F

Rationale for Setting Adequate Intakes

In the Dietary Reference Intake (DRI) nutrient reports, the Adequate Intake (AI) has been estimated in a number of different ways. Because of this, the exact meanings and interpretations of the AIs differ. Some AIs have been based on the observed mean intake of groups or subpopulations that are maintaining health and nutritional status consistent with meeting the criteria for adequacy. However, where reliable information about these intakes was not available, or where there were conflicting data, other approaches were used. As a result, the definition of an AI is broad and includes experimentally estimated desirable intakes.

These varying methods of setting an AI make using the AI for assessing intakes of groups difficult. When the AI is based directly on intakes of apparently healthy populations, it is correct to assume that other populations (with similar distributions of intakes) have a low prevalence of inadequate intakes if the mean intake is at or above the AI. For nutrients for which the AI was not based on intakes of apparently healthy populations, a group mean intake at or above the AI would still indicate a low prevalence of inadequate intakes for that group but there is less confidence in this assessment. Tables F-1 through F-6 give more details on the methods used to set the AIs for calcium, vitamin D, fluoride, pantothenic acid, biotin, and choline. For infants, AIs have been set for all nutrients evaluated to date (see table at the end of this book). For all these nutrients except vitamin D, the AI for infants is based on intakes of healthy populations that are fed only human milk. However, for the other age groups, only fluoride and pantothenic acid AIs are based on intakes of apparently healthy populations.

TABLE F-1 Adequate Intake (AI) for Calcium

Life Stage Group	AI (mg/d)	Basis for AI	Study Po
0–6 mo	210	Human milk content	
7–12 mo	270	Human milk content + solid food	
1–3 y	500	Extrapolation from AI for 4–8 y (desirable calcium retention)	
4–8 y	800	Calcium balance, calcium accretion, ΔBMC[b]	Balance n=60 g Matko
9–18 y	1,300	Desirable calcium retention, ΔBMC, factorial	Retentio 1. n=11 2. n=80 Matl 3. n=11 Hea BMC stu 1. n=94 2. n=48 3. n=70 (Joh
19–30 y	1,000	Desirable calcium retention, factorial	n=26 me Heane
31–50 y	1,000	Calcium balance, BMD[c]	Balance 1. n=13 (Hea 2. n=25 3. n=34 BMD stu 1. n=37 2. n=49 al., 1

	Study Population[a]
irable	
ΔBMC[b]	Balance studies: *n*=60 girls and 39 boys; aged 2–8 y; normal and healthy (Matkovic, 1991; Matkovic and Heaney, 1992)
factorial	Retention studies: 1. *n*=115 girls and 113 boys; aged 9–19 y (Martin et al., 1997) 2. *n*=80; aged 12–15 y; Caucasians (Greger et al., 1978; Jackman et al., 1997; Matkovic et al., 1990) 3. *n*=111 girls and 22 boys; aged 9–17 y; normal and healthy (Matkovic and Heaney, 1992)
	BMC studies: 1. *n*=94 Caucasian girls; mean age 12 y (Lloyd et al., 1993) 2. *n*=48 Caucasian girls; mean age 11 y (Chan et al., 1995) 3. *n*=70 pairs of identical twins; aged 6–14 y; 45 pairs completed the 3-y study (Johnston et al., 1992)
l	*n*=26 men and 137 women; aged 18–30 y; normal and healthy (Matkovic and Heaney, 1992)
	Balance studies: 1. *n*=130 premenopausal women (white Roman Catholic nuns); aged 35–50 y (Heaney et al., 1977) 2. *n*=25 healthy women; aged 30–39 y (Ohlson et al., 1952) 3. *n*=34 healthy women; aged 40–49 y (Ohlson et al., 1952)
	BMD studies: 1. *n*=37 premenopausal women; aged 30–42 y (Baran et al., 1990) 2. *n*=49 premenopausal, healthy women; aged 46–55 y; Netherlands (Elders et al., 1994)

continued

TABLE F-1 Adequate Intake (AI) for Calcium

Life Stage Group	AI (mg/d)	Basis for AI	Study Po
51–70 y	1,200	Desirable calcium retention, factorial, ΔBMD	Retentio 1. n=85 2. n=18 (Scl 3. n=18 (Spe 4. n=76 5. n=61 6. n=41 nun BMD stu 1. n=9 al., 1 1995 2. n =7
> 70 y	1,200	Extrapolation from AI for 51–70 y (desirable calcium retention), ΔBMD, fracture rate	
Pregnancy and lactation, <18 y	1,300	Bone mineral mass	
Pregnancy and lactation, 19–50 y	1,000	Bone mineral mass	

[a] Unless noted otherwise, all studies were performed in the United States or Canada.
[b] ΔBMC = change in bone mineral content.
[c] ΔBMD = change in bone mineral density.

	Study Population[a]
l, ΔBMD	Retention studies: 1. n=85 women with vertebral osteoporosis; aged 48–77 y (Hasling et al., 1990) 2. n=18 women and 7 men with osteoporosis; aged 26–70 y, mean age 53 (Selby, 1994) 3. n=181 balance studies of ambulatory men; aged 34–71 y, mean age 54 (Spencer et al., 1984) 4. n=76 women; aged 50–85 y (Ohlson et al., 1952) 5. n=61 postmenopausal women with osteoporosis (Marshall et al., 1976) 6. n=41 postmenopausal, estrogen-deprived women (white Roman Catholic nuns); mean age 46 y (Heaney and Recker, 1982; Heaney et al., 1978) BMD studies: 1. n=9 clinical trials in postmenopausal women (Aloia et al., 1994; Chevalley et al., 1994; Dawson-Hughes et al., 1990; Elders et al., 1991; Prince et al., 1991, 1995; Recker et al., 1996; Reid et al., 1995; Riis et al., 1987) 2. n =77 men; aged 30–87 y, mean age 58; 3-y study (Orwoll et al., 1990)
desirable rate	

Canada.

TABLE F-2 Adequate Intake (AI) for Vitamin D

Life Stage Group	AI (μg/d)	Basis for AI	Study Po
0–6 mo	5	Serum 25(OH)D[b] level	*n*= 256 fu
7–12 mo	5	Serum 25(OH)D level	1. *n*=18 h (Greer 2. *n*=150 3. *n*=38 h
1–3 y 4–8 y 9–13 y 14–18 y	5	Serum 25(OH)D level	1. *n*=104 Aarsko 2. *n*=90 r y (Gul
19–50 y	5	Serum 25(OH)D level	1. *n*=52 w
51–70 y	10	Serum 25(OH)D level	1. *n*=247 Hughe 2. *n*=333 1989) 3. *n*=249 Hughe
>70 y	15	Serum 25(OH)D level	1. *n*=60 w womer 2. *n*=109 al., 199 3. *n*=116
Pregnancy and lactation, all ages	5	Serum 25(OH)D level	

[a] Unless noted otherwise, all studies were performed in the United States or Canada.
[b] 25(OH)D = 25-hydroxyvitamin D.

Study Population[a]
n= 256 full-term Chinese infants (Specker et al., 1992)
1. n=18 healthy, full-term, human-milk-fed infants; 17 Caucasian, 1 Asian-Indian (Greer et al., 1982) 2. n=150 normal, full-term, formula-fed Chinese infants (Leung et al., 1989) 3. n=38 healthy infants, aged 6–12 months; Norway (Markestad and Elzouki, 1991)
1. n=104 boys and 87 girls; healthy, normal; aged 8–18 y; Norway (Aksnes and Aarskog, 1982) 2. n=90 randomly selected school students in Turkey; 41 girls, 49 boys; aged 6–17 y (Gultekin et al., 1987)
1. n=52 women; aged 25–35 y (Kinyamu et al., 1997)
1. n=247 healthy, postmenopausal, ambulatory women; mean age 64 y (Dawson-Hughes et al., 1995) 2. n=333 healthy, postmenopausal, Caucasian women; mean age 58 y (Krall et al., 1989) 3. n=249 healthy, postmenopausal, ambulatory women; mean age 62 y (Dawson-Hughes et al., 1991)
1. n=60 women living in a nursing home, mean age 84 y; and 64 free-living women, mean age 71 y (Kinyamu et al., 1997) 2. n=109 men and women living in a nursing home; mean age 82 y (O'Dowd et al., 1993) 3. n=116 men and women; mean age 81 y (Gloth et al., 1995)

Canada.

TABLE F-3 Adequate Intake (AI) for Fluoride

Life Stage Group	AI (mg/d)[a]	Basis for AI	Study Po
0–6 mo	0.01	Human milk content	
7–12 mo	0.5	Caries prevention	Caries pr
1–3 y	0.7	Caries prevention	calcula
4–8 y	1	Caries prevention	1. num 2. calcu mo 1979 3. calcu old estin in th 4. calcu Nutr
9–13 y	2	Caries prevention	
14–18 y, males	3	Caries prevention	
14–18 y, females	3	Caries prevention	
>19 y, males	4	Caries prevention	Caries pr
>19 y, females	3	Caries prevention	calcula 1. anal (Dab 2. anal 3. mea 1981 4. calcu com 5. dete (Osi 6. calcu (Kra
Pregnancy and lactation, <18 y	3	Caries prevention	
Pregnancy and lactation, 19–50 y	3	Caries prevention	

[a] For all life stage groups, the AI was calculated using 0.05 mg/kg/day as the amount of fluoride needed to prevent dental caries. This amount was based on the studies outlined in this table.
[b] Unless noted otherwise, all studies were performed in the United States or Canada.

Study Population[b]
Caries prevention was based on the following studies that measured or calculated fluoride intake in children: 1. number of infants not given; aged 1–9 y (McClure, 1943) 2. calculated total daily fluoride intake for a typical infant at age 2, 4, and 6 mo using food analyses and caloric intake estimates (Singer and Ophaug, 1979) 3. calculated average daily fluoride intake for a typical 6-mo-old infant and 2-y-old child using U.S. Food and Drug Administration food consumption estimates and food analyses; calculations were done for four dietary regions in the United States (Ophaug et al., 1980a, b, 1985) 4. calculated fluoride intake from 24-h dietary recalls of 250 mothers as part of Nutrition Canada Survey (Dabeka et al., 1982)
Caries prevention was based on the following studies which measured or calculated fluoride intake in adults: 1. analyzed duplicate diets of 24 adults and determined mean dietary intake (Dabeka et al., 1987) 2. analyzed hospital diet; n=93 food items (Taves, 1983) 3. measured dietary intake of 10 adult male hospital patients (Spencer et al., 1981) 4. calculated total daily intake for typical males aged 15–19 y using food composition and consumption data (Singer et al., 1980, 1985) 5. determined average daily intake from analysis of hospital diet; n=287 diets (Osis et al., 1974) 6. calculated daily intake from food analyses of diets from 16 U.S. cities (Kramer et al., 1974)

TABLE F-4 Adequate Intake (AI) for Pantothenic Acid

Life Stage Group	AI (mg/d)	Basis for AI	Study Po
0–6 mo	1.7	Human milk content	
7–12 mo	1.8	Mean of extrapolation from AI for 0–6 mo and adult AI[b]	
1–3 y	2	Extrapolation from adult AI	
4–8 y	3	Extrapolation from adult AI	
9–13 y	4	Extrapolation from adult AI	
14–18 y	5	Extrapolation from adult AI, urinary pantothenate excretion	1. *n*=26 b (Eisser 2. *n*=8 bo
≥ 19 y	5	Usual intake	Usual int 1. *n*=23 (4 Chin 2. *n*=7,27 Survey 3. *n*=37 n 65+ y (4. *n*=12 h al., 19
Pregnancy, all ages	6	Usual intake	
Lactation, all ages	7	Usual intake, maternal blood concentrations, secretion of pantothenic acid into milk	

[a] Unless noted otherwise, all studies were performed in the United States or Canada.
[b] To extrapolate from the AI for adults to an AI for children, the following formula is used $AI_{child} = AI_{adult}$ (F), where F = $(Weight_{child}/Weight_{adult})^{0.75}$ (1 + growth factor). To extrapolate from the AI for infants ages 0–6 months to an AI for infants ages 7–12 months, the following formula is used: $AI_{7-12\ mo} = AI_{0-6\ mo}\ (F)$, where F = $(Weight_{7-12\ mo}/Weight_{0-6\ mo})^{0.75}$.

	Study Population[a]
–6 mo	
	1. n=26 boys aged 14–19 y and 37 girls aged 13–17 y; all healthy volunteers (Eissenstat et al., 1986) 2. n=8 boys and 4 girls; aged 11–16 y (Kathman and Kies, 1984)
	Usual intake was based on 4 studies: 1. n=23 (16 females, 7 males), aged 18–53 y (mean 26 y), 19 Caucasian, 4 Chinese, all normal healthy volunteers (Kathman and Kies, 1984) 2. n=7,277 randomly selected British households from the U.K. National Food Survey (Bull and Buss, 1982) 3. n=37 males, 54 females (26 institutionalized, 65 noninstitutionalized), aged 65+ y (Srinivasan et al., 1981) 4. n=12 healthy men, half were aged 21–35 y and half were aged 65–79 y (Tarr et al., 1981)
ntrations, milk	

TABLE F-5 Adequate Intake (AI) for Biotin

Life Stage Group	AI (μg/d)	Basis for AI	Study Po
0–6 mo	5	Human milk content	1. *n*= 35 et al., 2. *n*=140 1985)
7–12 mo	6	Extrapolation from AI for 0–6 mo[a]	
1–3 y	8	Extrapolation from AI for 0–6 mo[b]	
4–8 y	12	Extrapolation from AI for 0–6 mo[b]	
9–13 y	20	Extrapolation from AI for 0–6 mo[b]	
14–18 y	25	Extrapolation from AI for 0–6 mo[b]	
Adults, all ages	30	Extrapolation from AI for 0–6 mo[c]	
Pregnancy, all ages	30	Extrapolation from AI for 0–6 mo	
Lactation, all ages	35	Extrapolation from AI for 0–6 mo + amount of biotin secreted into milk	

[a] To extrapolate from the AI for infants ages 0–6 months to an AI for infants ages 7–12 months, the following formula is used: $AI_{7-12\ mo} = AI_{0-6\ mo}\ (F)$, where $F = (Weight_{7-12\ mo}/Weight_{0-6\ mo})^{0.75}$.

[b] To extrapolate from the AI for infants ages 0-6 months to an AI for children and adolescents 1-18 years, the following formula is used: $AI_{child} = AI_{0\text{-}6\ mo}\ (F)$, where $F = (Weight_{child}/Weight_{0\text{-}6\ mo})^{0.75}$.

[c] To extrapolate from the AI for infants ages 0-6 months to an AI for adults, the following formula is used: $AI_{adult} = AI_{0\text{-}6\ mo}\ (F)$, where $F = (Weight_{adult}/Weight_{0\text{-}6\ mo})^{0.75}$.

Study Population
1. n= 35 mature milk samples from 38 healthy nursing mothers in Japan (Hirano et al., 1992) 2. n=140 healthy, full-term infants in Finland; 4 mo lactation (Salmenpera et al., 1985)
lk

TABLE F-6 Adequate Intake (AI) for Choline

Life Stage Group	AI (mg/d)	Basis for AI	Study Po
0–6 mo	125	Human milk content	
7–12 mo	150	Extrapolation from AI for 0–6 mo[a]	
1–3 y	200	Extrapolation from adult AI	
4–8 y	250	Extrapolation from adult AI	
9–13 y	375	Extrapolation from adult AI	
14–18 y, males	550	Extrapolation from adult AI	
14–18 y, females	400	Extrapolation from adult AI	
≥19 y, males	550	Prevention of ALT[b] abnormalities	n=16 hea
≥19 y, females	425	Prevention of ALT abnormalities	
Pregnancy, all ages	450	Prevention of ALT abnormalities + cost of pregnancy	
Lactation, all ages	550	Prevention of ALT abnormalities + amount of choline secreted into milk	

[a] To extrapolate from the AI for adults to an AI for children, the following formula is used $AI_{child} = AI_{adult}$ (F), where $F = (Weight_{child}/Weight_{adult})^{0.75}$ (1 + growth factor). To extrapolate from the AI for infants ages 0–6 months to an AI for infants ages 7–12 months, the following formula is used: $AI_{7-12\ mo} = AI_{0-6\ mo}$ (F), where $F = (Weight_{7-12\ mo}/Weight_{0-6\ mo})^{0.75}$.

[b] ALT = alanine aminotransferase.

	Study Population
	n=16 healthy male volunteers; aged 29 y (Zeisel et al., 1991)
ost of	
mount	