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Prevalence of obesity in British children born in 1946 and 1958

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Abstract

The prevalence of overweight at ages 7 and 11 years and in late adolescence was compared in two nationally representative cohorts of British children born in 1946 and 1958. Overweight was defined as weight that exceeded the standard weight for height, age, and sex by more than 20% (relative weight > 120%). The prevalence of overweight among 7 year olds born in 1958 was nearly twice that among those born in 1946. Changes in infant feeding practices, food supply, and level of physical activity might be responsible for this difference. By adolescence the prevalence of obesity in both cohorts had increased but the difference between cohorts had almost disappeared. Around 9% of adolescent girls and 7% of adolescent boys were overweight. If infant feeding practices have an influence on prevalence of overweight at 7 years the data from the two cohorts suggest that such an effect does not persist. In neither cohort was there a significant relation between the prevalence of obesity and social class in boys, but in girls the prevalence was higher among those from the lower socioeconomic groups. Correlation coefficients showing the strength of the relation between relative weights at different ages were remarkably similar for both cohorts. The risk of being obese later in childhood for those who had not been obese at the age of 7 was less than one in 10, whereas for those with a relative weight greater than 130% the risk exceeded six in 10.

Most obese adolescents became overweight after the age of 7, which suggests that prevention of obesity after this age might reduce obesity among school leavers and possibly young adults.

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Introduction

Factors that influence the prevalence of obesity during childhood are poorly understood, and it is not known to what extent changes in the environment alter the natural history of obesity. It has been claimed that the prevalence of obesity in childhood has increased over the past decades in association with changes in life style. Two national longitudinal surveys of British children born in 1946[1] and 1958[2] have provided an opportunity of studying the prevalence of obesity in children exposed to different environmental influences in their first years of life. We compared the prevalence of obesity among children born at a time of relative economic affluence with the prevalence among children born during a period of postwar food rationing. We also compared the risk for an overweight 7 year old in these two cohorts of remaining overweight during childhood and adolescence.

Subjects and methods

The National Survey of Health and Development[1] began as an investigation into the social and economic aspects of 13 687 births occurring during the first week in March 1946 in England, Scotland, and Wales. From this original population, excluding all multiple and illegitimate births, a sample consisting of all children whose fathers were non-manual or agricultural workers and a randomly selected one in four sample of children of other manual workers have been followed up at regular intervals from birth. The National Child Development Study[2] is a longitudinal study of all children in England, Scotland, and Wales born in the week 3-9 March 1958. This sample of 16 994 was originally studied at birth and was followed up at ages 7, 11, and 16 years; at each follow up later immigrants to Britain born during the week were incorporated into the study.

To ensure that both cohorts were comparable we excluded data from multiple and illegitimate births and from immigrants in the National Child Development Study (1958). Data from the National Survey of Health and Development (1946) were weighted to adjust for the one in four sampling of children of manual and self employed workers.

In the 1946 study heights and weights were measured at regular intervals including ages 7, 11, and 14½ by school doctors or nurses who were instructed to weigh each child in underclothes. In the 1958 study children were measured, also in underclothes, at ages 7, 11, and 16 as part of their medical examination. Children in both cohorts were measured close to their 7th and 11th birthdays, but there was an average interval of 18 months between the third measurements, taken at 14 years in the 1946 cohort and at 16 years in the 1958 cohort.

The data on the 1958 cohort were edited to eliminate errors of recording and coding as previously described for the 1946 cohort.[3] Data on height and weight that satisfied the inclusion criteria for this study were available for 74% of the cohort born in 1958 at 7 years, 70% at 11 years, and 61% at 16 years. Boys and girls who were 30% or more above standard weight for height at 7 were underrepresented at ages 11 and 16 compared with less overweight 7 year olds. To investigate the possible bias this might have had on the distribution of relative weight at 11 and 16 years we compared the observed distributions of relative weight at these ages with those weighted for non-response. In the category of most overweight boys (relative weight >130%) the difference between the observed and expected value was 0·7; in the remaining groups the differences were negligible.

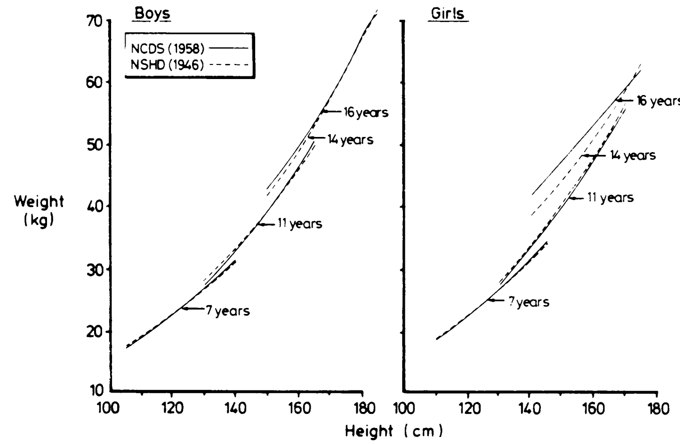

FIG 1—Standards of weight for height in boys and girls.
NCDS=National Child Development Study. NSHD=National Survey of Health and Development.

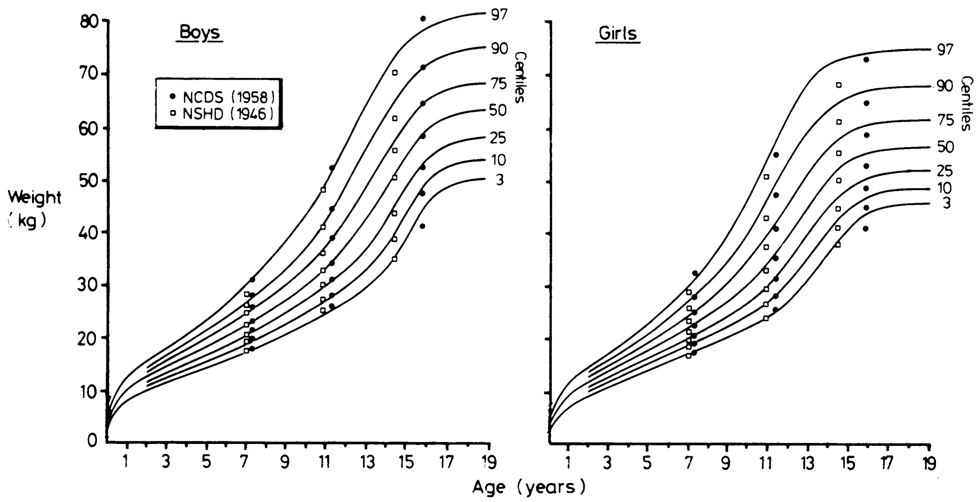

FIG 2—Height centiles for boys and girls. (Continuous lines are centiles from study of Tanner *et al.*[4])

NCDS=National Child Development Study: heights were adjusted for ages 7, 11, and 16. NSHD=National Survey of Health and Development: heights were based on measurements obtained between 7 years and 7 years 2 months, 10 years 10 months and 11 years, and 14 years and 14 years 6 months (mean ages 7·1, 10·9, and 14·5 years).

Data on both height and weight were available for 84% of the cohort born in 1946 at age 7 and 11 years and for 76% at 14 years. The better response rates in this cohort may perhaps be attributed to the greater frequency of contact, and therefore tracing, in this survey. There was no consistent tendency for non-response to be related to degree of overweight, although boys who were severely overweight (relative weight >130%) at the age of 7 yielded a particularly low response at 14. This may have affected the estimated risk of remaining overweight in adolescence in this group but is unlikely to have had an effect on the overall prevalence of obesity at 14.

Assessment of overweight—The method of estimating overweight was similar to that used previously in a study of overweight in the 1946 cohort.[3] An index of relative weight (weight expressed as a percentage of the standard weight for age, height, and sex) was used to express the degree of overweight. Overweight was defined as a weight that exceeded the standard weight by 20%. Although for any person relative weight cannot be regarded as a reliable measure of body fat, it is widely used in epidemiological studies to assess the prevalence of obesity in the population. Standards of weight for height were calculated for each cohort separately using the method previously described[3] (fig 1). Because of the age difference at the third measurement the relative weights used in this report were based on the standard of each cohort.

Results

DISTRIBUTION OF HEIGHT AND WEIGHT

Figure 2 shows height centiles for both cohorts compared with those of Tanner *et al.*[4] They were similar at 7 and 11 years, but the values for the 14 year old children born in 1946 and the 16 year old children born in 1958 were lower than those of Tanner *et al.*

Figure 3 shows weight centiles, for the two cohorts, again compared with those of Tanner *et al.*[4] Children born in 1958 were heavier at 7 years than those born in 1946 and their weight centiles were closer to those of Tanner *et al.* At 11 years both cohorts had similar weight centiles; those for boys were close to but those for girls lower than the centiles of Tanner *et al.* At 14 years boys and girls born in 1946 were lighter than the standard indicated by the centiles of Tanner *et al.* The distribution of weight of boys born in 1958 at 16 years showed greater variance than the centiles of Tanner *et al.*

The distributions of weight and height in the children from both cohorts agreed less well with the centiles of Tanner *et al* at the third measurement than that at earlier ages. Tanner *et al*, however, mentioned[4] that their standard curves were less accurately determined after the age of 15 because the sample size was small; this might explain the difference.

DISTRIBUTION OF RELATIVE WEIGHT

Table I shows the distribution of relative weight at ages 7, 11, 14, and 16 based on each cohort's own standards. In addition, the distribution of relative weight in the 1958 cohort is shown using the standards derived from the 1946 cohort. As it was necessary to use each cohort's own standards at ages 14 and 16 these were used throughout.

The distribution of relative weight at 7 and 11 years had a larger variance in the 1958 than the 1946 cohort. At these ages the difference between cohorts in distribution was highly significant for boys (age 7: $\chi^2_7=89·69$, $p<0·001$; age 11: $\chi^2_7=37·18$, $p<0·001$) In girls the difference in distribution was highly significant at 7 years ($\chi^2_7=80·6$, $p<0·001$) but was less pronounced at 11 years ($\chi^2_7=18·18$, $p<0·05$) and was no longer present at the third measurement at ages 14 and 16. The distributions of relative weight in boys aged 14 and 16 differed ($\chi^2_7=20·02$, $p<0·01$), but this was probably influenced by differences in maturity at these ages.

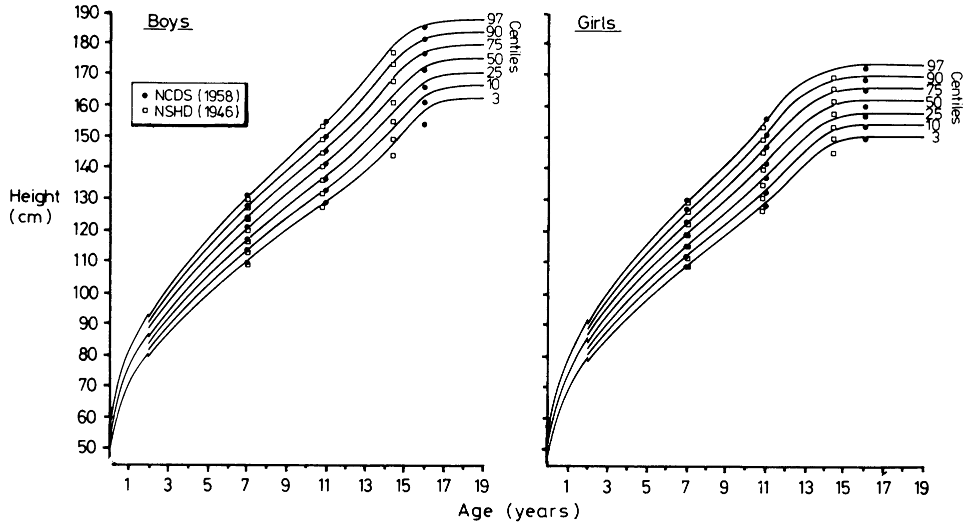

FIG 3—Weight centiles for boys and girls. (Continuous lines are centiles from study of Tanner *et al.*[4])

NCDS = National Child Development Study: weights were plotted at the mean ages at which measurements were carried out (7·3, 11·3, and 15·8 years). NSHD = National Survey of Health and Development: weights were based on measurements obtained between 7 years and 7 years 2 months, 10 years 10 months and 11 years, and 14 years and 14 years 6 months (mean ages 7·1, 10·9, and 14·5 years).

PREVALENCE OF OVERWEIGHT

Table II shows the percentage of overweight and severely overweight children in each cohort. In both cohorts the prevalence of overweight in boys and girls increased between 7 and 11 years. There was no change in the proportion of overweight children in the 1946 cohort between 11 and 14 years, but there was a decline in the prevalence of overweight in girls in the 1958 cohort between 11 and 16 years.

Comparison between the cohorts at 7 years showed that the prevalence of overweight in the 1958 cohort was almost twice that in the 1946 cohort (boys: $\chi^2_1=34\cdot47$, $p<0\cdot001$; girls: $\chi^2_1=32\cdot73$, $p<0\cdot001$). At 11 years this difference was less pronounced and significant only in boys ($\chi^2_1=8\cdot51$, $p<0\cdot01$). By adolescence this difference had almost disappeared and was not significant, even though a higher proportion of adolescent boys in the 1958 cohort than the 1946 cohort had a relative weight greater than 140% ($\chi^2_1=7\cdot05$, $p<0\cdot01$).

The social class groupings in the 1958 cohort were based on the Registrar General's classification of father's occupation. In this cohort the prevalence of overweight was significantly greater among girls from the lower than the higher socioeconomic groups (table III). This social class difference was apparent at 7 years and increased with age. There was no significant relation between social class and prevalence of obesity in boys, although more from the manual than non-manual social classes were overweight. A different classification of social class was used in the 1946 cohort, but at ages 11 and 14 there was again a greater proportion of overweight girls from the lower than the higher social classes. This difference was not apparent at 7 years and was not apparent among boys.

TABLE II—*Prevalence of overweight (relative weight >120%) at different ages*

	Boys		Girls	
Age (years)	NSHD (1946)	NCDS (1958)	NSHD (1946)	NCDS (1958)
7	2·0	4·0	3·8	6·3
11	6·4	7·9	9·6	10·4
14	6·5		9·6	
16		7·4		8·7

NSHD = National Survey of Health and Development. NCDS = National Child Development Study.
Significance of difference between cohorts: At age 7: boys p<0·001, girls p<0·001; at age 11: boys p<0·01, girls NS; at ages 14 and 16: boys and girls NS.

TABLE III—*Prevalence of overweight by social class in 1958 cohort (National Child Development Study)*

	Boys			Girls		
		Manual			Manual	
Age (years)	Non-manual	Class III	Classes IV, V	Non-manual	Class III	Classes IV, V
7	4·0	4·4	3·2	5·4	6·1	7·8
11	6·9	8·1	8·7	8·5	10·9	12·1
16	6·0	7·9	7·6	6·5	8·3	11·0

Boys: 7 years, $\chi^2_2=3\cdot32$, NS; 11 years, $\chi^2_2=3\cdot52$, NS; 16 years, $\chi^2_2=4\cdot90$, NS.
Girls: 7 years, $\chi^2_2=8\cdot42$, $p<0\cdot05$; 11 years, $\chi^2_2=10\cdot32$, $p<0\cdot01$; 16 years, $\chi^2_2=15\cdot38$, $p<0\cdot001$.

TABLE I—*Percentage distribution of relative weight*

	Relative weight (%)								Total No
	≤80	81-90	91-100	101-110	111-120	121-130	131-140	>140	
					Boys				
7 years:									
NSHD (1946)	0·2	7·6	43·2	38·2	8·7	1·5	0·3	0·2	4808*
NCDS (1958)	1·3	8·6	40·7	36·3	9·1	2·5	0·8	0·7	6316
NCDS using NSHD standards	1·2	8·3	40·7	35·8	9·8	2·7	0·8	0·7	6316
11 years:									
NSHD (1946)	1·1	14·6	39·9	28·1	9·9	3·2	2·0	1·2	4858*
NCDS (1958)	1·3	16·4	39·7	24·3	10·4	3·7	2·0	2·1	5792
NCDS using NSHD standards	1·5	18·2	40·4	23·4	9·1	3·4	2·0	2·1	5792
14 years:									
NSHD (1946)	1·0	14·9	37·6	28·5	11·3	4·2	1·4	1·0	4425*
16 years:									
NCDS (1958)	1·6	16·0	36·8	27·2	11·0	3·9	1·9	1·6	5028
					Girls				
7 years:									
NSHD (1946)	0·5	11·7	40·6	33·5	10·0	2·6	0·6	0·7	4593*
NCDS (1958)	1·6	12·9	39·7	29·6	9·9	3·8	1·1	1·4	5865
NCDS using NSHD standards	1·6	12·7	38·0	31·1	10·1	4·0	1·1	1·4	5865
11 years:									
NSHD (1946)	2·9	18·6	33·3	25·4	10·3	4·5	2·5	2·6	4560*
NCDS (1958)	2·9	19·4	33·5	22·4	11·5	5·3	2·7	2·3	5498
NCDS using NSHD standards	3·7	22·0	33·5	21·4	10·1	4·8	2·6	2·1	5498
14 years:									
NSHD (1946)	3·0	18·6	30·2	26·2	12·3	5·4	2·2	2·0	4052*
16 years:									
NCDS (1958)	3·0	17·8	32·5	25·7	12·3	5·1	2·0	1·6	4741

NSHD = National Survey of Health and Development. NCDS = National Child Development Study.
*Weighted numbers.

CORRELATIONS BETWEEN RELATIVE WEIGHTS AT DIFFERENT AGES

The correlation between relative weights at different ages indicates the extent to which relative weight remains stable between the two ages. Table IV shows that the corresponding values of the correlation coefficients were similar in both cohorts. The correlation coefficients for girls were generally higher than those for boys. As expected, the correlation coefficients decreased as the interval between measurements increased. The correlation between birth weight and subsequent relative weight in both sexes was low.

Tables V and VI show the proportion of children in each category of relative weight at 7 and 11 years who were overweight at subsequent measurements. There was close agreement between cohorts in the risk of being overweight at the next measurement for children in all but the overweight categories. In these categories the risk was higher for the children in the 1946 than the 1958 cohort. The estimated risk was probably more reliable for children in the 1958 cohort as the number of children actually measured in the extreme groups was larger than in the 1946 cohort, in which numbers were weighted. In the 1958 cohort eight in 10 children who had been severely overweight at 7 years (30% or more above the standard for height) were overweight at 11 years and six in 10 were overweight at 16 years.

Having established the risk of overweight children remaining overweight we reversed the direction of the analysis. Table VII shows the distributions of relative weight at 7 and 11 years for boys and girls who had a relative weight greater than 120% at 14 or 16 years. Over 40% of them had not been overweight at 11 years and roughly three quarters had not been overweight at 7 years.

TABLE IV—*Correlations between birth weight and relative weights at various ages*

	Boys			Girls		
	7 years	11 years	14 or 16 years	7 years	11 years	14 or 16 years
	National Survey of Health and Development (1946)					
Birth	0·15	0·11	0·11	0·16	0·11	0·11
7 years		0·62	0·52		0·69	0·59
11 years			0·73			0·74
	National Child Development Study (1958)					
Birth	0·05	0·02	0·04	0·02	0·02	0·01
7 years		0·61	0·49		0·64	0·55
11 years			0·73			0·68

Discussion

Comparison of the weight status of schoolchildren born in 1946 and 1958 showed that although fewer of the children born in 1946 were overweight at 7 years, the difference between the two populations had become less pronounced at 11 and had almost disappeared at 14 to 16 years. An explanation for this difference in the prevalence of obesity at 7 years may be that the nutrition of the 1946 cohort was influenced by food rationing, which continued after the war until 1954. Hollingsworth noted that by 1954 the nutritional value of the national diet appeared to have reached a peak and subsequently remained stable.[5] Thus during the first 7 years of life the 1958 cohort may possibly have had a higher energy intake than the 1946 one, but by the time each cohort had reached the second decade of life there was probably little, if any, difference in the national diet.

Infant feeding practices changed considerably between 1946 and 1958. In 1944, 1000 tons of canned, strained baby food was distributed, and by 1958 this had increased to 10 000.[5] Though it has been suggested that bottle feeding and the early introduction of solids[6-8] may be associated with a higher prevalence of obesity in infancy and later life, other studies[9-11] do not confirm such an association. Detailed information about infant feeding is not available for either cohort, but bottle feeding and the early addi-

TABLE V—*Prevalence of overweight (relative weight >120%) according to relative weight at age 7*

Relative weight at age 7 (%)	% of boys overweight at age:				% of girls overweight at age:			
	11		14	16	11		14	16
	NSHD (1946)	NCDS (1958)	(NSHD)	(NCDS)	NSHD (1946)	NCDS (1958)	(NSHD)	(NCDS)
≤80						(4)*		(10)†
81-100	1	1	2	2	2	2	2	2
101-120	10	9	10	10	13	14	13	12
121-130	61	55	46	36	56	52	43	39
>130	100	85	90	63	100	80	87	62

NSHD = National Survey of Health and Development. NCDS = National Child Development Study.
*Two children. †Five children.

TABLE VI—*Prevalence of overweight (relative weight >120%) according to relative weight at age 11*

Relative weight at age 11 (%)	% of boys overweight at age:		% of girls overweight at age:	
	14 (NSHD)	16 (NCDS)	14 (NSHD)	16 (NCDS)
≤80				
81-100	0·5	0·8	1	1
101-120	8	5	9	9
121-130	37	43	53	40
>130	78	70	76	65

NSHD = National Survey of Health and Development (1946). NCDS = National Child Development Study (1958).

TABLE VII—*Distribution (%) of relative weight at earlier ages of overweight adolescents*

Relative weight (%) at 14 or 16 years	Boys*				Girls*			
	Age 7		Age 11		Age 7		Age 11	
	NSHD (1946)	NCDS (1958)	NSHD (1946)	NCDS (1958)	NSHD (1946)	NCDS (1958)	NSHD (1946)	NCDS (1958)
≤80		1		0·5		2		
81-90		2		1	1	2		
91-100	16	9	3	6	12	12	4	6
101-110	40	36	19	8	35	30	18	13
111-120	29	30	30	28	27	25	15	22
121-130	11	13	16	21	13	14	25	25
131-140	2	5	19	14	6	6	14	16
>140	2	5	14	21	6	9	24	17

NSHD = National Survey of Health and Development. NCDS = National Child Development Study.
*NSHD (1946): 256 boys and 335 girls (weighted numbers); were overweight at 14 and their weights at 7 were available; 263 boys and 370 girls (weighted numbers) were overweight at 14 and their weights at 11 were available.
NCDS (1958): 257 boys and 293 girls were overweight at 16 and their weights at 7 and 11 were available.

tion of solids were probably more common among the children born in 1958 than among those born in 1946, and such differences in infant feeding may also have contributed to the higher prevalence of overweight among the 7 year old children in the 1958 cohort. If infant feeding practices have an effect on the prevalence of overweight at the age of 7 the data from the two cohorts suggest that such an effect is no longer present at the age of 14-16.

Decreased physical activity may also have contributed to the higher prevalence of overweight in the 7 year olds in the 1958 cohort. The large increase in the use of private vehicles since the 1950s, coinciding with a decline in the use of public transport,[12] may have influenced physical activity, and children born in 1958 may have been less active in their early childhood than those born in 1946.

Colley found that obesity in adolescent girls increased between 1959 and 1971 whereas there was little change in boys.[13] He used skinfold thickness as a measure of obesity and compared children measured in Aylesbury in 1971 with London children measured in 1959. Colley's data cannot be compared with those on these two cohorts because for them measurements of skinfold thickness were not obtained. Neither can trends in the prevalence of obesity in childhood and adolescence over a longer period of time be determined because relevant epidemiological data for children in the United Kingdom are scarce. Khosla and Lowe, reviewing four studies of adult male populations between 1930 and 1965, suggested that the adult population was becoming progressively more obese.[14] In view of this finding and of reports of increasing weight gain during infancy, the similarity between the cohorts, except at the age of 7, was unexpected.

In both cohorts there were more overweight girls than boys and the prevalence of obesity in both sexes increased between 7 and 11 years but varied little during adolescence. A study of children from Uppsala,[15] using similar criteria for the definition of overweight, also found a higher prevalence of overweight among girls. The prevalence of overweight among the Swedish schoolchildren was similar to that among the 7 year olds in the 1946 British cohort but was lower at 11 years. A more detailed comparison including eating habits and physical activity might help to explain why British children of 11 have a higher prevalence of overweight than Swedish children and to clarify our understanding of factors that contribute to the development of obesity in childhood.

The high prevalence of obesity in the two British cohorts underlines the need for more effective prevention and early treatment of children who are gaining excessive weight. The finding that 70% of overweight adolescents had not been overweight at 7 years suggests that preventive measures applied during school years might theoretically reduce the prevalence of overweight in adolescence.

In boys no relation was found between social class and prevalence of overweight, but in girls there was a higher prevalence among those from lower socioeconomic groups. Baird *et al*, in a study of London adults, also found striking differences in the prevalence of obesity between women of different social classes.[16] This relation between social class and overweight, however, is not found in all studies, possibly because different criteria are used for the definition of obesity and for the classification of social class. Hammond measured skinfold thickness in 3000 English boys aged 5-15 and divided them into three social categories.[17] The mean skinfold thickness was greatest in the highest social group and lowest in the lowest social group. Whitelaw measured skinfold thickness in 1120 London schoolboys aged 5-15 and found a trend towards increasing prevalence of obesity in the lower social groups.[15] In New York City Stunkard *et al*, using skinfold thickness as a measure of obesity, found a higher prevalence of obesity in girls from the lower class; similar but less striking differences were observed in boys.[19] Garn *et al* on the other hand, also using skinfold thickness, showed that boys and girls from low income groups were slightly leaner than those from high income groups, but that after puberty this was reversed.[20] Cook *et al* and Durnin *et al* found no evidence of an association between energy intake and social class in British children,[21 22] which suggests that variations in the prevalence of obesity among social classes in girls are probably not explained by differences in energy intake. It is not clear why this social class influence in girls was apparent earlier in the 1958 cohort than in the 1946 cohort, or why the prevalence of overweight in boys in this study seems to have been influenced less by social differences. More information on patterns of physical activity in boys and girls and attitudes to body image may help to answer this.

Although overweight children have an increased risk of being overweight adolescents compared with children of normal weight, the magnitude of this risk has not been defined previously for a British population. Longitudinal data from the two cohorts made an assessment of the risk possible and showed that severely overweight 7 year old children are likely to remain overweight throughout childhood. Nevertheless, most obese adolescents were not overweight in childhood. In other words, though the risk of becoming overweight is low for an individual 7 year old child of normal weight, it is from this group, which accounts for most 7 year olds, that most obese adolescents come. Thus one in 20 girls and one in 25 boys who had a normal weight (relative weight 91-110%) at 7 years were overweight at 11 years whereas the corresponding risk for Swedish children[15] was only one in 100.

The finding that nearly 3% of boys and 4% of girls had a relative weight greater than 130% during adolescence is disturbing. Baird *et al*[16] found a similar prevalence of severe overweight among a group of Londoners aged 15-29.[18] Such a degree of obesity in adults is associated with increased morbidity and mortality, but it is not yet known whether childhood obesity is also associated with a higher incidence later in life of diseases related to obesity. Since overweight children are at high risk of becoming overweight adults they would probably suffer more from these disorders than children who are not overweight. Further follow up of these two cohorts should confirm whether there is an association between childhood obesity and adult morbidity.

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Role of carcinoembryonic antigen in detection of asymptomatic disseminated disease in colorectal carcinoma

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Abstract

Fifty one patients were studied prospectively to evaluate the role of sequential determinations of the carcinoembryonic antigen concentration in the detection of asymptomatic disseminated disease after curative resection for colorectal carcinoma. Computed tomography of the liver was performed during the immediate postoperative period in all patients. Serum concentrations of the antigen were estimated at three month intervals for a minimum of two years.

Computed tomography at the time of operation detected occult hepatic metastases in 12 patients. Of the remaining 39 patients, six developed local recurrence alone, two developed disseminated disease in the absence of hepatic metastases, and one developed hepatic disease at 10 months, as detected by sequential computed tomography. Of all 13 patients with asymptomatic hepatic metastases, only eight developed an increase in serum carcinoembryonic antigen concentrations before death. The median interval between detection by computed tomography and rise in antigen concentration was 7·5 months. The corresponding median interval from increase in concentration to death was only 5·5 months. Of the six patients who developed local recurrence alone, only two had raised concentrations of the antigen.

These results suggest that increase in the serum carcinoembryonic antigen concentration occurs late in colorectal carcinoma.

Introduction

The role of carcinoembryonic antigen as a marker in the management of colorectal carcinoma has recently been reviewed.[1] It was concluded that sequential assay of plasma concentrations of the antigen was the best non-invasive technique available for the early detection of asymptomatic recurrence after apparently curative resection of colorectal carcinoma.

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Those observations were based on studies in which increased concentrations of the antigen occurred before clinical detection of recurrent disseminated disease.[2-4]

We reported that 29% of patients undergoing apparently curative resection for colorectal carcinoma had occult hepatic metastases which could be detected by computed tomography.[5] The presence of these metastases accounted for 88% of deaths within three years of surgery.[6] The ability to detect occult disseminated disease at the time of laparotomy provides a unique opportunity to re-evaluate the role of sequential estimations of carcinoembryonic antigen in the detection of asymptomatic disseminated disease.

Patients and methods

We studied 51 consecutive patients surviving apparently curative resection for colorectal carcinoma. Liver ultrasonography and computed tomography were performed during the immediate postoperative period in all patients. On the basis of these investigations patients were considered to have a disease free liver or to have occult hepatic metastases (hepatic metastases not detected by the surgeon). The accuracy of the initial hepatic scans was confirmed by progressive enlargement of lesions on sequential scans during follow up. This procedure has been fully described.[5]

All patients were reviewed one month after operation and at three month intervals thereafter for a minimum of 24 months (range 24-48 months) or until death. Blood was obtained for estimation of the carcinoembryonic antigen value at each visit. These assays were performed by a double antibody radioimmunoassay on unextracted serum.[7] The upper limit of normal (25 μg/l) was based on a study of normal people previously undertaken at this hospital.

All patients underwent careful clinical and radiological follow up. Sequential hepatic scanning was performed in those patients who had had an initial positive or equivocal scan. In addition, sequential hepatic scanning, barium enema examination, and sigmoidoscopy were performed when clinically indicated and in all patients whose serum concentration of carcinoembryonic antigen began to rise. All surviving patients underwent routine hepatic scanning two years after surgery.

Of the 51 patients studied, 39 were considered to have a disease free liver on the basis of hepatic scanning at the time of surgery. Thirty of these patients remained clinically and radiologically free of disease throughout the study. Six patients developed local recurrence alone, one of whom died during follow up. Two patients developed disseminated disease in the absence of hepatic metastases. Both of these died during follow up and necropsy confirmed absence of disease in the liver. In one of the 39 patients considered to have a disease free liver at the time of surgery hepatic metastases were detected by sequential computed tomography at 10 months. This patient subsequently died 32 months after surgery.