

Quantitative Growth of Skin and Subcutaneous Tissue in Relation to Human Surface Area.

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The body is enveloped in skin in immediate contact with the external environment. But the developmental changes in the mass of this covering and of the tela subcutanea immediately under it have received little study.

Bischoff¹ presented a carefully prepared study of the weights of the skin, fat, and various parts of the body of a premature and 2 full-term infants, an adolescent child, and 2 adults. Various later authors (Brüel, Dursy, Volkmann and Wacherman, quoted from Welcker and Brandt,² von Liebig,³ Vierordt,⁴ Jackson,⁵ and Roe⁶)

TABLE I.
Age Changes in Amount of Skin and Tela Subcutanea from 5 Fetal Months to Maturity.

Age Sex	5 lunar months* Newborn*		Maturity		
	M + F	M + F	M	F	M + F
No.	—	—	13	2	15
Mean age (yrs)	—	—	37	39	37+
Mean stature (cm)	22.9	50.5	168.8	159.5	—
Mean wt (kg)	0.261	3.000	57.300	50.147	—
Calculated surface area (cm ²)	347.8	2,102.0	16,273	14,953	15,613
Mean skin wt (g)	10.7	187.2	3,289.7	3,000.0	3,145.0
Mean tela subcutanea wt (g)	2.0	392.0	6,604.0	11,897.0	9,250.5
Calculated skin wt per cm ² body surface (g)	0.031	0.086	0.202	0.200	0.201
Calculated tela subcutanea wt per cm ² body surface (g)	0.006	0.200	0.406	0.796	0.601
Ratio of skin wt to tela subcutanea wt†	5.35	0.48	0.50	0.25	0.34

* Age calculated from length according to the formula of Scammon and Calkins.⁹

†The ratio of skin to tela subcutanea was computed from the values for these structures given in 10 of the thirteen cadavers measured.

¹ Bischoff, E., *Z. f. rat. Med.*, 1863, Ser. 3, **20**, 75.

² Welcker, H., und Brandt, A., *Arch. f. Anthropol.*, 1903, **28**, 1.

³ von Liebig, G., *Arch. f. Anat. u. Physiol.*, Jhrg. 1874, 96.

⁴ Vierordt, H., *Anatomische, physiologische und physikalische Daten und Tabellen*, 3 Aufl., Jena, Gustav Fischer, 1906, p. 42 et seq.

⁵ Jackson, C. M., *Am. J. Anat.*, 1909, **9**, 119.

⁶ Roe, H. E., *Anat. Rec.*, 1933, **55**, 127.

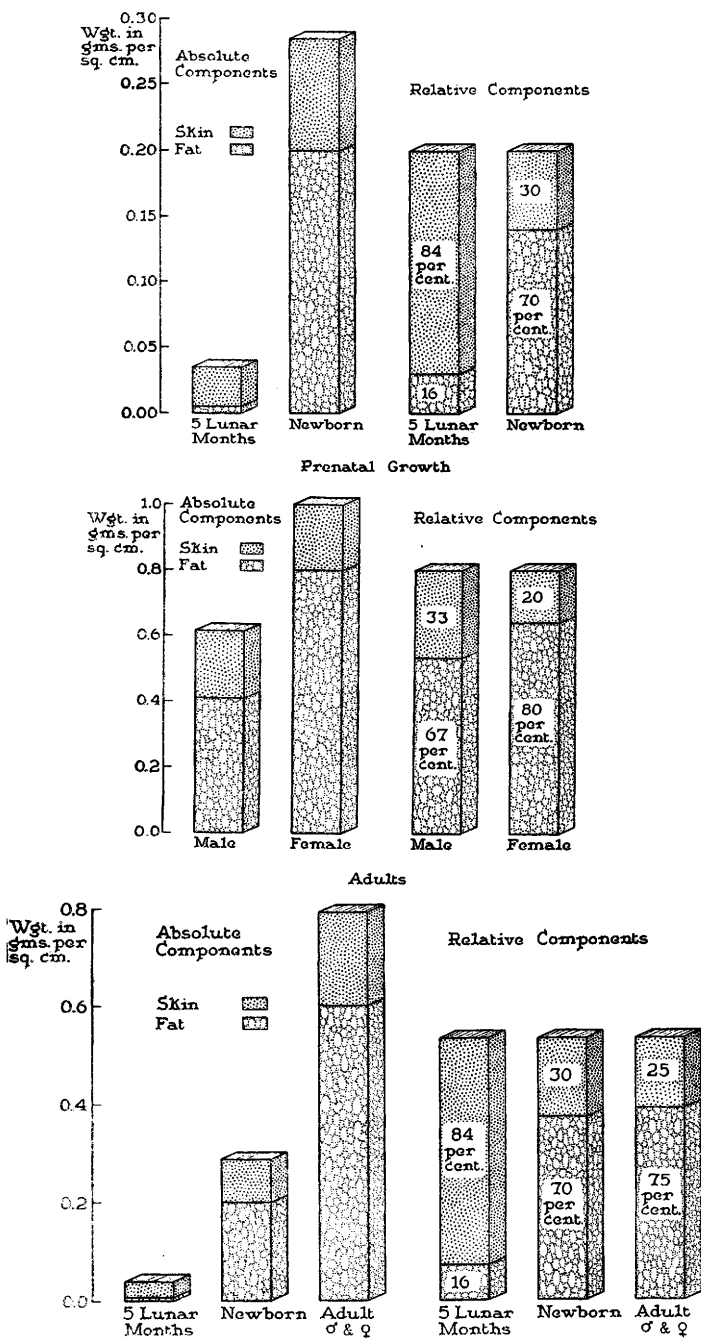


Fig. 1 (top); Fig. 2 (center); Fig. 3 (bottom).

have studied various parts of the body, including quantitative skin changes.

The total weight of the skin and the tela subcutanea at 5 lunar months, at birth, and in maturity (in males, females, and both sexes) has been collated from these data. The mean skin weight and tela subcutanea weight per square centimeter were calculated by the surface formulae of Scammon and Klein⁷ and of Boyd,⁸ and the body length-body weight formulae of Scammon and Calkins.⁹ These data are shown in Table I. They are illustrated in histographic form in Figs. 1, 2, and 3.

Between 5 and 10 lunar months there is a very striking change. The skin increases about 17.5 times in absolute weight, while the tela subcutanea increases about 196 times. But the surface area of the body increases to such a degree during this time interval that the tela subcutanea increases but a little less than 35 times in terms of grams per square centimeter of surface.

In the adult, when both sexes are considered, it is found that the ratio of skin and tela subcutanea per square centimeter of surface is almost identical with that at birth. However, the ratio of the tela subcutanea in adult females alone is higher than in the newborn. There is comparatively little change in the proportion of skin to tela subcutanea in the 2 sexes.

The distribution of fat in the fetus and newborn infant (Berg¹⁰) is remarkably different from that in the adult. With this in mind, we might think of the changes in tela subcutanea as largely those of distribution, the relative quantity remaining approximately the same.

⁷ Scammon, R. E., and Klein, A. D., *PROC. SOC. EXP. BIOL. AND MED.*, 1930, **27**, 461.

⁸ Boyd, E., *The Growth of the Surface Area of the Human Body*, Minneapolis, University of Minnesota Press, 1935, p. 103 *et seq.*

⁹ Scammon, R. E., and Calkins, L. A., *PROC. SOC. EXP. BIOL. AND MED.*, 1923, **20**, 353; *PROC. SOC. EXP. BIOL. AND MED.*, 1924, **21**, 549; *PROC. SOC. EXP. BIOL. AND MED.*, 1924, **22**, 157.

¹⁰ Berg, W., *Z. f. Morphol. u. Anthropol.*, 1911, **13**, 205.