PLASMA LIPID VALUES IN CHILDHOOD OBESITY

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SYNOPSIS

A study was made on 129 obese children to assess the relation of fasting plasma concentrations of cholesterol and triglyceride with clinical features of obesity.

Mean values for both plasma cholesterol (195 mg/dl) and triglyceride (77 mg/dl) did not differ from those found in non-obese children. Greater than expected numbers of children however were found with raised values of either cholesterol or triglyceride. Three children were found to have familial Type II hyperlipoproteinaemia, and eighteen were found to have a fasting triglyceride of greater than 120 mg/dl. No correlation was found between plasma cholesterol values and clinical features of obesity, but significant correlation was found between plasma triglyceride values and degree and duration of obesity, particularly amongst those children whose obesity started after the first year of life.

The association of obesity with increased incidence of ischaemic heart disease has been established in a number of studies. The Framingham Study Report of 1967 (Kannel et al., 1967) showed that antecedent relative weight and weight gain after age 25 years, were strongly related to risk of subsequent angina pectoris and sudden death from ischaemic heart disease (I.H.D.). Obesity was shown to be an independent factor in influencing rate of development of I.H.D. in men. In women, obesity was significantly related only when associated with hypertension and hypercholesterolaemia. The independent association of raised serum cholesterol levels and I.H.D. in men was also established in the Framingham Study. Obesity has been shown to be associated with raised serum levels of cholesterol and triglyceride, but studies have been largely confined to adults. (Hollister et al., 1964, Nestel and Monger 1967 and 1968, Jackson et al., 1971). Fosbrooke et al., (1971) reported a study of fifteen grossly obese children with normal plasma cholesterol and triglyceride values.

The purpose of this paper is to report fasting plasma values of cholesterol and triglyceride in a group of obese children, in order to assess the relationship of obesity and plasma lipid values in those individuals whose obesity commenced early in life. It was hoped also to establish a range of fasting plasma lipid values in this age group of obese children so that observations on individual obese children may be more easily evaluated.

MATERIAL

129 obese children were studied. Of these, 101 were children with substantial obesity who had been referred to the Obesity Research Clinic, Royal Children's Hospital, Melbourne. 28 children had developed obesity secondary to physical inactivity due to a variety of neuromuscular disorders. These included muscular dystrophy, meningomyelocele and brain and spinal cord damage due to trauma, anoxia or infection.

Degree of obesity was measured by skinfold thicknesses at multiple sites using the Harpenden skinfold caliper.

Degree of overweight, expressed as a percentage of actual weight in excess of expected
weight for height and age (Tanner et al., 1966) ranged from 20% to 176% with a mean of 60% overweight. Children with neuromuscular disorders could not be assessed for degree of overweight in this way, as growth failure was common. All children had triceps and subscapular skinfold thickness measurements above the 90 centile for age and sex (Tanner and Whitehouse, 1962) and most were greatly in excess of the 97 centile. Duration of obesity was from 2-15 years. All had become obese in the childhood years before puberty, and a third had developed obesity in the first 2 years of life. Age at time of study ranged from 2 to 17 years. There were 59 boys and 70 girls.

Forty-five non-obese children aged 2 to 17 years in good health had fasting plasma samples taken as an index of normal control values.

METHODS

A sample of venous blood was taken after an overnight fast of 11 to 13 hours. Diet had been unrestricted for the preceding three days. Blood in almost all cases was placed in a heparinized tube and plasma was immediately separated. Lipoprotein electrophoresis on paper was carried out on fresh plasma, and the remainder was frozen for subsequent estimation of lipid values.

Plasma cholesterol was estimated by modification of the method of Searcy and Berquist (1960). Plasma triglyceride was estimated by method of Van Handel and Zilversmit (1957) and lipoprotein paper electrophoresis was by the method of Lees and Hatch (1963).

RESULTS

Fasting Plasma Cholesterol Values

The mean value of fasting plasma cholesterol for the group was 195 ± 47 mg/dl (mean ± 1 S.D.). Frequency distribution of values is shown in Figure 1. Ten children had values greater than 250 mg/dl, and of these, 3 values were greater than 300 mg/dl. Family studies and lipoprotein electrophoresis suggested that these 3 children had familial Type II hyper-
lipoproteinaemia of Fredrickson's classification (Fredrickson 1967). Ages of those children with plasma cholesterol values greater than 250 mg/dl were evenly distributed within a range of 8 to 17 years.

Mean value of fasting plasma cholesterol of the normal children studied was 183 ± 40 mg/dl (mean ± 1 S.D.).

**Fasting Plasma Triglyceride Values**

The mean value of fasting plasma triglyceride was 77 mg/dl (23-159 mg/dl, 95% limits). The marked skew distribution of values is shown in Figure 2. Eighteen children had values greater than 120 mg/dl associated with markedly increased density of pre beta lipoprotein bands on electrophoresis. No chylomicron fraction was evident in any plasma sample. The ages of these 18 children with raised triglyceride values ranged from 9 to 15 years and 16 were aged 12 years or more. Family studies were made on 6 of these children, and 5 of these had at least one first degree relative who had a marked pre beta lipoprotein band and hypertriglyceridaemia.

Mean value of fasting plasma triglyceride for the normal children studied was 73 mg/dl (40-123 mg/dl, 95% limits). Only one child had a value greater than 120 mg/dl, and skew distribution of values for the group was less apparent than for the obese group.

**Figure 2. Distribution of plasma triglyceride values.**

No correlation was found between fasting plasma cholesterol values and the degree of obesity as judged either by percentage overweight or subscapular skinfold thickness values. No correlation was found between cholesterol values and duration of obesity or the age of the child.

On the other hand correlation was found between plasma triglyceride and subscapular skinfold thickness values (r = .42, p < .001). Logarithmic transformation was applied to both
triglyceride and skinfold thickness values to overcome the skew distribution of results.

Some correlation was also found between plasma triglyceride values after logarithmic transformation and the duration of obesity ($r = .35, p < .05$). This correlation was found to apply more strongly ($r = .62, p < .001$) if only those children whose obesity dated from after the first year of life were considered ($n = 71$). Amongst those children who developed obesity in the first year of life, a substantial proportion had low triglyceride values unrelated either to duration or degree of their obesity, and irrespective of the age at which they were studied.

**DISCUSSION**

In this study mean values for cholesterol for both normal and obese groups was similar to those reported by Clarke et al. (1970) for American school children and by Hill for Australian school children (personal communication) and median values reported by Godfrey et al. (1972) for Western Australian school children.

A correlation between obesity and plasma cholesterol concentration has been reported in adults (Albrink and Meigs 1964, Hollister et al., 1967). No such correlation was found in our study between skinfold thickness and cholesterol values, but a greater than expected number of elevated values were found amongst the obese children. Clarke et al. (1970) also found the highest values of cholesterol tended to occur amongst the overweight boys in his study. Hames and Greenberg (1961) in a study of 1400 children showed some correlation between cholesterol values and weight adjusted for height and age in girls between the ages of 6 to 11 years, but not in boys.

The finding of 3 children with familial hypercholesterolaemia was perhaps surprising, as the incidence of Type II hyperlipoproteinemia has been quoted as 1 in 200 (Glueck et al., 1971). Godfrey et al. (1972) reported 2 children with cholesterol levels greater than 300 mg% in his report on 929 children. Harlan et al. (1967) in a study of an adult population suggested the incidence of familial hypercholesterolaemia however was 1.4%. An association of Type II hyperlipoproteinaemia and obesity has not been established and in our studies it may well be coincidental.

The mean value for fasting plasma triglyceride concentrations of obese children was not different from the normal children tested, nor from results reported on normal young adults by Carlson and Lindstedt (1969). The obese group was however characterised by a substantial number of children with high concentrations of endogenous triglyceride associated with prominent pre beta lipoprotein bands on electrophoresis. These high values were found amongst the older children and particularly those whose obesity had started some time after infancy. Ford et al. (1968) have suggested that "acquired" rather than "constitutional" obesity was associated with hypertriglyceridaemia, and our findings would be compatible with such a proposition. The finding of some correlation between degree of obesity (judged by skinfold thickness measurements) and triglyceride values is compatible also with the proposition that large fat cells are related to metabolic disturbance associated with obesity (Bjorntorp and Sjostrom 1971). Harlan et al. (1967) also related raised levels of triglyceride to acquired obesity and carbohydrate intolerance. This association of impaired glucose tolerance with raised triglyceride values was also documented in adults by Albrink and Meigs in 1964. We have previously shown a significant correlation between glucose tolerance and fasting plasma glycerol values (Court et al., 1971) and have also found amongst this group an association between raised triglyceride values and abnormal glucose tolerance in all but the children whose obesity dated from infancy (unpublished data).

Thus it would appear that obese children as a group have fasting plasma lipid values comparable with the non-obese population, but a higher than expected number of them have raised values of cholesterol or triglyceride concentrations.

**REFERENCES**

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**JOURNAL OF PAEDIATRIC RADIOLOGY**

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Bill Caldicott