Level of Fatness and Size Attainment

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ABSTRACT In a generally low-income group of 4,888 White boys and girls, 740 obese children (above the 85th percentile for the triceps fatfold) stand systematically taller, by 0.64 Z scores, than 840 lean boys and girls (below the 15th percentile for fatness) a difference increasing to 1 S.D. at ages 11–12, suggesting a direct effect of the level of fatness on standing height and a cumulative fatness-related difference in the annual rate of growth.

Clinically-obese boys and girls tend both to greater stature and to demonstrated maturational advancement (Wolff, '55; Quaade, '55). Within a study population, unselected for the degree of fatness, those children who are fatter (as radiogrammetrically determined) are both larger in body size and advanced in both skeletal and sexual maturation (Garn and Haskell, '59, '60). It is not certain, however, whether the fatness-size relationship is part of a developmental continuum, or primarily the contribution of the obese, "Pickwickian" extreme. There is need to ascertain whether lean children are as size-reduced as obese boys and girls are stature-increased, in a sizeable population sample, and in population-context.

To resolve this question, we have newly examined (a) triceps fatfold data and (b) stature (standing height) data on 4,888 boys and girls of European derivation, and generally from lower income families. All children were participants in the Ten-State-Nutrition Survey of 1968–1970, and from the states of California, Kentucky, Massachusetts, Michigan, New York, South Carolina, West Virginia, and Washington. Fatfold data quality has been carefully examined, state by state, and is the subject of a separate publication (Garn, '73).

At each midpoint age, from age 1 to age 12, lean boys and girls (below the 15th percentile for the triceps fatfold) and obese boys and girls (above the 85th percentile for the triceps fatfold) were identified by a special computer program, and then stature-compared. The "cut-off" values for lean and "obese" subjects are given, by age and sex, in the table. Statures were then compared with the median stature values for the group as a whole, and expressed (for each age and sex) as Z scores or standard deviation units relative to the group as a whole. The present data analysis, therefore, consists of 740 lean boys and girls, and an almost equal number of 780 obese boys and girls, and their age-specific statures as compared with the total group of nearly 5,000 children in the total sample from five geographical regions.

As shown in the table (table 1) the 780 obese boys and girls, defined in terms of age-and-sex specific fatfolds, tend to be taller than the 740 lean boys and girls, by as much as 6 cm and more. This size-trend is true without exception for the boys (12 out of 12 comparisons) and nearly so for the girls (11 out of 12 age-comparisons). The differences are highly significant by sign test (23:1 as against the chance or 12:12 distribution). Expressed relative to the stature medians for the total group, the lean boys and girls averaged −0.21 Z scores, i.e., 0.2 S.D. below stature expectancy. In contrast the obese boys and girls (above the 85th percentile for the triceps fatfold) averaged a weighted 0.48 Z scores *above* stature expectancy for age and sex, or nearly 0.5 Standard Deviations. Overall, the rounded Z score differences for stature (comparing the obese with the lean) approximates 0.64 Z for the boys and a closely similar 0.68 Z for the girls from age 1 through 12. There

TABLE 1

Stature comparisons of lean and obese boys and girls

Age	Lean			Obese			Difference in Z-scores [3]
	No.	Cut-off [1]	Stature [2]	No.	Cut-off [1]	Stature [2]	
		mm	*cm*		*mm*	*cm*	
				Boys			
1	15	7.0	75.0	18	13.0	78.3	0.57
2	20	7.0	84.6	24	13.0	87.0	0.52
3	25	7.0	95.1	26	13.0	96.5	0.32
4	26	6.0	101.8	27	12.0	102.2	0.08
5	34	6.0	107.3	34	12.0	111.4	0.72
6	31	6.0	113.5	34	12.0	115.9	0.38
7	39	6.0	120.0	42	12.0	124.5	0.74
8	39	6.0	123.3	40	12.0	129.6	0.85
9	35	6.0	130.8	39	15.0	133.3	0.42
10	41	6.0	135.2	41	15.0	138.8	0.55
11	37	7.0	139.1	39	17.0	147.3	1.14
12	37	7.0	141.8	37	20.0	149.7	1.00
Weighted mean (1–12)							0.64
Mean (11–12)							1.07
				Girls			
1	23	5.0	72.1	23	12.0	75.9	0.69
2	21	5.0	85.6	23	12.0	87.6	0.40
3	19	7.0	93.4	22	12.0	90.3	−0.60
4	28	7.0	98.3	28	12.0	101.5	0.58
5	30	7.0	105.7	32	12.0	106.1	0.07
6	33	7.0	111.6	34	13.0	116.0	0.71
7	34	7.0	118.0	37	14.0	123.4	0.85
8	33	7.0	123.7	34	12.0	126.4	0.44
9	36	7.0	127.8	38	14.0	137.2	1.40
10	36	7.0	134.2	37	15.0	140.8	0.97
11	34	8.0	138.7	37	18.0	146.4	0.97
12	34	8.0	146.4	34	20.0	152.9	0.86
Weighted mean (1–12)							0.68
Mean (11–12)							0.92

[1] I.e., the 15th and 85th percentiles, respectively, for the triceps fatfolds. See text.
[2] Median values for the lean and obese children using the fatfold cut-offs given.
[3] Difference between the median statures of the obese and the lean expressed as standard deviation units relative to the total sample of 4888.

is a large size difference between the 780 obese boys and girls and the 740 lean boys and girls and it is tempting to suggest a causal relationship, i.e., that the stored caloric excess makes for greater linear growth.

As further shown in the single table, there is increasing statural (standing height) divergence between the lean and the obese groupings, from only 3–4 cm at age 1, to 6 cm and more at age 11 and 12. At age 11–12, the lean boys and girls are −0.37 Z (i.e., nearly 0.4 S.D. below stature expectancy). At the same ages, the obese boys and girls — above the 84th percentile for fatness — stand some 0.54 Z above group stature expectancy. At age 11–12, therefore, the obese and the lean boys and girls differ by approximately one standard deviation in stature; though the data are cross-sectional, it is tempting to suggest that the stature effect is cumulative, and much the same in the two sexes.

Clearly the lean boys and girls are below median stature for the group at all ages considered and the obese boys and girls are above median stature for the group at all ages considered, so the "fatness effect" constitutes a continuum, even as early as the first birthday. Moreover, the lean boys and girls are less staturereduced at all ages (−0.2 Z) than the obese boys, and girls are stature increased at the same ages (+0.5 Z), a fact consistent with the positively skewed distribution of the compressed double triceps fatfolds. It is interesting to observe that the sex-specific Z-scored statural differences are similar in both sexes, even though the girls are absolutely fatter (as measured by the triceps fatfolds) throughout.

These new and extensive findings in boys and girls of below-median U.S.A. per-capita incomes are consistent with previous findings from longitudinal study populations and for obese children, but they provide additional quantification, they extend the generalizations down to age 1, and they bring lean boys and girls into the comparison. It may be added that similar trends exist in a separate sample of boys and girls of largely African ancestry (American Negro or "Black") similarly collected and similarly analyzed.

For growth studies in general, it is increasingly evident that stature can not be studied in a vacuum, in the absence of information on the level of fatness. This applies within populations, in comparing different socio-economic or regional groups, or between populations, where different gene pools are often compared without correction for the level of caloric nutrition. This is particularly true when survey populations are compared with previously-collected "norms." Finally, it should be observed that lean boys and girls tend to be below median stature for the group, and far below the stature of obese boys and girls. In this respect, lean boys and girls in the U.S.A. begin to resemble those in underdeveloped countries, and suggest the need for more careful surveillance, just as we are now increasingly concerned with those who are obese.

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