Diet and serum cholesterol

An Australian family study

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SUMMARY Dietary intake patterns were studied in families in Busselton, Western Australia, known to have mothers and children with high, median, or low serum cholesterol values. There were no significant differences in the percentage contributions to total daily calories by protein, fat, or carbohydrate in mothers, children, or their families from these three groups. The results support the view that diet, *per se*, does not account for differences in observed serum cholesterol levels within a culturally homogeneous community.

It has been clearly established that hypercholesterolaemia is associated with an increased risk of early coronary artery disease (Kannel *et al.*, 1971) and that it is one of the main coronary risk factors. It has also been shown that atherosclerosis, the precursor of coronary heart disease, may originate in childhood (Holman *et al.*, 1958) and is present in many individuals in the second decade of life (Enos *et al.*, 1955). However, controversy still exists about the relative contributions of various factors to this problem, including the intake of dietary cholesterol, to the development of subsequent coronary events (Palmer, 1975).

The serum cholesterol levels of schoolchildren aged between 6 and 17 years have been measured at regular intervals as part of the population studies of the town of Busselton, Western Australia. A study of serum cholesterol levels of 929 children in that community and those of their parents showed a significant correlation between parents and children throughout a wide range of cholesterol values (Godfrey *et al.*, 1972). The children's serum cholesterol levels were more closely related to those of their mothers than of their fathers. It was suggested by Godfrey *et al.* that the role of the mothers in controlling the family diet, particularly that of younger children, might explain this closer relationship and therefore be important in the subsequent development of coronary artery disease.

The present study was designed to determine whether any differences in food consumption patterns exist among families in Busselton which might influence the level of child-mother serum cholesterol values observed there.

Subjects and methods

Busselton is a coastal town about 200 km south of Perth, the capital city of Western Australia. Since 1966 the inhabitants of the town, numbering approximately 7000, have co-operated in a population study initiated and sustained by a local medical practitioner, Dr. K. J. Cullen. Further details of the community and the population studies are given by Curnow *et al.* (1969).

Three groups were selected for study. The basis for their selection was the serum cholesterol level of mother and child.*

'High' cholesterol group: child and mother with serum cholesterol >240 mg/100 ml (6.21 mmol/l) (12 mothers and 15 children).

'Median' cholesterol group: child with serum cholesterol of 150-200 mg/100 ml (3.89-5.18 mmol/l) and mother with serum cholesterol falling within the range 200-240 mg/100 ml (5.18-6.23 mmol/l) (13 mothers and 21 children).

'Low' cholesterol group: child with serum cholesterol <150 mg/100 ml (3.89 mmol/l) and mother with cholesterol <200 mg/100 ml (5.18 mmol/l) (16 mothers and 22 children).

The food consumption patterns of the three groups

*The lowest and highest 5% and the median serum cholesterol levels observed by Godfrey *et al.* (1972) were used to select high, low, and median children's levels for these groups. The levels of maternal cholesterol rated as high, median, or low, have been selected on the basis of risk of ischaemic heart disease (Wynn, 1967). Dietary inquiries indicated that there had been no significant alterations in eating patterns in the 6 months between late 1973 when the serum cholesterol values were obtained and early 1974 when data on nutrient intake were collected.

were compared. In addition, the food consumption of the families to which the index mothers and child or children belonged were compared to determine whether any differences in patterns of consumption existed between the index mother and child or children and the family as a whole.

All members of the families of the three groups kept a 24-hour record in household measures of all food and fluids consumed. The mothers in these families also provided details of birthweights of children and the type and duration of infant feeding, and what changes, if any, had been made in the diet of any individual member or of the family as a result of investigations during any of the population surveys. Heights and weights, recorded at the same time as blood samples were taken for serum cholesterol estimations, were obtained from the Busselton Population Survey records. Body weights of mothers were assessed according to their percentage of ideal weight for height (Jelliffe, 1966). Because many of the children were approaching puberty, their body weights were assessed as percentages of weight for height for age (Jelliffe, 1966). Calculation of nutrient intakes using a computer programed for this purpose was done at the Western Australian Institute of Technology from Table III of *Tables of Composition of Australian Foods* (Thomas and Corde, 1970).

Results

Diet. There were no significant differences in the percentage contribution to total daily dietary calories by protein, fat, or carbohydrate in mothers or children from the high, median, or low cholesterol groups (Tables 1, 2). Similarly, there were no

Table 1 *Percentage of total daily calories from protein, fat, and carbohydrate in Busselton mothers**

	Percentage from protein	Percentage from fat	Percentage from carbohydrate
'High' cholesterol group (n = 12)	13.8 ± 2.8 (9.5–17.6)	39.7 ± 5.3 (34.8–49.9)	46.5 ± 6.5 (34.5–52.6)
'Median' cholesterol group (n = 13)	16.4 ± 3.9 (11.5–25.0)	42.4 ± 5.9 (28.7–53.0)	41.2 ± 8.4 (25.1–59.8)
'Low' cholesterol group (n = 16)	15.2 ± 4.1 (10.2–26.0)	40.0 ± 11.8 (12.2–58.7)	44.8 ± 13.2 (27.7–77.6)

*Tables 1, 2, 3, and 5, results given as means ± SD, with ranges in parentheses.

significant differences in the percentage contribution to total daily caloric intakes by these nutrients in the families from the three groups (Table 3).

Although 9 of the 41 families claimed to have made some dietary changes aimed at lowering high cholesterol levels, in fact the dietary data indicated

Table 2 *Percentage of total daily dietary calories from protein, fat, and carbohydrate in Busselton children*

	Percentage from protein	Percentage from fat	Percentage from carbohydrate
'High' cholesterol group (n = 15)	13.7 ± 2.6 (9.4–17.7)	35.4 ± 5.5 (26.6–45.3)	50.9 ± 6.6 (39.3–61.6)
'Median' cholesterol group (n = 21)	13.6 ± 2.6 (10.2–20.4)	39.7 ± 6.3 (30.5–53.6)	46.7 ± 7.1 (29.8–59.1)
'Low' cholesterol group (n = 22)	13.0 ± 2.3 (10.3–18.7)	37.0 ± 5.7 (27.5–50.2)	50.0 ± 6.1 (35.7–61.5)

Table 3 *Percentage of total daily dietary calories from protein, fat, and carbohydrate in Busselton families*

	Percentage from protein	Percentage from fat	Percentage from carbohydrate
'High' cholesterol group (n = 12)	13.0 ± 2.6 (10.2–19.4)	38.3 ± 4.5 (29.4–45.6)	48.7 ± 6.0 (36.2–59.5)
'Median' cholesterol group (n = 12)	14.0 ± 1.7 (10.8–16.8)	39.7 ± 4.5 (29.0–45.1)	46.3 ± 5.7 (38.8–60.2)
'Low' cholesterol group (n = 16)	13.7 ± 2.2 (10.6–18.4)	37.9 ± 7.6 (28.2–55.1)	48.4 ± 8.5 (32.5–59.2)

that none adhered to such a diet. For example, in many cases the only change made was to use occasionally polyunsaturated margarine to replace butter for spreading.

Weight. No subjects were less than 85% of the anthropometric weight standards used (Table 4). 7 of the 41 mothers (17%) were obese, i.e. >120% of

Table 4 *Body weights of index mothers and children*

	Percentage of ideal weight/height of mothers		
	<80	80–120	>120
'High' cholesterol group (12)	0	10	2
'Median' cholesterol group (13)	0	10	3
'Low' cholesterol group (16)	0	14	2

	Percentage of ideal weight/height/age of children		
	<80	80–120	>120
'High' cholesterol group (15)	0	14	1
'Median' cholesterol group (21)	0	18	3
'Low' cholesterol group (22)	0	20	2

ideal weight for age. 6 of the 58 children (10%) were more than 120% of ideal weight for height for age. None of the children in the 'high' or 'low' cholesterol group was more than 125% of ideal weight for height for age. 3 children in the 'median' cholesterol group were above 125% of weight for height for age and had mothers over 125% of their weight for height.

Table 5 *Incidence and duration of breast feeding*

	No. of children	Birthweight (kg)	No. breastfed > 1 month	Duration of breast-feeding (m)		
				1-3	3-6	>6
'High' cholesterol group						
Index children	15	3.1±0.5 (2.4-3.8)	12 (80%)	5	5	2
'Median' cholesterol group						
Index children	21	3.2±0.4 (2.5-4.1)	19 (90.4%)	9	3	7
'Low' cholesterol group						
Index children	22	3.4±0.5 (2.5-4.7)	18 (81.8%)	10	3	5

Infant feeding. Most index children in the sample had been breast fed for one month or longer. Table 5 gives the incidence and duration of breast feeding in these children, and birthweights. Cows' milk and Lactogen were the most commonly used formulae for feeding infants; this was so for infants who had been breast fed for a short time before being changed to formulae, as well as those who were formula fed from birth. Unsweetened evaporated milk or the proprietary formulae S26 (Nestlé) or SMA (Wyeth) were rarely used, and then only for infants of less than 3 months.

Solids were usually introduced at 3-4 months in each group, though some mothers introduced cereals as early as 6-8 weeks. 'Baby' rice (Heinz) and Farex (Glaxo-Allenbury) were the most common first solids introduced, with the later addition of broths, vegetables, and fruits in no particular order.

Discussion

Food patterns are formed at an early age. Traditionally they are transmitted from parent to child. In the Australian nuclear family, the mother, through her role in child care and in preparing food for the family, is obviously a key figure in this transmission.

The pattern of eating by Australians, and the kinds of food which formed this pattern were based largely on those of England, Scotland, and Ireland from where the majority of the early immigrants came. On to this basic pattern have been grafted changes necessitated in early Australia by a limited availability of foods, and in more recent years by the changing pattern of Australian life, the greater heterogeneity of the Australian population through migration, and by the promotion of the food in-

dustry. The magnitude of any changes wrought in family food patterns by such environmental factors as these remains a matter for conjecture. However, with such a common cultural background,* it is not surprising that the food consumption patterns of the family groups, and of the index mother/child group, should be similar.

The main sources of protein in all groups were flesh products (meat, fish, chicken), milk, and eggs. Almost all fat was obtained from animal sources such as eggs, milk, cheese, meat, fish, chicken, cream, butter, or from monounsaturated oils, such as olive oil. Less, often far less, than 10 g of fat per day was derived from other than animal sources such as cereals. Few people used polyunsaturated fats in preference to saturated. Carbohydrate in all family diets was contributed by a variety of foods, including vegetables, fruits, cereals, refined sugar, and products which contained refined sugar.

Human breast milk is known to be higher in cholesterol than commercial infant formulae or those based on cows' milk. The question of whether a cholesterol challenge is required in infancy in order to induce the normal metabolic pathways which regulate cholesterol metabolism has been suggested (Laird, 1975) and is interesting in view of the decline in breast feeding in Western communities over recent years. However, after studying the serum cholesterol levels of breast- and bottle-fed children, Friedman and Goldberg (1975) concluded that breast feeding offered no protection against high serum cholesterol later in life. Our own study of Busselton children indicates a high incidence of breast feeding in all groups, irrespective of later cholesterol levels.

Obesity is recognized as a coronary risk factor. However, not all obese people have raised serum lipids (Palmer, 1975). Nor was obesity (>120% of ideal body weight) any more a feature of mothers or children with high cholesterol levels than of those with low or median levels in the present study (see Table 4).

*Recent (1975) Busselton Population Studies data show that 95% of adults living there were born either in Western Australia, other parts of Australia, or the United Kingdom. Nearly 90% of adults had one or both parents with these origins.

Correlation between habitual diet and average serum cholesterol levels is good between contrasting populations (Keys, 1970). However, within a given culture, people eating the same kind of food can have different serum lipids (Blackburn, 1976). Those who develop coronary heart disease do not necessarily eat differently from those who do not (Finegan *et al.*, 1968, 1969; Committee on Diet and Heart Diseases, 1974).

Blackburn (1976) suggests two reasons why correlations between diet and serum cholesterol levels are weak within a given culture. One of these is the relative homogeneity of a national diet. The common origins of a large percentage of the Busselton population, and the varieties of foods used by the families in the study support this.

The second is the measuring tool. Most methods of dietary assessment measure either current dietary habits and food consumption, or those extending back over a period of time, the length of which is dependent on the memory of the subject, as is the accuracy of the recall. In the Framingham study, a method of diet history taking was developed based on the assumption that most individuals have well-established and relatively fixed food habits (Mann *et al.*, 1962). On this basis the dietary estimate could thus be extrapolated to behaviour over many years. Subsequently the limitations of this assumption were acknowledged (Dawber *et al.*, 1962). Our aim in this study was to observe any significant present differences in food consumption patterns between the three selected groups, and based on our criteria the groups showed a close similarity. The results support the view, that *per se*, diet does not account for differences in observed cholesterol levels within a culturally homogeneous group.

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Addendum

Since this paper was accepted for publication the authors' attention has been drawn to a report from the Tecumseh group in Michigan, USA (Nichols *et al.*, 1976). In a study of a large number of adults they found no relation between serum cholesterol and quality, quantity, or proportions of fat, carbohydrate, or protein consumed over a 24-hour period, thus supporting the findings of the present study.

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