALANCE & AVAILABILITY

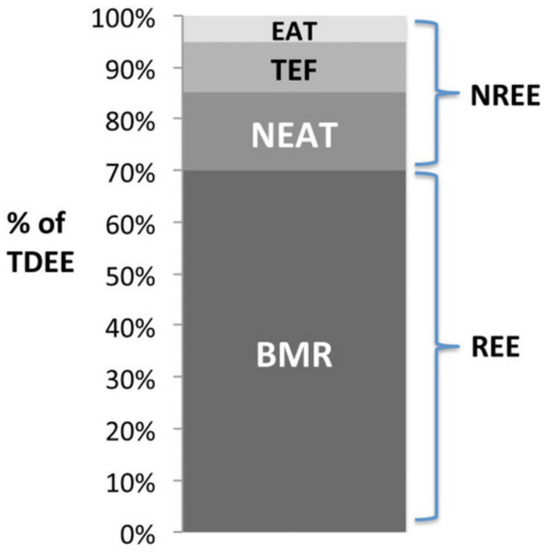
learn nutrition, change lives

Energy balance 101

Probably the most basic function of nutrition is to provide energy to the body. This energy, typically measured in kilocalories (Kcal), enables every metabolic function from extracting more energy from glucose to maintaining proper neuronal function. Energy allows for everything, and so it stands to reason that those looking to maximise athletic performance need to be aware of how much they need.

Energy balance 102

The easiest way to conceptualise what our body uses energy for is exemplified in the image to the right, taken from “Metabolic adaptation to weight loss: Implications for the athlete” by Trexler et al, 2014. The image represents the energy expenditure of a typical person.



As you can see, your total daily energy expenditure (TDEE) can be broken into four components:

- REE or resting energy expenditure, or BMR or basal metabolic rate. This is the energy that your body uses at rest to turn over cell components that need to be replaced, to beat your heart, to breathe, to regulate your temperature, and everything else you might do while spending all day in bed doing nothing. Importantly this includes things like sex hormone production, maintaining your immune system, and other key parts of life. Keep this in mind:
- NEAT or Non-Exercise Activity Thermogenesis; calories burned for instance fidgeting, or standing to cook a meal
- TEF or the thermic effect of food; the energy needed to extract and use the energy within your food
- EAT or exercise activity thermogenesis, the energy you use when exercising

Energy balance, the equations

To estimate your needs, you can utilise a calculation like the one listed below:

Men: (10 × weight in kg) + (6.25 × height in cm) - (5 × age in years) + 5.
Women: (10 × weight in kg) + (6.25 × height in cm) - (5 × age in years) - 161.

This gives you your BMR, which you can then multiply by an activity factor as per the below to estimate your TDEE:

- Little to no activity = BMR x 1.2
- Light exercise (1–3 days per week), or a moderately active job i.e. hairdresser and no exercise = BMR x 1.375
- Moderate exercise (3–5 days per week), or light exercise and a moderately active job, or heavy exercise and an inactive job = BMR x 1.55
- Heavy exercise (5 days per week hard training), or moderately active job i.e. postman and moderate exercise = BMR x 1.725
- Very heavy exercise (twice per day, extra heavy workouts), or someone with a very active job i.e. a factory worker who exercises a lot = BMR x 1.9

This would then be rounded to the nearest 50kcal with a range of 100kcal or so either side, so a calculated 3127kcal maintenance could be rounded to 3150, and the individual would be recommended to consume 3050-3250kcal.

The Limitations of Energy Balance

This is a great starting point but for athletes we can do more. Looking closely at the image again, you can see that the different components represent larger or lesser proportions of the average person's TDEE with REE making up an average of 70% and EAT making up an average of 5. To place that within context, consider that the average man requires 2500kcal according to nutritional guidelines, meaning that they burn around 17500kcal per week.

5% of this would be 875kcal, representing three 300kcal sessions per week. About right for the average person! If you exercise more, however, then your EAT could feasibly take up far more of your energy expenditure. This has important ramifications for how you manage your nutrition for a very simple reason:

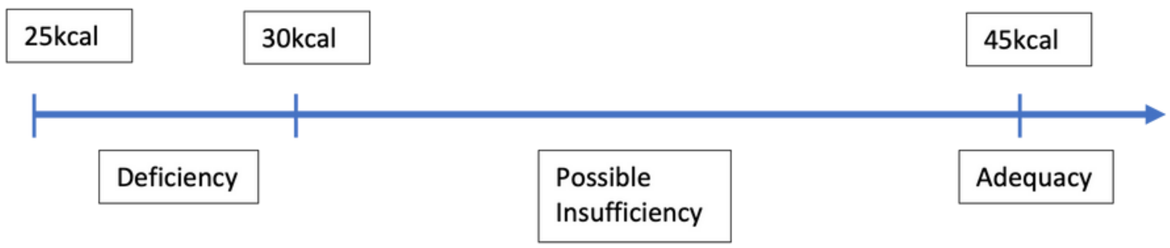
According to the law of energy conservation, energy can't be created or destroyed. That means that in order for energy to be used, it needs to come from somewhere and if you're expending more energy during exercise, that leaves less energy for everything else. In people who carry additional bodyweight this deficit can be made up here by breaking down stored bodyfat assuming the difference between in and out is not too drastic, but in relatively lean people or those who exercise **a lot?**

Energy Availability

When discussing athletic performance and the avoidance of energy deficiency (referred to as RED-S or Relative Energy Deficiency in Sport), energy availability is a better indicator. Energy availability can be thought of as the energy available to your bodily functions after you have exercised-away some of the food you've eaten, and as you can probably surmise, if your energy availability falls below what your body needs to perform its daily functions, then those functions can't happen. So how do we define this?

The Energy Availability Spectrum

Energy Availability is best thought of as a spectrum.



Most of the research done in this area has been done in female athletes, and indeed the spectrum above is based on these data. According to the International Olympic Committee, 45kcal/kg per day is considered an adequate intake for female athletes, avoiding all issues associated with RED-S and so representing proper fuelling. When it comes to male athletes, however, this figure is harder to pin down and arguably male athletes can get by on a lower figure without succumbing to the same issues (given that amenorrhoea is not an issue here).

In both sexes, 30kcal/kg is considered the cut-off point after which clinical issues present, though again the data supporting this hard cut off point for male athletes are less robust. Even with this caveat kept in mind this is a good workable figure and so going below this is generally to be avoided outside of extreme exceptions, for instance the latter stages of physique contest preparation when health is often cast aside in order to achieve the necessary low bodyfat levels.

Where Should We Aim?

It's typically advisable to ensure that both your daily and weekly EA are at or above 45kcal/kg if performance is your goal. This is usually best achieved by looking principally at weekly EA, and then potentially increasing intake a little on days involving particularly long bouts of exercise. For instance, for a person with a weekly EA of 46kcal/kg but one day at 36 thanks to a very long run, additional fuel on the exceptional day is warranted to bring the daily total up to speed.

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Calculating EA – Step 1

Take your bodyweight in kilograms and subtract your bodyfat percentage to get your lean body mass. To estimate bodyfat percentage in a way that is ‘good enough’ for the purpose here, use The Navy Body Fat Calculator.

For example, if you were 85kg and 20% bodyfat, you would find 20% of 85 which is 17, and subtract this from 85 to give 68kg of lean body mass. Write down your figure and start a new set of calculations.

Now you need to work out your energy intake. You can estimate this by tracking your food intake using an app like MyFitnessPal.

And then work out your energy expenditure during exercise. You can use a sports watch for this, or you can get an estimate using this calculator.

There are now two different figures that are worth calculating – a weekly and a daily EA.

Calculating weekly EA

To calculate weekly EA – take an average of 7 days of eating (add 7 days of calorie tracking together and divide by 7) and an average of 7 days of exercise (add all exercise calories together then divide by 7, even if you only trained 4 times this week). Subtract the exercise calories from your intake and then divide this by your lean body mass.

For example, if I eat 3000kcal on average and burn 700kcal 4 times per week, it would give me:

700x4 = 2800
2800/7 = 400kcal
3000kcal–400kcal = 2600kcal

We could then divide this by the 68kg we calculated earlier to give a **weekly EA of 38kcal/kg** rounded to the nearest kcal.

Calculating weekly EA

It would then be beneficial to work out a daily EA because of course your EA will be lower on training days than non-training days. This doesn't matter so much in this case, as you will soon see, but it matters a lot in some instances because it's possible for weekly EA to be adequate but daily EA to not be, which can cause issues especially in female athletes as we will soon see.

To calculate daily EA, do the same but for each training and non-training day, of course comparing daily intake to each day's exercise kcal. For one of the training days above, therefore, EA would be:

(3000-700) / 68 = **34kcal/kg** when rounded to the nearest kcal

Consequences of Low EA

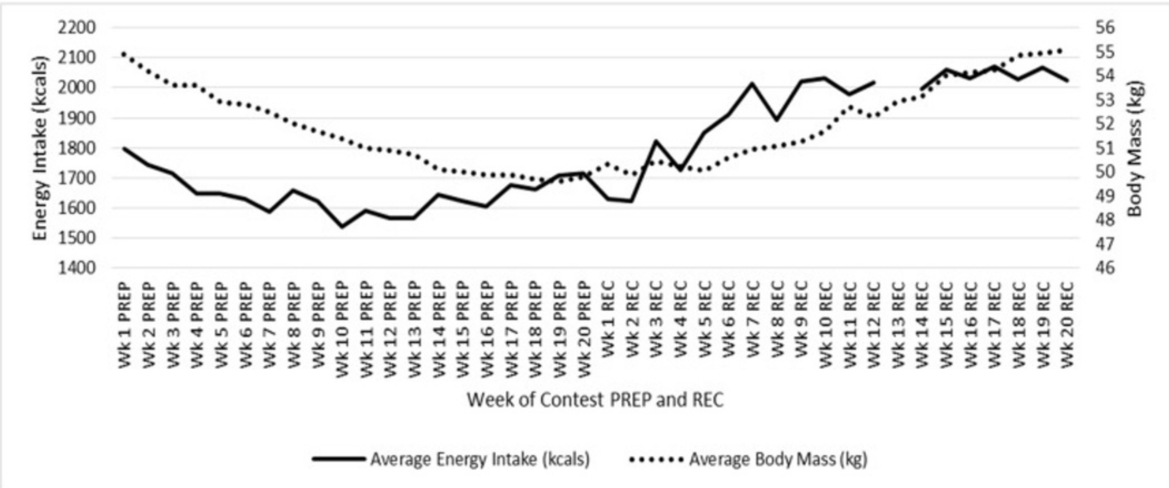
To bring this into clear focus, here are two examples of what can happen when EA is insufficient.

The first is a case study looking at a 20 year old collegiate competitive swimmer, entitled Extremely low testosterone due to relative energy deficiency in sport: a case report. He sought medical help after noticing his weight, bodyfat level, and performance all dropping throughout a training year and was found to have 'profoundly' low total and free testosterone, with total testosterone at 30ng/dl compared to the normal range of 348-1197.

After examination, he was found to be eating around 2000 kcal per day and expending around 4000kcal per day, in part intentionally so as to reduce bodyfat levels. Upon reducing training demand and increasing food intake, his testosterone levels increased within two weeks and eventually normalised. This example is interesting because RED-S is typically thought of as being a major risk for weight class and physique based sports, but this provides a clear example of the more wide-reaching risks for athletes in general. It's also notable that at the lowest point his bodyfat level was a lean but far from shredded 15%, reminding us that this isn't merely an issue of being too lean, but training too much and undereating independent of physique changes.

Consequences, continued

As a second case study in a natural bikini competitor, *Dietary Intake, Body Composition, and Menstrual Cycle Changes during Competition Preparation and Recovery in a Drug-Free Figure Competitor: A Case Study* published by Halliday and colleagues in 2016. The figure below illustrates the primary point that needs to be made here, with PREP being the preparatory period and REC being the recovery period post competition.



What you can see is that at week 1 of prep she was eating 2100kcal, this dropped to 1700 ahead of the competition, and then was crept back up to 2100kcal over the following weeks. This doesn't seem too striking until you learn that her last menstrual cycle happened at week 11 of PREP, and her menstrual cycle did not return until 71 weeks post competition. This is most likely because prior to PREP her EA was a little over 32, and at the end of the study period highlighted in the image above it was a little over 35. To clarify, this means that she lost her menstrual cycle when her bodyweight hit 51kg at week 11 and despite returning to 55kg, it didn't come back. Energy availability, rather than changes in body composition per se, is a primary factor in the wellbeing of athletes, and so we must always keep it at the forefront of our minds.

Summary

To summarise, most active people, even recreational exercisers, can benefit from simply ensuring they estimate their TDEE and avoid going below this for prolonged periods outside of times when deliberate weight loss is the goal. For this you would simply use the formulae and activity multipliers above. Athletes, however, would be better off ensuring they're maintaining their energy availability at or above 45kcal/kg lean body mass and so you could either start here, or could calculate TDEE via typical methods and then cross reference with EA calculations to ensure the athlete gets all they need.

References

Dave, S.C. and Fisher, M. (2022) Relative energy deficiency in sport (red – S), *Current Problems in Pediatric and Adolescent Health Care.*

Halliday TM, Loenneke JP, Davy BM. (2016). Dietary Intake, Body Composition, and Menstrual Cycle Changes during Competition Preparation and Recovery in a Drug-Free Figure Competitor: A Case Study. *Nutrients.*

Narla A, Kaiser K, Tannock LR/ (2018). Extremely low testosterone due to relative energy deficiency in sport: a case report. *AACE Clin Case Rep.*

Trexler, Eric & Smith-Ryan, Abbie & Norton, Layne. (2014). Metabolic adaptation to weight loss: Implications for the athlete. *Journal of the International Society of Sports Nutrition.*

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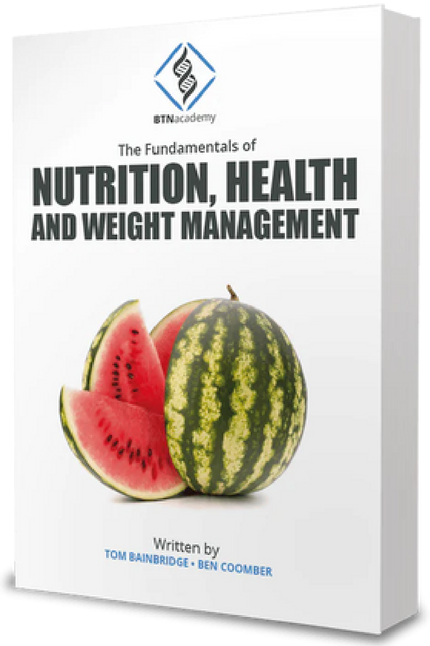

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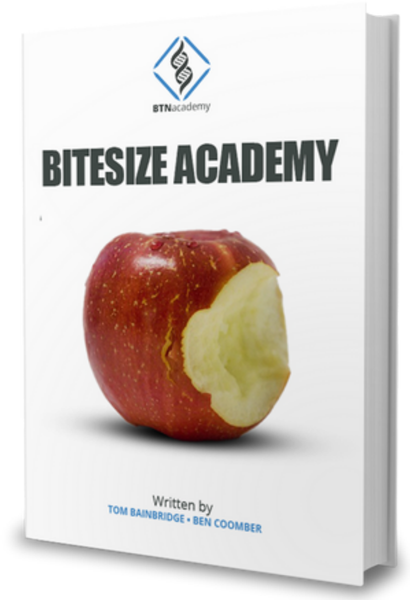

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