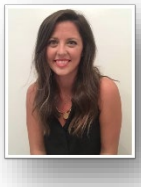
Differentiate between the differences in methodologies used to develop previous and current DRIs for energy

Presenter: Jessica M Lowe, DCN, MPH, RDN – Medical Science Liaison

Live event date: September 20th, 2023 - *Recording on NutriciaLearningCenter.com*



Learning Objectives:

Review the recently released energy guidelines for infants and children

Differentiate between the differences in methodologies used to develop previous and current DRIs for energy

Notes:

Nutricia North America supports the use of breast milk wherever possible.

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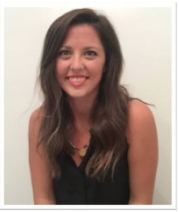
Thank you for joining!
We'll begin shortly



What's New With the DRIs for Energy for Infants and Children?

Jessica M Lowe, DCN, MPH, RDN
Medical Science Liaison
September 20, 2023

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What's new with the DRIs for energy for infants and children?

Jessica M Lowe, DCN, MPH, RDN | Medical Science Liaison

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Disclosures

Jessica Lowe, DCN, MPH, RDN is employed by Nutricia North America as a medical science liaison.

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Objectives

1. Review the recently released energy guidelines for infants and children
2. Differentiate between the differences in methodologies used to develop previous and current DRIs for energy

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Dietary Reference Intakes (DRIs)

Definition	Reference values to guide the planning and assessing of nutrient intakes in the United States and Canada
Inclusion	One or more DRI values are available for 51 nutrients including vitamins, minerals, macronutrients and energy
Intention	Reduce the risk of both nutrient inadequacy and excessive nutrient intake
Utilization	Provide the scientific basis for nutrient professionals, governments, and non-governmental organizations to carry out activities

(1) Dietary Reference Intakes. Health.gov. Updated January 18, 2023. Retrieved August 16, 2023 from https://health.gov/our-work/nutrition-physical-activity/dietary-guidelines/dietary-reference-intakes (2) Murphy SP, et al. History of nutrition: the long road leading to the Dietary Reference Intakes for the United States and Canada. Adv Nutr. 2015;7(1):157-168.

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History of DRIs

1941

The first RDAs for protein, energy and 8 vitamins and minerals were established by the US National Research Council at the request of the National Defense Advisory Commission.

Number of nutrients in the DRIs increased from 8 to 25

1989

The Food and Nutrition Board (FNB) released a Diet and Health Report which revied the role of specific nutrients and food components in the risk of noncommunicable diseases.

RDA: Recommended daily allowance; FNB: Food and Nutrition Board
Murphy SP, et al. History of nutrition: the long road leading to the Dietary Reference Intakes for the United States and Canada. Adv Nutr. 2015;7(1):157-168.

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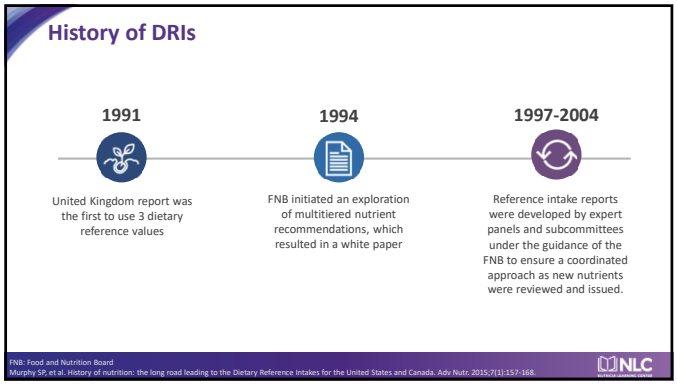
History of DRIs
1991
United Kingdom report was the first to use 3 dietary reference values
1994
FNB initiated an exploration of multitiered nutrient recommendations, which resulted in a white paper
1997-2004
Reference intake reports were developed by expert panels and subcommittees under the guidance of the FNB to ensure a coordinated approach as new nutrients were reviewed and issued.
FNB: Food and Nutrition Board
Murphy SP, et al. History of nutrition: the long road leading to the Dietary Reference Intakes for the United States and Canada. Adv Nutr. 2015;7(1):157-168.
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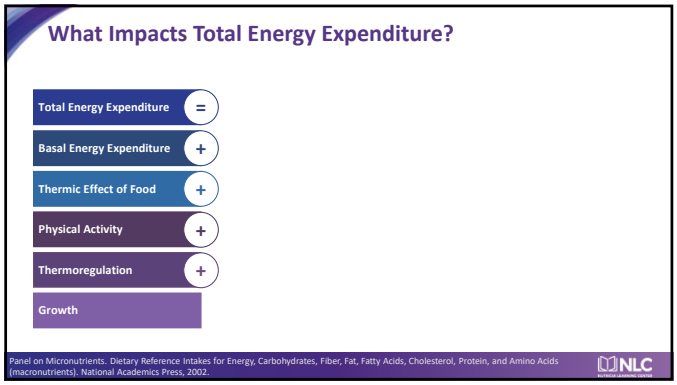
What Impacts Total Energy Expenditure?
Total Energy Expenditure =
Basal Energy Expenditure +
Thermic Effect of Food +
Physical Activity +
Thermoregulation +
Growth
Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.
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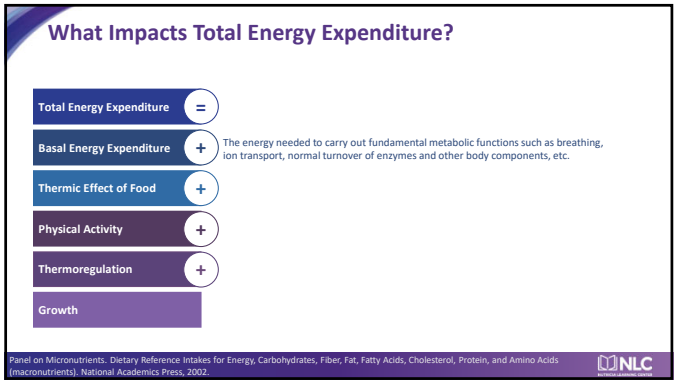
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Total Energy Expenditure =
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The energy needed to carry out fundamental metabolic functions such as breathing, ion transport, normal turnover of enzymes and other body components, etc.
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Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.
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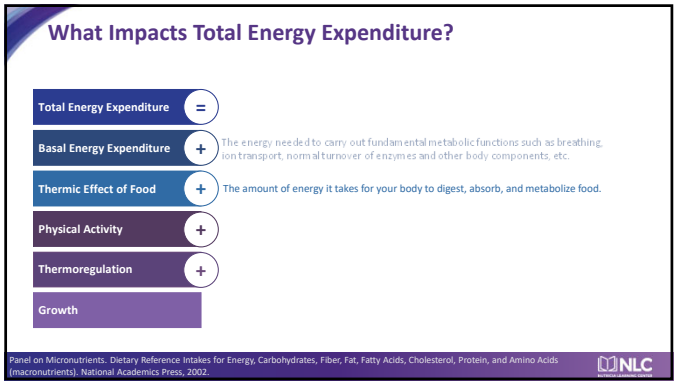
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The amount of energy it takes for your body to digest, absorb, and metabolize food.
Physical Activity
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Thermoregulation
+
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Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.
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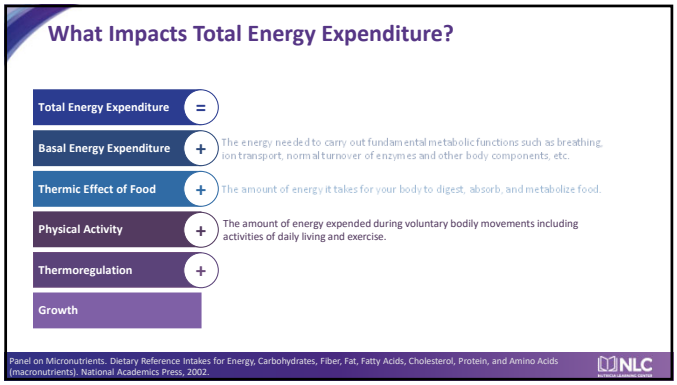
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Thermic Effect of Food
+
The amount of energy it takes for your body to digest, absorb, and metabolize food.
Physical Activity
+
The amount of energy expended during voluntary bodily movements including activities of daily living and exercise.
Thermoregulation
+
Growth
Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.
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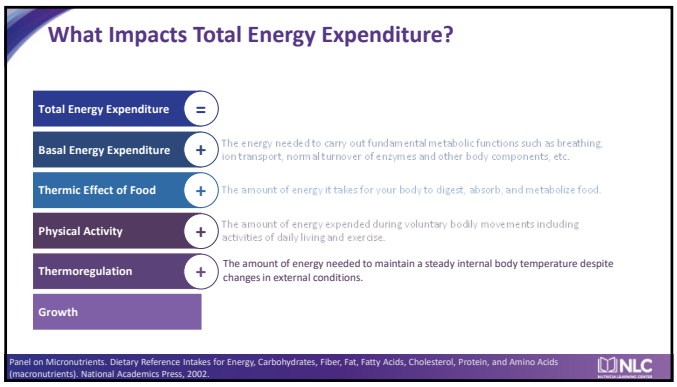
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Physical Activity
+
The amount of energy expended during voluntary bodily movements including activities of daily living and exercise.
Thermoregulation
+
The amount of energy needed to maintain a steady internal body temperature despite changes in external conditions.
Growth
Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.
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What Impacts Total Energy Expenditure?

Total Energy Expenditure	=	
Basal Energy Expenditure	+	The energy needed to carry out fundamental metabolic functions such as breathing, ion transport, normal turnover of enzymes and other body components, etc.
Thermic Effect of Food	+	The amount of energy it takes for your body to digest, absorb, and metabolize food.
Physical Activity	+	The amount of energy expended during voluntary bodily movements including activities of daily living and exercise.
Thermoregulation	+	The amount of energy needed to maintain a steady internal body temperature despite changes in external conditions.
Growth		The amount of energy required for tissues deposition in children and pregnant women.

Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.

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DRI for Energy: 2002-2005

Indicators for Estimating the Requirement for Energy

Reported Energy Intake

- In principle could be used for weight maintenance
- Literature documents underreporting food intake

Factorial Approach

EER = BMR x AF

- Limitation: only takes into account certain activities
- May underreport energy requirements

Doubly Labeled Water

$^2H_2{}^{18}O$

- Considered the most reliable measurement of energy expenditure

EER = estimated energy requirements; BMR = basal metabolic rate; AF = activity factor
Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.

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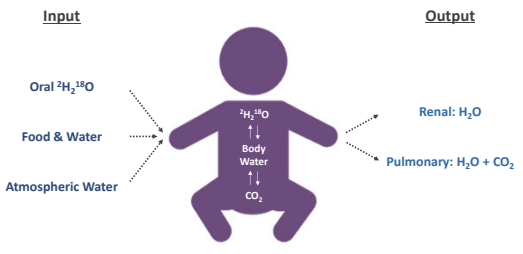
Doubly Labeled Water



$^2H_2{}^{18}O$ = doubly labeled water; H_2O = water; CO_2 = carbon dioxide
(1) Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002. (2) Delany JP. Chapter 12: Doubly labeled Water for Energy Expenditure. Emerging technologies for nutrition research: Potential for assessing military performance capability. Washington (DC):1997.

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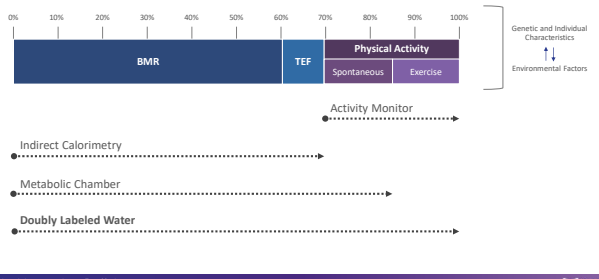
Most Reliable Measurement of Energy Expenditure



BMR = basal metabolic rate; TEF = thermic effect of food

(1) Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002. (2) DeLany JP. Measurement of energy expenditure. Pediatr Blood Cancer. 2012;58(1):129-136. (3) von Loeffelholz C, et al. Non-exercise activity thermogenesis in human energy homeostasis. Endotext. 2022.

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Number of Infants & Children Represented in DLW Studies

2002/2005 (n=487)	Life Stage
116	0-6 months
72	7-11 months
132	1-2 years
129	3-8 years
28	9-13 years
10	14-18 years

Interpolation with studies that reported food intake and used a factorial approach

(1) Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002. (2) National Academies of Sciences, Engineering, and Medicine. Dietary Reference Intakes for Energy. 2023.

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Number of Infants & Children Represented in DLW Studies

2002/2005 (n=487)	Life Stage	2023 (n=2433)
116	0-6 months	469
72	7-11 months	114
132	1-2 years	250
129	3-8 years	879
28	9-13 years	304
10	14-18 years	417

(1) Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002. (2) National Academies of Sciences, Engineering, and Medicine. Dietary Reference Intakes for Energy. 2023.

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Estimating Energy Requirements in Infants (0-36 months)

Estimated Energy Requirements =

Total Energy Expenditure + The energy expended throughout a 24-hour period: basal metabolic rate, thermic effect of food, and energy expended as a result of physical activity.

Energy Cost of Growth The energy contained in tissue deposited during growth phases, based on the proportion of protein and fat being deposited in the new tissue.

(1) Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002. (2) National Academies of Sciences, Engineering, and Medicine. Dietary Reference Intakes for Energy. 2023.

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2002-2005 DRI for Energy: 0-36 months

Estimated Energy Requirements	=	Total Energy Expenditure	+	Energy Cost of Growth
0-3 months	=	(89 x weight [kg] - 100)	+	175 kcal
4-6 months	=	(89 x weight [kg] - 100)	+	56 kcal
7-12 months	=	(89 x weight [kg] -100)	+	22 kcal
13-36 months	=	(89 x weight [kg] -100)	+	20 kcal

kg = kilograms; kcals = kilocalories
Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.

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2002-2005 DRI for Energy: 0-36 months

Age: 1 month
Weight: 4.4kg (-0.12)
Length: 55cm (0.14)
Wt/Lt: -0.38

Estimated Energy Requirements	=	Total Energy Expenditure	+	Energy Cost of Growth
0-3 months	=	(89 x weight [kg] - 100)	+	175 kcal

kg = kilogram; cm = centimeter; wt = weight; lt = length; kcal = kilocalories
Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.

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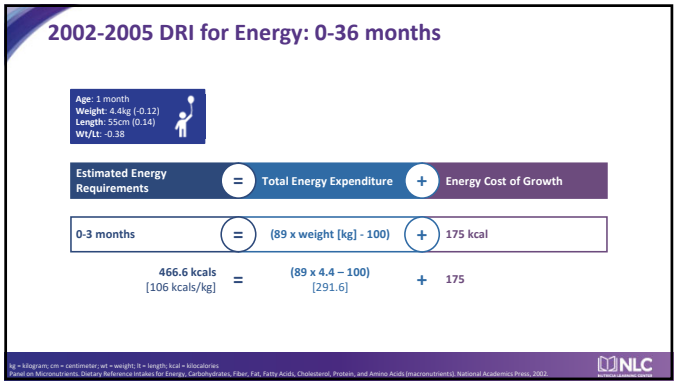
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Weight: 4.4kg (-0.12)
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Estimated Energy Requirements
=
Total Energy Expenditure
+
Energy Cost of Growth
0-3 months
=
(89 x weight [kg] - 100)
+
175 kcal
466.6 kcals
[106 kcals/kg]
=
(89 x 4.4 – 100)
[291.6]
+
175
kg = kilogram; cm = centimeter; wt = weight; lt = length; kcal = kilocalories
Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academies Press, 2002.
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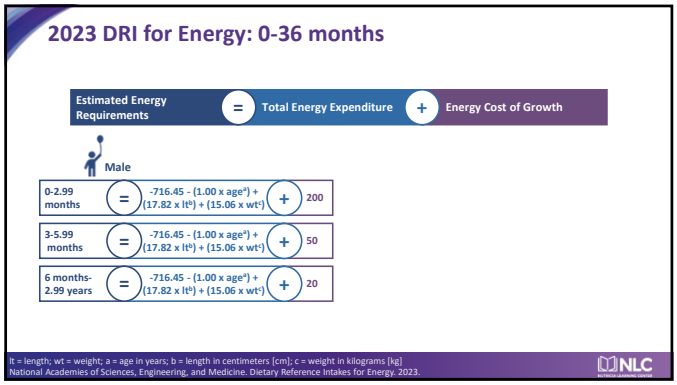
2023 DRI for Energy: 0-36 months
Estimated Energy Requirements
=
Total Energy Expenditure
+
Energy Cost of Growth
Male
0-2.99 months
=
-716.45 - (1.00 x age[a]) + (17.82 x lt[b]) + (15.06 x wt[c])
+
200
3-5.99 months
=
-716.45 - (1.00 x age[a]) + (17.82 x lt[b]) + (15.06 x wt[c])
+
50
6 months-2.99 years
=
-716.45 - (1.00 x age[a]) + (17.82 x lt[b]) + (15.06 x wt[c])
+
20
lt = length; wt = weight; a = age in years; b = length in centimeters [cm]; c = weight in kilograms [kg]
National Academies of Sciences, Engineering, and Medicine. Dietary Reference Intakes for Energy. 2023.
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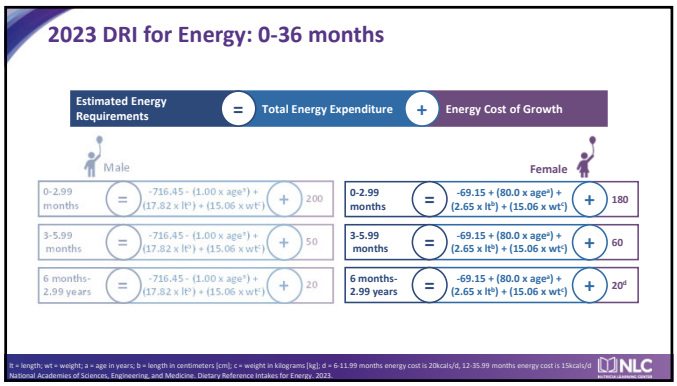
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+
50
6 months-2.99 years
=
-716.45 - (1.00 x age[a]) + (17.82 x lt[b]) + (15.06 x wt[c])
+
20
Female
0-2.99 months
=
-69.15 + (80.0 x age[a]) + (2.65 x lt[b]) + (15.06 x wt[c])
+
180
3-5.99 months
=
-69.15 + (80.0 x age[a]) + (2.65 x lt[b]) + (15.06 x wt[c])
+
60
6 months-2.99 years
=
-69.15 + (80.0 x age[a]) + (2.65 x lt[b]) + (15.06 x wt[c])
+
20[d]
lt = length; wt = weight; a = age in years; b = length in centimeters [cm]; c = weight in kilograms [kg]; d = 6-11.99 months energy cost is 20kcals/d, 12-35.99 months energy cost is 15kcals/d
National Academies of Sciences, Engineering, and Medicine. Dietary Reference Intakes for Energy. 2023.
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2023 DRI for Energy: 0-36 months

Age: 1 month
Weight: 4.4kg (-0.12)
Length: 55cm (0.14)
Wt/Lt: -0.38

Estimated Energy Requirements	=	Total Energy Expenditure	+	Energy Cost of Growth
0-3 months	=	-716.45 - (1.00 x age^a) + (17.82 x lt^b) + (15.06 x wt^c)	+	200 kcal

kg = kilograms; cm = centimeters; lt = length; wt = weight; kcal = kilocalories a = age in years; b = lt in cm; c = wt in kg
National Academies of Sciences, Engineering, and Medicine. Dietary Reference Intakes for Energy. 2023.

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2023 DRI for Energy: 0-36 months

Age: 1 month
Weight: 4.4kg (-0.12)
Length: 55cm (0.14)
Wt/Lt: -0.38

Estimated Energy Requirements	=	Total Energy Expenditure	+	Energy Cost of Growth
0-3 months	=	-716.45 - (1.00 x age^a) + (17.82 x lt^b) + (15.06 x wt^c)	+	200 kcal
529.8 kcals [120 kcals/kg]	=	-716.45 - (1.00 x 0.08) + (17.82 x 55) + (15.06 x 4.4)	+	200

kg = kilograms; cm = centimeters; lt = length; wt = weight; kcal = kilocalories a = age in years; b = lt in cm; c = wt in kg
National Academies of Sciences, Engineering, and Medicine. Dietary Reference Intakes for Energy. 2023.

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Estimating Energy Requirements in Children (3-18 years)

Estimated Energy Requirements	=	
Total Energy Expenditure	+	The energy expended throughout a 24-hour period: basal metabolic rate, thermic effect of food, and energy expended as a result of physical activity.
Energy Cost of Growth	+	The energy contained in tissue deposited during growth phases, based on the proportion of protein and fat being deposited in the new tissue.
Physical Activity Level		An index of physical activity, which is defined as the ratio of TEE:BEE, reflects differences in lifestyle, geographic habitat, and socioeconomics.

(1) Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002. (2) National Academies of Sciences, Engineering, and Medicine. Dietary Reference Intakes for Energy. 2023.

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2002/2005 DRI for Energy: 3-18 years - boys

Estimated Energy Requirements	=	Total Energy Expenditure (includes PA)	+	Energy Cost of Growth
3-8 years	=	88.5 - (61.9 x age[a]) + PA x (26.7 x wt[b] + 903 x ht[c])	+	20 kcal
9-18 years	=	88.5 - (61.9 x age[a]) + PA x (26.7 x wt[b] + 903 x ht[c])	+	25 kcal

PA Coefficient	
Sedentary	1.00
Low Active	1.13
Active	1.26
Very Active	1.42

PA = Physical Activity; wt = weight; ht = height; kcal = kilocalories; a = age in years; b = wt in kilograms [kg]; c = ht in centimeters [cm]
Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.

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2002/2005 DRI for Energy: 3-18 years - girls

Estimated Energy Requirements	=	Total Energy Expenditure (includes PA)	+	Energy Cost of Growth
3-8 years	=	135.3 - (30.8 x age[a]) + PA x (10 x wt[b] + 934 x ht[c])	+	20 kcal
9-18 years	=	135.3 - (30.8 x age[a]) + PA x (10 x wt[b] + 934 x ht[c])	+	25 kcal

PA Coefficient	
Sedentary	1.00
Low Active	1.16
Active	1.31
Very Active	1.56

PA = Physical Activity; wt = weight; ht = height; kcal = kilocalories; a = age in years; b = wt in kilograms [kg]; c = ht in centimeters [cm]
Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.

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2002/2005 DRI for Energy: reference weights (0-2 years)

Boys

Age (months)	Reference Wt (kg)	EER (kcal/d)	EER (kcal/kg/d)
1	4.4	472	107.2
2	5.3	567	107.0
3	6.0	572	95.3
4	6.7	548	81.8
5	7.3	596	81.6
6	7.9	645	81.6
7	8.4	668	79.5
8	8.9	710	79.8
9	9.3	746	80.2
10	9.7	793	81.8
11	10.0	817	81.7
12	10.3	844	81.9
15	11.1	908	81.8
18	11.7	961	82.1
21	12.2	1006	82.5
24	12.7	1050	85.0

Girls

Age (months)	Reference Wt (kg)	EER (kcal/d)	EER (kcal/kg/d)
1	4.2	438	104.3
2	4.9	500	102.0
3	5.5	521	94.7
4	6.1	508	83.3
5	6.7	553	82.5
6	7.2	593	82.9
7	7.7	608	79.0
8	8.1	643	79.4
9	8.5	678	79.8
10	8.9	717	80.6
11	9.2	742	80.7
12	9.5	768	80.8
15	10.3	837	81.3
18	11.0	899	81.7
21	11.6	952	82.1
24	12.1	997	82.4

Wt = weight; kg = kilograms; kcal = kilocalories; d = day
Panel on Micronutrients. Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (macronutrients). National Academics Press, 2002.

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2023 DRI for Energy: 3-18.99 years - boys

Estimated Energy Requirements	=	Total Energy Expenditure (includes PA)	+	Energy Cost of Growth
Inactive	=	$-447.51 + (3.68 \times age^a) + (13.01 \times ht^b) + (13.15 \times wt^c)$	+	3 years = 20 kcals 4-8 years = 15 kcals 9-13 years = 25 kcals 14-18 years = 20 kcals
Low Active	=	$19.12 + (3.68 \times age^a) + (8.62 \times ht^b) + (20.28 \times wt^c)$	+	3 years = 20 kcals 4-8 years = 15 kcals 9-13 years = 25 kcals 14-18 years = 20 kcals
Active	=	$-388.19 + (3.68 \times age^a) + (12.66 \times ht^b) + (20.46 \times wt^c)$	+	3 years = 20 kcals 4-8 years = 15 kcals 9-13 years = 25 kcals 14-18 years = 20 kcals
Very Active	=	$-671.75 - (3.68 \times age^a) + (15.38 \times ht^b) + (23.25 \times wt^c)$	+	3 years = 20 kcals 4-8 years = 15 kcals 9-13 years = 25 kcals 14-18 years = 20 kcals

PA = Physical Activity; ht = height; wt = weight; kcals = kilocalories; a = age in years; b = height in centimeters [cm]; c = weight in kilograms [kg]
National Academies of Sciences, Engineering, and Medicine. Dietary Reference Intakes for Energy. 2023.

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2023 DRI for Energy: 3-18.99 years - girls

Estimated Energy Requirements	=	Total Energy Expenditure (includes PA)	+	Energy Cost of Growth
Inactive	=	$55.59 - (22.25 \times age^a) + (8.43 \times ht^b) + (17.07 \times wt^c)$	+	3-8 years = 15 kcals 9-13 years = 30 kcals 14-18 years = 20 kcals
Low Active	=	$-297.54 - (22.25 \times age^a) + (12.77 \times ht^b) + (14.73 \times wt^c)$	+	3-8 years = 15 kcals 9-13 years = 30 kcals 14-18 years = 20 kcals
Active	=	$-189.55 - (22.25 \times age^a) + (11.74 \times ht^b) + (18.34 \times wt^c)$	+	3-8 years = 15 kcals 9-13 years = 30 kcals 14-18 years = 20 kcals
Very Active	=	$-709.59 - (22.25 \times age^a) + (18.22 \times ht^b) + (14.25 \times wt^c)$	+	3-8 years = 15 kcals 9-13 years = 30 kcals 14-18 years = 20 kcals

PA = Physical Activity; ht = height; wt = weight; kcals = kilocalories; a = age in years; b = height in centimeters [cm]; c = weight in kilograms [kg]
National Academies of Sciences, Engineering, and Medicine. Dietary Reference Intakes for Energy. 2023.

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The Main Differences

Sex specific equations	Age specific PA coefficients
Length incorporated into infant equations	Predictive equations are detailed and complex

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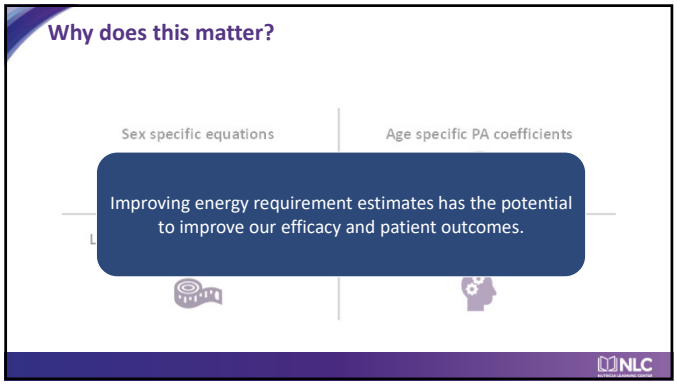
Why does this matter?
Sex specific equations
Age specific PA coefficients
Improving energy requirement estimates has the potential to improve our efficacy and patient outcomes.
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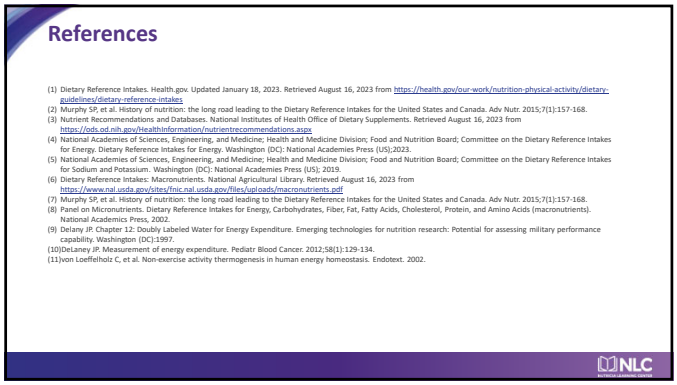
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