

## NEW REFERENCE VALUES FOR ENERGY INTAKE – SUPPLEMENTAL MATERIAL

**Table S1: Reference measurements of height and weight for infants, children, adolescents and adults in Germany**

Age	Height [cm]		Weight [kg]	
	m	f	m	f
<b>Infants<sup>a</sup></b>				
0 to under 4 months	58.4	57.1	5.6	5.1
4 to under 12 months	70.6	68.7	8.6	7.9
<b>Children and adolescents<sup>b</sup></b>				
1 to under 4 years	92.9	91.3	13.9	13.2
4 to under 7 years	114.5	114.3	20.2	20.1
7 to under 10 years	133.6	132.4	29.3	28.7
10 to under 13 years	149.4	151.0	41.0	42.1
13 to under 15 years	166.9	162.7	55.5	54.0
15 to under 19 years	178.2	165.5	69.2	59.5
<b>Adults<sup>c</sup></b>				
19 to under 25 years	179.4	165.8	70.8	60.5
25 to under 51 years	179.2	165.1	70.7	60.0
51 to under 65 years	176.7	162.6	68.7	58.2
65 years and older	174.2	161.1	66.8	57.1

<sup>a</sup> The reference measurements correspond to the 50<sup>th</sup> percentile of the WHO child growth standards [1] for 2 months and 8 months, respectively.

<sup>b</sup> The reference measurements each correspond to the 50<sup>th</sup> percentile of the anthropometrical measurements used in the German Health Interview and Examination Survey for Children and Adolescents in Germany (KiGGS; 2003–2006) [2]. In each case the values stated are for the mid-point of the respective age range, i.e. for 2.5 years, 5.5 years, 8.5 years, 11.5 years, 14.0 years and 17 years.

<sup>c</sup> The reference measurements for height correspond to the median of the height measurements from the German Health Interview and Examination Survey for Adults (DEGS1) [3]. Body weight was calculated using the height measurements based on an assumed BMI of 22 kg/m<sup>2</sup>. Following ages from DEGS1 are based on the specified age groups: for 19 to under 25 years - the age group of 18 to 29 years from DEGS1; for 25 to under 51 years - the age group 30 to 39 years from DEGS1; for 51 to under 65 years - the age group 50 to 59 years from DEGS1; for 65 years and older - the age group 60 to 69 years from DEGS1.

**Figure S1: Equation to calculate energy expenditure in infants according to [4]**

$$\text{Energy expenditure [kcal/day]} = 92.8 * \text{body weight [kg]} - 152$$

$$\text{[MJ/day]} = 0.388 * \text{body weight [kg]} - 0.635$$

**Table S2: Energy storage in developing tissue in infants [5, 6]**

Age [months]	0–3	3–6	6–9	9–12
<b>Boys</b>				
Stored protein [g/day] <sup>a</sup>	2.6	2.3	2.3	1.6
Stored fat [g/day] <sup>a</sup>	19.6	3.9	0.5	1.7
Body weight gain [g/day] <sup>a</sup>	32.7	17.7	11.8	9.1
Energy storage in developing tissue [kcal/g] <sup>b</sup>	6.0	2.8	1.5	2.7
Energy storage in developing tissue [kJ/g] <sup>b</sup>	25.1	11.6	6.2	11.4
<b>Girls</b>				
Stored protein [g/day] <sup>a</sup>	2.2	1.9	2.0	1.8
Stored fat [g/day] <sup>a</sup>	19.7	5.8	0.8	1.1
Body weight gain [g/day] <sup>a</sup>	31.1	17.3	10.6	8.7
Energy storage in developing tissue [kcal/g] <sup>b</sup>	6.3	3.7	1.8	2.3
Energy storage in developing tissue [kJ/g] <sup>b</sup>	26.2	15.6	7.4	9.8

<sup>a</sup> from [6]

<sup>b</sup> calculation of energy storage in developing tissue [5] taking into account 1 g of stored protein = 5.65 kcal and 23.6 kJ, respectively, and 1 g of stored fat = 9.25 kcal and 38.7 kJ, respectively:

$$\frac{(\text{stored protein [g/day]} * 5.65 \text{ kcal and } 23.6 \text{ kJ, respectively}) + (\text{stored fat [g/day]} * 9.25 \text{ kcal and } 38.7 \text{ kJ, respectively})}{\text{body weight gain [g/day]}}$$

**Table S3: Calculation of the guiding values for energy intake for infants**

Age [months]	1	2	3	4	5	6	7	8	9	10	11	12
<b>Boys</b>												
Body weight [kg] <sup>a</sup>	4.5	5.6	6.4	7	7.5	7.9	8.3	8.6	8.9	9.2	9.4	9.6
Body weight gain [g/day] <sup>b</sup>	34.1	39.9	27.2	20.6	17.4	14.1	11.9	10.5	9.5	8.6	8.1	8.0
<u>Energy storage for growth</u> in kcal/g <sup>c</sup>	6.0	6.0	6.0	2.8	2.8	2.8	1.5	1.5	1.5	2.7	2.7	2.7
in kcal/day <sup>d</sup>	204	239	163	57	48	39	18	16	14	23	22	22
Energy expenditure <u>not accounting for</u> energy storage for growth [kcal/day] <sup>e</sup>	266	368	442	498	544	581	618	646	674	702	720	739
Energy expenditure <u>accounting for</u> energy storage for growth in kcal/day <sup>f</sup>	470	607	605	555	592	620	636	662	688	725	742	761
in kcal/kg of body weight per day	104	108	94	79	79	78	77	77	77	79	79	79
Mean value <sup>g</sup> in kcal/kg of body weight per day (rounded)	97 (100)				78 (80)							
MJ/kg of body weight per day (rounded)	0.41 (0.4)				0.33 (0.3)							
Multiplied by reference weight <sup>h</sup> kcal/day	541				672							
MJ/day	2.26				2.81							
<b>Energy expenditure - rounded</b> <b>kcal/day</b>	<b>550</b>				<b>700</b>							
<b>MJ/day</b>	<b>2.3</b>				<b>2.8</b>							
<b>GIRLS</b>												
Body weight [kg] <sup>a</sup>	4.2	5.1	5.8	6.4	6.9	7.3	7.6	7.9	8.2	8.5	8.7	8.9
Body weight gain [g/day] <sup>b</sup>	29.3	33.7	23.9	19.5	16.3	13.4	11.5	10.4	9.1	8.2	7.8	7.7
<u>Energy storage for growth</u> in kcal/g <sup>c</sup>	6.3	6.3	6.3	3.7	3.7	3.7	1.8	1.8	1.8	2.3	2.3	2.3
in kcal/day <sup>d</sup>	183	211	150	73	61	50	20	18	16	19	18	18
Energy expenditure <u>not accounting for</u> energy storage for growth [kcal/day] <sup>e</sup>	238	321	386	442	488	525	553	581	609	637	655	674
Energy expenditure <u>accounting for</u> energy storage for growth in kcal/day <sup>f</sup>	421	532	536	514	549	575	574	599	625	656	674	692
in kcal/kg of body weight per day	100	104	92	80	80	79	75	76	76	77	77	78
Mean value <sup>g</sup> in kcal/kg of body weight per day (rounded)	94 (100)				77 (80)							
MJ/kg of body weight per day (rounded)	0.39 (0.4)				0.32 (0.3)							
Multiplied by reference weight <sup>h</sup> kcal/day	481				611							
MJ/day	2.01				2.55							
<b>Energy expenditure - rounded</b> <b>kcal/day</b>	<b>500</b>				<b>600</b>							
<b>MJ/day</b>	<b>2.0</b>				<b>2.6</b>							

<sup>a</sup>50<sup>th</sup> percentile of the WHO child growth standards [1] <sup>b</sup>from [www.who.int/childgrowth/standards/velocity/lms\\_weight\\_girls\\_1mon\\_p.pdf](http://www.who.int/childgrowth/standards/velocity/lms_weight_girls_1mon_p.pdf) or [www.who.int/childgrowth/standards/velocity/lms\\_weight\\_boys\\_1mon\\_p.pdf](http://www.who.int/childgrowth/standards/velocity/lms_weight_boys_1mon_p.pdf) (viewed on 17/11/2014) assuming 1 month consists of 30 days <sup>c</sup>see Table S2 <sup>d</sup>Gain in body weight [g/day] multiplied with energy storage for growth [kcal/g] <sup>e</sup>calculated using the energy expenditure per day as determined using the DLW method [4], for equation see Figure S1 <sup>f</sup>calculated using "energy expenditure not accounting for energy storage for growth" per day + energy storage for growth per day <sup>g</sup>Mean value from months 1–4 and 5–12, respectively <sup>h</sup>Reference weight see Table S1

**Table S4: Resting energy expenditure (REE) and guiding values for the energy intake for children and adolescents**

Age [years]	REE <sup>a</sup>		Guiding value for energy intake <sup>b</sup>							
	MJ/day	kcal/day	PAL 1.4		PAL 1.6		PAL 1.8		PAL 2.0	
			MJ/day	kcal/day	MJ/day	kcal/day	MJ/day	kcal/day	MJ/day	kcal/day
<b>Boys</b>										
1 to under 4	3.4	820	4.8	1,200	5.5	1,300	-	-	-	-
4 to under 7 <sup>c</sup>	4.1	970	5.7	1,400	6.6	1,600	7.4	1,800	-	-
7 to under 10 <sup>c</sup>	4.9	1,170	6.9	1,700	7.9	1,900	8.9	2,100	-	-
10 to under 13	5.6	1,340	7.9	1,900	9.0	2,200	10.1	2,400	11.3	2,700
13 to under 15	6.7	1,610	9.5	2,300	10.8	2,600	12.2	2,900	13.5	3,200
15 to under 19	7.7	1,850	10.9	2,600	12.5	3,000	14.1	3,400	15.6	3,700
<b>Girls</b>										
1 to under 4	3.2	760	4.5	1,100	5.1	1,200	-	-	-	-
4 to under 7	3.8	910	5.4	1,300	6.1	1,500	6.9	1,700	-	-
7 to under 10	4.5	1,080	6.4	1,500	7.3	1,800	8.2	2,000	-	-
10 to under 13	5.2	1,230	7.3	1,700	8.3	2,000	9.4	2,200	10.4	2,500
13 to under 15	5.7	1,380	8.1	1,900	9.3	2,200	10.4	2,500	11.6	2,800
15 to under 19	6.0	1,430	8.5	2,000	9.7	2,300	10.9	2,600	12.1	2,900

<sup>a</sup>According to [7], for 1 to under 4 years the equation from 0 to 3 years was used, for 4 to under 10 years, the equation from 3 to 10 years and from 10 to under 19 years the equation from 10 to 18 years. The median height and weight measurements used as a basis for the calculation can be found in Table S1. <sup>b</sup>Coefficient of 1,01 for growth taken into account <sup>c</sup>There appears to be an error in the equation for 3 to 10 year-old boys for kcal/day [8]. Consequently the equation for MJ/day is used and then converted into kcal/day.

**Figure S2: Regression equation for the calculation of resting energy expenditure (REE) in adults - according to Müller et al. [9]**

$$\text{REE [MJ/day]}^a = 0.047 * \text{weight [kg]} + 1,009 * \text{gender (women 0, men 1)} - 0.01452 * \text{age [years]} + 3.21$$

<sup>a</sup>convert MJ/day into kcal/day by multiplying by 239

**Table S5: Resting energy expenditure (REE) and guiding values for energy intake for adults**

Age [years] <sup>a</sup>	REE <sup>b</sup>		Guiding values for energy intake							
	MJ/day	kcal/day	PAL 1.4		PAL 1.6		PAL 1.8		PAL 2.0	
			MJ/day	kcal/day	MJ/day	kcal/day	MJ/day	kcal/day	MJ/day	kcal/day
<b>Men</b>										
19 to under 25	7.2	1,730	10.1	2,400	11.6	2,800	13.0	3,100	14.5	3,500
25 to under 51	7.0	1,670	9.8	2,300	11.2	2,700	12.6	3,000	14.0	3,300
51 to under 65	6.6	1,580	9.3	2,200	10.6	2,500	11.9	2,800	13.2	3,200
65 and older	6.4	1,530	9.0	2,100	10.3	2,500	11.5	2,800	12.8	3,100
<b>Women</b>										
19 to under 25	5.7	1,370	8.0	1,900	9.2	2,200	10.3	2,500	11.5	2,700
25 to under 51	5.5	1,310	7.7	1,800	8.8	2,100	9.9	2,400	11.0	2,600
51 to under 65	5.1	1,220	7.1	1,700	8.2	2,000	9.2	2,200	10.2	2,400
65 and older	5.0	1,180	6.9	1,700	7.9	1,900	8.9	2,100	9.9	2,400

<sup>a</sup>mean age for the age group 19 to under 25 years = 22 years; for 25 to under 51 years = 38 years; for 51 to under 65 years = 58 years; for 65 and older = 65 years

<sup>b</sup>calculated using the regression equation from Figure S2 according to Müller et al. [9] for a reference person of mean height and a body weight corresponding to a BMI of 22 kg/m<sup>2</sup>

**Table S6: Calculation of the additional energy expenditure in pregnant women with an average gain in body weight of 12 kg (based on [5])**

Body weight gain and energy storage in developing tissue during pregnancy:					
		1 <sup>st</sup> Trimester <sup>a</sup>	2 <sup>nd</sup> Trimester <sup>a</sup>	3 <sup>rd</sup> Trimester <sup>a</sup>	Total <sup>a</sup>
<b>Body weight gain</b>	[%]	11	47	42	100 %
	[g/day]	16.7	60.6	54.2	12,000 g
<b>Protein storage</b>	[%]	0	20	80	100 %
	[g/day]	0	1.3	5.1	597 g
<b>Fat storage</b>	[%]	11	47	42	100 %
	[g/day]	5.2	18.9	16.9	3,741 g
Additional energy expenditure during pregnancy (determined using the increase in energy expenditure and energy storage in developing tissue):					
		1 <sup>st</sup> Trimester	2 <sup>nd</sup> Trimester	3 <sup>rd</sup> Trimester	Total (rounded)
<b>Protein storage<sup>b</sup></b>	[kcal/ day]	0	7.3	29.0	3,370 kcal
	[kJ/ day]	0	30.3	121.2	14.1 MJ
<b>Fat storage<sup>b</sup></b>	[kcal/ day]	48.2	174.9	156.3	34,600 kcal
	[kJ/ day]	201.6	731.7	653.8	144.8 MJ
<b>Energy expenditure <u>not accounting for</u> energy storage in developing tissue<sup>c</sup></b>	[kcal/ day]	20.0	85.0	310.0	38,560 kcal
	[kJ/ day]	85.0	350.0	1,300.0	161.4 MJ
<b>Energy expenditure <u>accounting for</u> energy storage in developing tissue<sup>d</sup></b>	[kcal/ day]	68.2	267.1	495.3	76,530 kcal
	[kJ/ day]	286.6	1,112.0	2,075.0	320.3 MJ
<b>Additional energy expenditure</b> (Guiding value for additional energy intake)	[kcal/day] rounded	<b>70</b>	<b>250</b>	<b>500</b>	
	[kJ/day] rounded	<b>290</b>	<b>1,100</b>	<b>2,100</b>	
	[MJ/day] rounded	<b>0.3</b>	<b>1.1</b>	<b>2.1</b>	

<sup>a</sup>According to Butte & King [10] from FAO [5, 11]: For body weight gain and energy storage in developing tissue - first trimester estimated with 79 days and second and third trimesters both with 93 days. <sup>b</sup>Protein and fat storage estimated using longitudinal studies on body composition during pregnancy and an energy content of 5.65 kcal/g (23.6 kJ/g) stored protein and 9.25 kcal/g (38.7 kJ/g) stored fat [6]. <sup>c</sup>calculated using energy expenditure per day determined using the DLW method [5] <sup>d</sup>Sum of "energy expenditure not accounting for energy storage in developing tissue" and energy storage for developing tissue (fat and protein)

## References

- 1 WHO (ed): WHO child growth standards - length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for age. Geneva, 2006.
- 2 RKI: Referenzperzentile für anthropometrische Maßzahlen und Blutdruck aus der Studie zur Gesundheit von Kindern und Jugendlichen in Deutschland (KiGGS) 2003-2006. Gesundheitsberichterstattung des Bundes. Berlin, 2011.
- 3 Mensink, G B M, Schienkiewitz A, Haftenberger M, Lampert T, Ziese T, Scheidt-Nave C: Übergewicht und Adipositas in Deutschland: Ergebnisse der Studie zur Gesundheit Erwachsener in Deutschland (DEGS1). Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 2013;56(5-6):786–794.
- 4 Butte NF: Energy requirements of infants. Public Health Nutr 2005;8:953–967.
- 5 FAO, WHO, UNU (eds): Human energy requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. Food and Nutrition Technical Report Series. Rom, 2004.
- 6 Butte NF, Hopkinson JM, Wong WW, Smith EO, Ellis KJ: Body composition during the first 2 years of life: an updated reference. Pediatr Res 2000;47:578–585.
- 7 Henry CJK: Basal metabolic rate studies in humans: measurement and development of new equations. Public Health Nutr 2005;8(7A):1133–1152.
- 8 EFSA: Scientific opinion on dietary reference values for energy. EFSA Journal 2013;11:3005.
- 9 Müller MJ, Bosy-Westphal A, Klaus S, Kreymann G, Luhrmann PM, Neuhauser-Berthold M, Noack R, Pirke KM, Platte P, Selberg O, Steiniger J: World Health Organization equations have shortcomings for predicting resting energy expenditure in persons from a modern, affluent population: generation of a new reference standard from a retrospective analysis of a German database of resting energy expenditure. Am J Clin Nutr 2004;80:1379–1390.
- 10 Butte NF, King JC: Energy requirements during pregnancy and lactation. Energy background paper prepared for the joint FAO/WHO/UNU consultation on energy in human nutrition 2002.
- 11 Butte NF, King JC: Energy requirements during pregnancy and lactation. Public Health Nutr 2005;8:1010–1027.