Obesity in schoolchildren

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SUMMARY

In 1971 triceps skinfold thickness was measured in a sample of 6-14-year-old children attending school in Aylesbury, Buckinghamshire. The sample consisted of 1,243 boys and 1,183 girls. In both boys and girls triceps skinfolds tended to increase with age, this being most marked in the girls. If a 25 mm triceps skinfold is taken as indicating obesity, then 32.4% of the 14-year old girls and 3.6% of the 14-year-old boys would be classified as obese. Comparison with the findings of the 1959 study of London schoolchildren suggests that obesity in 14-year-old girls has become more prevalent.

INTRODUCTION

Although obesity is now thought to be a large and increasing problem among schoolchildren in the United Kingdom it is difficult to evaluate this opinion as evidence from epidemiological field surveys of changes in its incidence is lacking.

It is generally agreed that obesity may be defined in terms of an excess of adipose tissue; this can be estimated from measurement of total body fat, but the techniques needed are complicated and do not lend themselves to field surveys. However, an indirect estimate of the proportion of adipose tissue in the body may be derived from the measurement of triceps skinfold thickness. Seltzer, Goldman, and Mayer (1965), in their study of obese adolescent girls, concluded that, of a number of the common anthropometric measurements, the triceps skinfold was the best predictor of body density, and hence the percentage of total body fat. Durnin and Rahaman (1967), in a similar study, examined 48 12 to 15-year-old boys and 38 13 to 16-year-old girls. They concluded that skinfolds, either as the sum of skinfold thickness at several sites or of single sites, predicted body density better than other anthropometric measurements made on the same subjects. The evidence suggests that triceps skinfold thickness is an

adequate index of body density and thus of the percentage of total body fat. The measurement of triceps skinfolds is simple and suitable for use in field surveys. This paper describes the findings from an investigation, using triceps skinfolds as the index of obesity, of the prevalence of obesity in primary and secondary schoolchildren.

METHODS

In 1971 triceps skinfolds were measured in 6 to 14-year-old children attending primary or secondary schools in Aylesbury, Buckinghamshire. This town is situated 40 miles north-west of London and in 1971 had a total population of 40,569. A cluster sampling technique was used to yield a representative population for study of approximately 2,500 children in the age range 6-14 years. Schools were taken as the primary sampling units. These consisted of four primary schools taking 6 to 10-year-olds and three secondary schools taking children from 10 to 15 years old, all situated in the south-western sectors of the town. The primary schools drew children only from the immediate neighbourhood, while the secondary schools also took children from elsewhere in the town and surrounding rural areas. The population sampled consisted of all pupils who were on the school roll and who were 6 to 14 years old at the time of the study. A total of 2,598 children (1,328 boys and 1,270 girls) were eligible. Due to absences (34) and refusals (138) by parents to allow their children to be examined, 2,426 children out of the 2,598 (93.4%) were examined, a satisfactory response rate for a study of this type. Table I lists the population examined by age, sex, and school. For administrative reasons it was not possible to conduct the study within the same school term. Schools 1, 2, 3, 4, and 5 were surveyed during May and June 1971, and schools 6 and 7 in September 1971. The same team of observers examined children in all seven schools. One observer measured height and weight while another measured left arm circumference and left triceps skinfold

thickness using Harpenden skinfold calipers. For the latter measurement the child stood with the left arm hanging freely, the posterolateral border of the left acromion and upper border of the olecranon were identified by palpation, and the distance between these points was measured to the nearest millimetre with a flexible steel rule. A mark was made midway between these two bony points with a felt-tipped pen. A skinfold was pulled out in the vertical plane 2.5 cm above this mark, and with the calipers held horizontally, the jaws were applied so that the ink mark was midway between them. The jaws were then allowed to grip and the skinfold was released. The dial was read to the nearest 0.2 mm below when the indicator had stopped moving, or when the needle changed from the phase of fast movement to slow. The jaws were then released and reapplied and a second reading was made. Both readings were recorded and their mean was used in the analysis.

To avoid systematic bias due to prior knowledge of the child's weight for height, observers measured and recorded the triceps skinfolds without knowing the recorded height and weight.

During the survey six observers made measurements of triceps skinfold thickness. Past experience has shown that between-observer differences for this measurement may be large in relation to other sources of variation (Edwards *et al.*, 1955). In this study, however, systematic differences between the observers in their assessment of triceps skinfolds are small compared with other differences reported later in this paper. For example, the group mean triceps skinfold thickness obtained by observers who measured children of the same sex and age differed by less than 2.5 mm.

RESULTS

Figures 1 and 2 give the distribution of triceps skinfolds in the Aylesbury boys and girls by seven

FIG. 1. Distribution by selected percentiles of triceps skinfold: Aylesbury boys.

different percentiles for each age group. The boys show little change with age in triceps skinfold thickness for percentiles below the 75th. At the 90th percentile and above, triceps skinfold thickness increases with age up to 13 years of age, after which age it diminishes. As a result, the degree of skewness also increases with age to reach a maximum at 13 years of age. In general, the girls show an increase in percentile values of triceps skinfold thickness with age which does not decline in the 14-year-olds. The degree of skewness increases with age until the fourteenth year.

Differences between the sexes in the distribution of skinfold thickness can be seen in Figure 3. Here the frequency distributions of left triceps skinfolds have been plotted for boys and girls who were 6, 8, 10, 12, and 14 years old. At each age the girls' distribution of skinfold is shifted to a higher level than the boys'. This difference is smallest among the 6-year-olds but in each subsequent yearly age

TABLE I
POPULATION EXAMINED BY AGE, SEX, AND SCHOOL

School			Age (years)																			
			6		7		8		9		10		11		12		13		14		All	
			M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1	..	..	56	42	47	33														103	75	
2	..	..	70	57	65	50					1									136	108	
3	..	..			28	19	1													226	244	
4	..	..			21	21	65	76	55	64	43	51	35	34						252	218	
5	..	..					62	43	59	62	68	51	42	41						252	238	
6	..	..											10	20	99	71	95	77	48	70	274	
7	..	..									4		81		101	112	80	91	8	4		300
All	..	..	126	99	161	123	128	119	114	126	115	105	168	186	200	183	175	168	56	74	1,243	1,183

M = male; F = female

FIG. 2. Distribution by selected percentiles of triceps skinfold: Aylesbury girls.

group it increases, so that in the 14-year-olds the distributions have shifted to such an extent that the overlap is small. In the older girls especially, the distributions have a greater range than those of the boys.

DISCUSSION

The distribution of skinfold thickness in the Aylesbury children conforms in general to the expected patterns. In the older girls, however, it is surprising how much the distributions are skewed towards such large skinfolds.

Seltzer *et al.* (1965), in their study of triceps skinfolds as predictors of body density, proposed that adolescent girls with triceps skinfolds of 25 mm and over should be characterized as obese. At this level of triceps skinfold thickness they calculated that body fat accounted for some 38.5% of body weight; in 'normal' children only 28.7% of body weight was fat. If a triceps skinfold thickness of 25 mm or over is taken as indicating obesity, then, as can be seen in Table II, 32.4% of the Aylesbury 14-year-old girls are obese. If a 25 mm triceps skinfold thickness is also taken for the 14-year-old boys as defining obesity, then only 3.6% would be classified as obese. There is, however, no evidence that a 25 mm triceps skinfold thickness in boys has the same value in

FIG. 3. Frequency distribution of left triceps skinfold thickness: Aylesbury children, 1971.

indicating obesity as it does in girls. A similar point can be made about the younger children. In them, due to their different body build and smaller upper limbs, a triceps skinfold thickness of less than 25 mm might indicate a comparable

TABLE II
PROPORTION OF CHILDREN WITH TRICEPS SKINFOLD THICKNESS OVER 20 AND 25 mm BY AGE AND SEX*

Age (years)	Population		Triceps Skinfold Thickness			
			% over 20 mm		% over 25 mm	
	Boys	Girls	Boys	Girls	Boys	Girls
6 ..	126	99	0.0	1.0	0.0	1.0
7 ..	161	123	1.2	1.6	0.6	0.0
8 ..	127	119	0.8	3.4	0.0	0.8
9 ..	114	125	3.5	11.2	0.9	2.4
10 ..	115	105	4.3	16.2	3.5	3.8
11 ..	167	185	7.8	17.3	0.6	7.0
12 ..	200	183	6.5	23.5	3.5	6.0
13 ..	175	168	12.6	29.2	7.4	10.7
14 ..	56	74	3.6	56.8	3.6	32.4
All ..	1,241	1,181	5.0	17.3	2.3	6.4

*Four children with absent triceps skinfold measurements.

level of obesity to that of the older girls. Clinically, many children with triceps skinfold thickness of 20 mm appear obese. If this level is taken to indicate obesity (Table II) 3.5% of the 9-year-old boys and 11.2% of the 9-year-old girls are obese.

Two methodological points are raised by these findings in the girls. First, the high values of triceps skinfolds found in older girls could be an artefact due to systematic observer bias in this measurement. But, as already noted, there is no evidence that there are any other than trivial systematic differences between the observers. Further, these same observers also measured the older boys who have a quite different distribution of skinfolds from the girls.

Secondly, the sample may not be wholly representative of all Aylesbury children. The 1971 census lists 4,055 children aged 5-9 and 3,345 aged 10-14 as being resident in Aylesbury at that time. In the study 966 primary schoolchildren aged 6-9 years were examined, representing at least 25% of children in this age group in the town. We have no reason to suppose that these younger children are not a satisfactory sample of Aylesbury children of this age. The older children do not all reside in Aylesbury; 49.2% of the girls and 47.6% of the boys lived outside the town. The observed patterns of obesity in these children may not therefore be typical of Aylesbury 10 to 14-year-olds. On the other hand, the findings may be typical of children of this age in the town of Aylesbury and the surrounding area.

In the absence of published data from other comparable population studies in the United Kingdom it is uncertain how far the findings in Aylesbury may be typical of the country as a whole. The Aylesbury data can, however, be compared with that collected by the London County Council (LCC) during the examination of schoolchildren in

London in 1959 (Scott, 1961) (Fig. 4). Among boys there is little difference between the Aylesbury (1971) and LCC (1959) skinfold distributions. In contrast, the girls show a marked difference in the distributions at ages over 9 years, in that the Aylesbury girls measured in 1971 have larger skinfolds than the LCC girls measured in 1959.

CONCLUSION

Obesity, as indicated by triceps skinfold thickness over 25 mm, is a highly prevalent condition among 14-year-old girls in Aylesbury. The evidence points to an increase in the prevalence of obesity since the survey among LCC children in 1959. The findings in Aylesbury require confirmation by studies of children elsewhere in the United Kingdom. Should such studies also reveal a high prevalence of obesity, then efforts will be needed on a national scale to develop methods for the identification of obese children and for their treatment. At the same time greater emphasis will need to be placed on the prevention of obesity in infancy and childhood.

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FIG. 4. Frequency distribution of left triceps skinfold thickness: children in Aylesbury, 1971 and LCC, 1959.

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