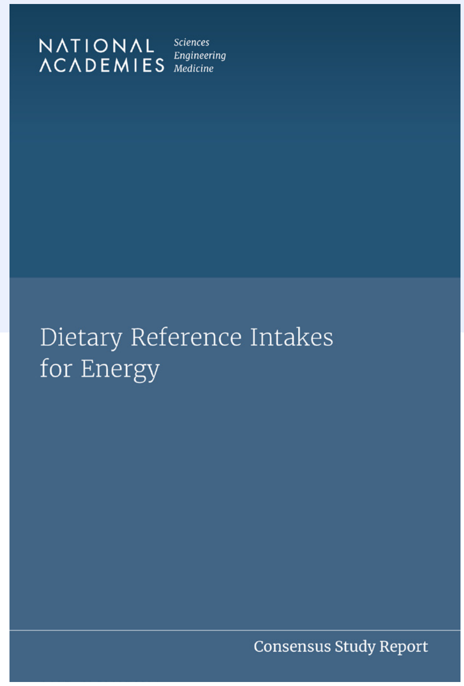
NATIONAL ACADEMIES *Sciences Engineering Medicine*

Consensus Study Report
Highlights

Dietary Reference Intakes for Energy



The Dietary Reference Intakes (DRIs) are a set of reference values that encompass a safe range of intake and provide recommended nutrient intakes for the United States and Canada. The DRIs for energy are used widely to provide guidance for maintaining energy balance on both an individual and group level. The U.S. and Canadian governments asked the National Academies of Sciences, Engineering, and Medicine to convene an expert committee to examine the evidence and recommend updated Estimated Energy Requirements (EERs) for their populations.

The need to re-examine DRIs for energy, last updated in 2005, stemmed from two key factors. First, both U.S. and Canadian populations have experienced an imbalance in energy intake and expenditure during the past several decades, such that weight status has trended toward overweight and obesity across all demographics. Second, new scientific evidence has advanced knowledge about energy intake and expenditure through the use of doubly labeled water (DLW) analysis.

2023 UPDATES TO DRIS FOR ENERGY

EER equations represent the committee’s estimates of energy requirements by age/sex, physical activity, and life-stage group.

- The DRI population was considered relative to the current health status of general U.S. and Canadian populations. To be more inclusive, individuals who are overweight, obese, or have chronic diseases are now included in the DRI population.
- The data source for DLW was expanded to include databases that represent more diverse population groups.

- An approach was developed to incorporate the physical activity level (PAL) into age/sex categories. The committee used multiple methods to determine a PAL category. These methods provide a more thorough approach to capture the correct category.

HOW ENERGY DIFFERS FROM OTHER NUTRIENTS

For all nutrients except energy, the adequacy of a group's intake for a given nutrient can be evaluated by comparing the usual mean intake of that group to the mean requirement for that group (i.e., the estimated average requirement [EAR], or average intake requirement that meets the requirements of 50 percent of individuals in an age/sex group). The prevalence of nutrient inadequacy is estimated as the proportion of the age/sex group with usual intakes below the EAR (IOM, 2000). For individuals, usual intake above the EAR is assumed to be adequate. These quantitative relationships are not directly applicable to energy. While the EAR is the midpoint of the distribution of requirements of a broad age/sex group, the EER is an estimate of the midpoint of a range of requirements that applies to individuals of the same sex, age, height, weight, and PAL category. Furthermore, because energy requirements and intakes are correlated, the prevalence of inadequacy cannot be estimated by determining the proportion with self-reported intakes below the EER. Unlike other nutrients, the energy requirement distribution does not relate to a DRI value, such as the Recommended Dietary Allowance (RDA) or the Tolerable Upper Intake Level (UL).

For most nutrients, intake-response assessments are used to identify the EAR for a DRI age/sex group, and data on variability are considered to establish the RDA at an intake level that meets or exceeds the needs of almost all individuals in that group. Although consuming an intake level at or above the RDA exceeds the requirements of almost everyone, no risk occurs unless the intake level exceeds the UL. However, this approach is not appropriate for energy, as there are adverse consequences (i.e., weight gain) for individuals whose energy intake exceeds their energy expenditure.

It is also not useful to compare an individual's self-reported energy intake with a calculated expenditure due to bias that occurs in self-reported intake data and an inherent variability in energy expenditure among individuals with similar characteristics. Rather, weight is frequently used as an indicator of the relationship between energy intake and energy expenditure. Body mass index (BMI) is most often calculated to screen and categorize individuals and groups. BMI values outside of a defined normal range serve as an indicator of over- or underconsumption of energy and can be used in calculating the EER for various age/sex groups. An additional complication is that energy balance may be moderated by diet-related components other than carbohydrate, protein, fat, and alcohol, namely the microbiome and dietary fiber.

DERIVATION OF THE EER EQUATIONS

The EER is used to predict an appropriate energy intake to plan and assess diets for individuals and groups. The EER equations represent the committee's estimates of energy requirements by age/sex, physical activity, and life-stage group. The committee used the total energy expenditure (TEE) equations to develop EER equations by age/sex and life-stage groups for the United States and Canada.

For simplicity, the TEE prediction equation is presented with slopes for height and weight separately for each PAL category in the following format:

$$\text{TEE} = \text{Intercept} + A \times \text{Age (years)} + B \times \text{Height (cm)} + C \times \text{Weight (kg)}$$

In a weight-stable person, the TEE is the most accurate measure of a person's EER. For a growing individual, such as an infant or a child, the EER is the sum of the TEE and the energy cost of growth. For a pregnant woman, particularly during the second and third trimesters, the EER is the sum of the TEE and the energy cost of tissue accretion during pregnancy in both the fetal and maternal tissues. For a lactating woman, the EER is the sum of the TEE and the energy cost of milk production. Therefore, the TEE prediction equation forms the basis for the EER equations with further adaptations, for these specified age/sex and life-stage groups.

APPLICATIONS OF THE DRIs FOR ENERGY: PLANNING ENERGY INTAKES

Selecting the Appropriate PAL Category

A challenging aspect of using the EER equations is selecting the appropriate PAL category, which must be done for individuals aged 3 years and older. The PAL represents the ratio of the TEE (as determined in DLW studies) to measured or calculated basal energy expenditure or resting energy expenditure. The committee identified four PAL categories (inactive, low active, active, and very active) based on approximate quartiles of the PAL distributions among age groups of participants in DLW studies.

A descriptive analysis of daily activity patterns (see Table 7-1) can provide guidance for classifying an individual's PAL category. Of note is that individuals in the "inactive" PAL category are not completely sedentary but are minimally active beyond what is involved in daily living and do little or no occupational physical activity.

Examples of How to Use the EER Equations for Planning Energy Intakes of Individuals

Step 1. Select the EER equation and calculate the EER.

For example, the EER for a 22-year-old nonpregnant/nonlactating woman who is 165 cm in height, weighs 63 kg, and is determined to have a low active PAL based on the guidance provided above is calculated as follows:

EER = 575.77 − (7.01 × age in years) + (6.60 × height in cm) + (12.14 × weight in kg)
= 575.77 − (7.01 × 22) + (6.60 × 165) + (12.14 × 63)
= 575.77 − 154.22 + 1,089.0 + 764.82
= 2,275 kcal/day

Another example is for a young child for whom PAL is not included in the equation. The EER for a 2-year-old boy who is 98 cm in height and weighs 15.5 kg, is calculated as follows:

EER = −716.45 − (1.00 × age in years) + (17.82 × height in cm) + (15.06 × weight in kg) + 20 [energy cost of growth]
= −716.45 − (1.00 × 2) + (17.82 × 98) + (15.06 × 15.5) + 20
= −716.45 − 2 + 1746.4 + 233.4 + 20
= 1,281 kcal/day

Step 2. Monitor body weight over time and adjust intake as required.

Because an individual's actual energy requirement may vary considerably from the EER, it is important to monitor body weight over time.

CONCLUDING REMARKS

These EER equations provide a baseline that allows dietary planners and assessors to estimate energy needs and monitor energy balance to enhance the general health of individuals and populations in the United States and Canada.

TABLE 7-1

Example of Daily Activities Associated with Physical Activity Level (PAL) Categories in Adults

ACTIVITIES OF DAILY LIVING (ADLS) FOR ALL ACTIVITY LEVELS	INACTIVE PAL (PAL ~1.4)	LOW ACTIVE PAL (PAL ~1.6)	ACTIVE PAL (PAL ~1.75)	VERY ACTIVE PAL (PAL ~2.05)
30 minutes walking; plus ~90 minutes light to moderate activity (household tasks, vacuuming, raking the lawn, etc.)	ADL only	ADL + 60–80 minutes walking (3–4 mph)	ADL + 30–50 minutes walking (3–4 mph) + 45 minutes moderate cycling + 40 minutes doubles tennis	ADL + 45 minutes moderate cycling + ~25 minutes jogging (10 min/mile) + 60 minutes doubles tennis

NOTE: ADL = activities of daily living; mph = miles per hour; PAL = physical activity level. Ranges for PAL categories: inactive: 1.0 ≤ PAL < 1.53; low active: 1.53 ≤ PAL < 1.68; active: 1.68 ≤ PAL < 1.85; very active: 1.85 ≤ PAL < 2.50.

SOURCE: Modified from Table 12.2, IOM, 2002/2005.

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COMMITTEE ON DIETARY REFERENCE INTAKES FOR ENERGY **Anna Maria Siega-Riz** (*Chair*), University of Massachusetts Amherst; **Regan L. Bailey,** Texas A&M University; **Ethan M. Balk;** Brown University School of Public Health; **Susan I. Barr,** University of British Columbia; **Loneke T. Blackman Carr,** University of Connecticut, Storrs (*until May 9, 2022*); **Nancy F. Butte,** Baylor College of Medicine; **Scott E. Crouter,** The University of Tennessee Knoxville; **Amy H. Luke,** Loyola University Chicago; **Susan B. Roberts,** Tufts University (*until June 16, 2022*); **Heidi J. Silver,** Vanderbilt University Medical Center; **Janet A. Tooze,** Wake Forest School of Medicine; **William W. Wong,** Baylor College of Medicine; **Elizabeth A. Yetley,** National Institutes of Health (*Retired*)

STAFF **Ann L. Yaktine,** Director, Food and Nutrition Board; **Alice Vorosmarti,** Associate Program Officer; **Melanie Arthur,** Senior Program Assistant

CONSULTANTS **Richard Troiano,** National Institutes of Health (Retired); **David Allison,** Indiana University School of Public Health Bloomington; **Carmen Tekwe,** Indiana University School of Public Health Bloomington; **Roger Zoh,** Indiana University School of Public Health Bloomington; **Stephanie Dickinson,** Indiana University School of Public Health Bloomington; **Lilian Golzarri Arroyo,** Indiana University School of Public Health Bloomington; **Aaron Cohen,** Indiana University School of Public Health Bloomington; **Jocelyn Mineo,** Indiana University School of Public Health Bloomington

FOR MORE INFORMATION

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