



BIA-formulas for children adolescents: overview of publications (in detail)

Author, year	Formula	Description of the study	Bibliography
Cordain et al. (1988):	$FFM = 6.86 + 0.81 \times (Ht^2/R)$ (Ht in cm)	A total of 30 healthy children were examined by means of BIA, densitometry and Potassium 40 total body metering. Boys (n=14): 12.5 years, height 157.7 ± 8.4 cm, weight 46.3 ± 8.7 kg. Girls (n=16): 11.6 years, height 153.5 ± 8.3 cm, weight 44.5 ± 7.7 kg.	Cordain Loren, R. Whicker, J. Johnson: Body Composition Determination in Children Using Bioelectrical Impedance. Growth Dev. Aging (1988) 52: 37-40.
Davies et Preece 1988	$TBW = -0.5 + 0,60 \times (Ht^2/R)$ (Ht in m)	The 26 healthy children examined were 12.9 ± 3.3 years old, weighed 39.8 ± 15.4 kg and were 1.41 ± 0.18 m in height. The formula was validated using deuterium dilution.	S. Davies Peter, M. Preece: The prediction of total body water using bioelectrical impedance in children and adolescents. Annals of Human Biology, 1988, Vol. 15, No. 3, 237-240.
De Lorenzo et al. 1998	$FFM = 2.33 + 0.588 \times (Ht^2/R) + 0.211 \times wt$ (Ht in cm)	This formula was evaluated by de Lorenzo on 35 schoolchildren aged from 7.7 to 13 years. Comparison method: DEXA.	De Lorenzo A., SP. Sorge, Iacopino L., Andewoli A., de Luca PP., Sasso FF.: Fat-Free Mass by bioelectrical impedance vs dual-energy x-ray absorptiometry (DEXA). Appl. Radiat. Isot. 1998; 49: 739-741.
Deurenberg et al. 1989	$FFM = 0.430 \times 104 \times Ht^2/R + 0.354 \times wt + 0.9 \times sex$ (sex: 1 = male, 2 = female; Ht in m)	The data were obtained from 73 healthy prepubertal children aged from 8 to 11 years. The children weighed 31.8 ± 5.5 (boys) and 29.8 ± 3.8 kg (girls). The body height was $1.37m \pm 0.05$ (boys) and 1.36 m ± 0.06 (girls).	Deurenberg P., Kooy, K., Paling, A., Withagen, P.: Assessment of Body Composition in 8-11 year old Children by Bioelectrical Impedance. European Journal of Clinical Nutrition 1989, 43, 623-629.
Deurenberg et al. 1990	Boys and girls aged from 7 to 9 years: $FFM = 0.640 \times 104 \times (Ht^2/R) + 4.83$ Girls of 10-12 and boys of 10-15 years: $FFM = 0.488 \times 104 \times (Ht^2/R) + 0.221 \times wt + 12.77 \times Ht - 14.7$ Girls older than 13 and boys older than 16 years: $FFM = 0.258 \times 104 \times (Ht^2/R) + 0.375 \times wt + 6,3 \times sex + 10.5 \times Ht - 0.164 \times age - 6.5$ (sex: 1 = male, 2 = female; Ht in m)	A total of 246 children aged from 7 to 25 years were examined by means of BIA, densitometry and anthropometry. Since the results depended closely on age, 3 age-groups were formed.	Deurenberg P., Kusters, C., Smit H.: Assessment of body composition by bioelectrical impedance in children and young adults is strongly age-dependent. European Journal of Clinical Nutrition 1990, 44, 261-268.
Fjeld et al. 1990	$TBW = 0.76 + 0.18 \times /Ht^2/R) + 0.39 \times wt$ (Ht in cm)	This formula for determining total body water TBW was evaluated on 65 Peruvian children. Some of the children were suffering from malnutrition or under-weight. Their age was 3 - 30 months; their weight lay between 3.4 and 14.4 kg. The formula was validated using deuterium dilution.	Fjeld CR., Freundt-Thurne J., Schoeller, DA.: Total Body water measured by O18 dilution and impedance in well and malnourished children. Pediatric Research 1990; Vol. 27, No. 1, 98-102.
Houtkooper et al. 1989	$FM (\%) = -1.11 \times (Ht^2/R) + 1.04 \times wt + 15.16$ (Ht in cm)	In this work, 41 girls and 53 boys aged from 10 to 14 were examined. The children were on average 155.9 and 153.1 cm in height respectively, and weighed 50.6 and 47.5 kg respectively. The formula was validated using anthropometry and deuterium dilution.	Houtkooper LB, Lohmann TG, Going SB, Hall MC. Validity of bioelectrical impedance for body composition assessment in children. J. Appl. Physiol. 1989; 66: 814-821.



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Houtkooper et al. 1992	$FFM = 0.61 \times (Ht^2/R) + 0.25 \times wt + 1.31 \text{ (Ht in cm)}$	Houtkooper developed this formula in comparison to anthropometry, densitometry and deuterium dilution on 25 schoolchildren aged from 10 to 14 years, and on 68 children aged from 11 to 19 years. The children were 153.6 +/- 10.6 cm in height and weighed 47.0 +/- 11.3 kg.	Houtkooper LB., SB. Going, TG. Lohman, AF. Roche, M. Van-Loan: Bioelectrical impedance estimation of fat-free body mass in children and youth: a crossvalidation study. J. Appl. Physiol. 1992; 71: 366-373.
Kushner et al. 1992	$TBW = 0.593 \times (Ht^2/R) + 0.065 \times wt + 0.04 \text{ (Ht in cm)}$	The measurements obtained from 62 adults, 37 pre-pubertal children, 44 preschool children and 32 underweight premature infants were validated with BIA and deuterium dilution.	Kushner Robert F., D. Schoeller, C. Fjeld, and L. Danford: 12. Is the impedance index (ht ² /R) significant in predicting total body water? Am. J. Clin. Nutr. 1992; 56: 835-9.
Mayfield et al. 1991	$TBW \text{ (ml)} = 215.6 WL^2 / R + 592$	Special formula for underweight infants. W = Weight in kg, L= Crown-heel length in cm. Content: 32 underweight premature infants < 2500 g were measured at birth and at 4 to 7 days after birth. The formula was validated using deuterium for TBW and bromide for ECW.	Mayfield Steven R., Ricardo Uauy, and Dawn Waidelich: Body Composition of low-birth-weight infants determined by using bioelectrical resistance and reactance. Am. J. Clin. Nutr. 1991; 54:296-303.
Schaefer et al. 1994	$FFM = 0.65 \times (Ht^2/R) + 0.68 \times \text{age} + 0.15 \text{ (Ht in cm)}$	Developed on E 112 healthy children aged 11.8 ± 3.7 years. The fat-free mass FFM was validated with Potassium 40 total body metering.	F. Schaefer, M. Georgi, A. Ziegler and K. Schärber. Pediatric Research, Vol. 35, No. 5, 1994, 617-624. Usefulness of Bioelectric Impedance and Skinfold Measurements in Predicting Fat-Free Mass Derived from Total Body Potassium in Children.
Wabitsch et al. 1996	$TBW = 0.35 \times (Ht^2/R) + 0.27 \times \text{age} + 0.14 \times wt - 0.12 \text{ (Ht in m)}$	The formula was developed using 146 overweight children aged 12.7 ± 3.0 years. The children weighted 74.1 ± 22.3 kg with a body height of 158.5 ± 15.7 cm. Reference method: deuterium dilution.	M. Wabitsch, U. Braun, E. Heinze, R. Muche, H. Mayer, W. Teller, C. Fusch: Body Composition in 5-18-y-old obese children and adolescents before and after weight reduction as assessed by deuterium dilution and bioelectrical impedance analysis. Am. Journal of Clin. Nutrition, 1996; 64: 1-6.
Wühl et al. 1996	$TBW = 1.99 + 0.144 \times (Ht^2/R) + 0.40 \times wt \text{ (Ht in cm)}$	Special formula for determining the body water in the case of children and young people requiring dialysis. 14 patients with peritoneal dialysis were on average 11.9 years old; 9 patients with haemodialysis were on average 16.6 years old. Validation with deuterium dilution.	E. Wühl, C. Fusch, K. Schärer, O. Mehls, F. Schaefer. Assessment of total body water in paediatric patients on dialysis. Nephrol. Dial. Transplant (1996) 11: 75-80.

Definition:

wt = weight (kg); Ht = height (in m or cm); TBW = Total Body Water in l; FFM = Fat-Free-Mass in kg; FM = Fat Mass or BF = Body Fat = Weight – FFM; Age = years;