DIETARY FAT, SERUM CHOLESTEROL, AND ISCHÆMIC HEART DISEASE IN CEYLON

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The role of dietary fat in the pathogenesis of ischæmic heart disease has been the subject of increasing investigation and discussion in recent years. Keys (1953, 1956a, 1957) postulated that the diet, through its fat content, played an important role in the development of coronary heart disease; and that saturated fats, by increasing the serum cholesterol level, influenced atherogenesis and a tendency to develop thrombosis. This view has been supported, amongst others, by Jolliffe and Archer (1959) who have evaluated data based upon records of the World Health Organization and the Food and Agriculture Organization collected from 20 countries. They, too, stress the importance of the quality of dietary fat (i.e. saturated versus unsaturated). They showed that the death rate from degenerative heart disease was related statistically to the percentage of saturated fat in the diet. Ceylon is mentioned as a country where both fat intake and incidence of ischæmic heart disease are low. Some comparative figures are given in Table I.

This investigation has been undertaken to determine the possible ætiological factors in patients suffering from ischæmic heart disease in Ceylon, and deals with the fat intake and serum cholesterol of these patients and a discussion of the significance of the data. In addition data on the incomes of the patients were obtained, as in Ceylon diets are largely conditioned by the economic status of each individual.

TABLE I

DEATH RATES FOR MEN AGED 55 TO 59 YEARS AND ENVIRONMENTAL FACTORS FOR 6 COUNTRIES

Country	Death rate per 100,000 from arteriosclerotic and degenerative heart disease	Average total available daily calories	Total fat intake (% total calories)	Daily fat intake (g./day)
U.S.A.	704.7	3,070	39.2	134
Australia	577.4	3,160	37.9	133
Canada	588.3	3,130	38.0	132
Ceylon	103.4	1,980	15.2	33
U.K.	427.5	3,270	38.4	140
Japan	122.5	2,005	7.9	18

The above figures are reproduced from Table I of the paper: "Coronary heart disease and dietary habits" by Jolliffe and Archer (1959). Column 5 has been calculated from the data in columns 3 and 4.

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MATERIALS AND METHODS

This study was based on 200 consecutive patients suffering from ischaemic heart disease treated personally at the Kandy General Hospital, and Nursing Home. Complete records of a further 18 patients treated during this period were not available and they were therefore excluded. The diagnosis was based on clinical findings confirmed in every case by positive electrocardiographic proof. All patients had at least one routine 12-lead electrocardiogram taken on admission and another on discharge. Where indicated, additional leads and more frequent tracings were taken. Serum glutamic oxalacetic transaminase (S.G.O.T.) estimations were made as a routine, soon after admission. Dietetic histories were obtained by a questionnaire, and details of the diet consumed each week per patient's family were noted, special inquiries on fatty foods being made: the daily intake per adult capita was then calculated. At least one serum cholesterol estimation was made in every patient. Thirty-six normal controls between the ages of 30 and 60 years were drawn from male subjects among hospital employees, blood donors, and volunteers.

RESULTS

The age and sex distribution of the patients are shown in Table II. Of the 200 patients, there were 180 men and 20 women, a ratio of 9:1. The maximum incidence occurred between 51 and 60 years. The average daily fat consumption per patient for the whole series was 55 g. The individual fat consumption was found to bear a distinct relation to the family monthly income and the income per head per day as shown in Tables III and IV.

Most of the fat consumed was saturated fat: in the lower income group this came mostly from coconut (extensively used in cooking); in the higher income groups, there was a proportionate increase in animal fats and dairy produce.

TABLE II
AGE AND SEX DISTRIBUTION OF 200 PATIENTS SUFFERING FROM ISCHÆMIC HEART DISEASE

Age-group (yr.)	No. of patients	
	Men (180)	Women (20)
20-30	1	0
31-40	18	2
41-50	45	5
51-60	82	8
61-70	27	5
71-80	6	0
Over 80	1	0

TABLE III
AVERAGE FAT CONSUMPTION OF THE ADULT RELATED TO THE FAMILY MONTHLY INCOME
(£1 = Rs 13.33 cents)

Family income per month (rupees)	Average daily fat consumption (g.)
<100	40
100-250	49
251-500	65
>500	81

TABLE IV

AVERAGE DAILY FAT CONSUMPTION RELATED TO INCOME PER HEAD PER DAY
(1 rupee=approx. 1s. 6d.)

Income per head per day (rupees)	Average daily fat consumption (g.)
<1	42
1.01-2	66
>2	75

TABLE V

COMPARISON OF SERUM CHOLESTEROL OF MALE PATIENTS, IRRESPECTIVE OF AGE AND INCOME GROUP, WITH NORMAL CONTROLS

Mean serum cholesterol (mg./100 ml.)	Normal control (% of subjects)	Patients (% of subjects)
<200	28	22
200-250	64	50
>250	8	28

TABLE VI

COMPARISON OF SERUM OF MALE PATIENTS ACCORDING TO INCOME GROUP SHOWING PERCENTAGE OF PATIENTS IN EACH GROUP

Income (Rs/head/day)	Per cent of patients	Serum cholesterol (mg./100 ml.)
<1	40	221.2±41.2
1.01-2	28	247.8±50.2
>2	32	245.1±47.6

TABLE VII

COMPARISON OF SERUM CHOLESTEROL OF PATIENTS AND CONTROLS BY AGE-GROUP

Age-group (yr.)	Normal controls		Patients	
	No.	Mean	No.	Mean
31-40	7	192.6±18.4	16	241.1±50.3
41-50	17	209.1±33.5	29	241.3±42.2
51-60	12	238.4±23.8	57	234.5±48.4
61-70	Nil	—	21	219.7±35.7

Of the 200 patients, 56 consumed less than 40 g., 84 between 41 and 70 g., and 60 over 70 g. The average serum cholesterol level of the men, 234.4 mg./100 ml. (± 46.1), was higher than in the normal group, 212 mg./100 ml. (± 49.2) (Table V). As the income and fat consumption increased, the serum cholesterol of patients increased up to a limit. There was a statistically significant difference between the serum cholesterol of those earning less than one rupee, and those earning more (Table VI).

Statistically the serum cholesterol levels of patients in the fourth and fifth decades were significantly higher than those of the normal controls for the same age-groups. There was no significant difference between patients and controls in the sixth decade (Table VII).

DISCUSSION

Much has been written about the role of dietary fat as a cause of ischæmic heart disease and atherosclerosis. The evidence is mainly of an epidemiological nature, and vital statistics and statistics concerning food habits gathered from different countries have been used to support this theory. The inherent dangers and fallacies in this form of evidence have already been referred to by Yudkin (1957, 1959), and by Yerushalmy and Hilleboe (1957). The specific mortality figures derived from death certificates are subject to limitation and great variation from country to country. Accuracy of certification depends on the quantity and quality of medical care, on local customs, on the systems of medicine adopted, and on the diagnostic habits of the medical profession. The percentage error in certification is so variable in different countries that the figures are not comparable. This point is well illustrated in the case of Japan: all workers are agreed that fat consumption amongst the Japanese is remarkably low, estimated at about 20 g. fat a day, where the fats used are rich in unsaturated fatty acids, the normal mean plasma cholesterol national value being 210 mg./100 ml. Keys (1956b) quoted vital statistics obtained from Japan to strengthen his hypothesis—the low incidence of coronary heart disease in keeping with the very low intake of dietary fat in the national diet. These findings are contradicted by Pollak (1959) who found a high incidence of atherosclerosis and cardiovascular disease in spite of an “anti-atherogenic diet” low in calories and fat. He found no evidence to support the concept that high levels of plasma cholesterol were atherogenic. Gore, Hirst, and Koseki (1959) made a comparative study of aortic atherosclerosis in the United States, Japan, and Guatemala, and concluded that, in view of the comparatively low incidence of fatal coronary artery disease in Japan and the relatively low levels of serum cholesterol amongst the Japanese, it was surprising not to find a more striking difference in the aortæ between the U.S. and Japan. Schroeder (1958) found atherosclerosis involving coronary arteries very common in Japan; myocardial infarction accounted for a large percentage of sudden deaths and was common at necropsy.

In like manner, the low death rate from ischæmic heart disease in Ceylon (103·4 per 100,000 for males aged 55–59 years) mentioned in the United Nations Organization data (Joliffe and Archer, 1959) does not give a true picture of the prevalence of the disease in the country. It is a common disease among men over 30 years, and recent vital statistics from Ceylon show that heart disease is the chief cause of death in men over 30 years of age, and, of the specific causes mentioned, arteriosclerotic and degenerative heart disease is by far the most common (Table VIII). This fact is also borne out by morbidity statistics as shown by the number of in-patients treated in hospitals. Excluding patients suffering from infectious fevers, acute respiratory disorders, dysentery (amœbic and bacillary), anæmia, and malnutrition, ischæmic heart disease and its complications are the leading diseases for which men over 30 are admitted.

A study of Table VIII also illustrates some of the fallacies and dangers of relying on vital statistics. For instance, 8121 deaths were attributed to “senility without mention of psychosis, ill-defined and unknown causes” (B45) and represent 33 per cent of all deaths in men over 30 years. 1333 deaths were attributed to “other diseases of the heart” (B27). The nature of the diseases included under this heading, which are responsible for 45 per cent of cardiac deaths recorded, is less certain. Bacterial endocarditis is uncommon in this age-group, and cardiomyopathy and endomyocardial fibrosis are rare in Ceylon (the common causes are listed separately). If heart diseases of unknown cause were added to degenerative and atherosclerotic heart disease and were due (as they could be) to ischæmic heart disease, the incidence of coronary artery disease would appear very much higher. Therefore, these figures give no idea of the prevalence of ischæmic heart disease.

The average daily fat consumption per patient in this study was 55 g. and bore a direct relation to the economic status of the individual, the fat being mainly saturated fat. Broadly, there were three economic levels (Table IV) and the average fat consumption was 42, 66, and 75 g. respectively. These findings were similar to the results of Cullumbine, Bibile, and Wikramanayake (1949) who made a dietetic survey of the various communities in Ceylon (373 families) in 1949. They too found

TABLE VIII

CHIEF CAUSES OF DEATH IN MEN OVER 30 YEARS OF AGE IN CEYLON

Causes of death	Age-group (yr.)												Total
	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	
All causes	815	1018	957	1502	1535	2076	2200	2614	2696	2241	2309	4080	24,043
Tuberculosis of respiratory system (B1)	63	78	85	102	106	104	92	80	62	37	14	15	938
Malignant neoplasms, including neoplasms of lymphatic and hæmatopoietic tissues (B18)	36	44	52	100	134	164	97	140	76	61	29	25	958
Anæmias (B12)	40	30	47	77	85	116	110	150	113	103	63	58	992
Rheumatic fever (B24)	3	6	2	6	5	5	14	18	22	18	17	13	129
Chronic rheumatic heart disease (B25)	3	4	9	2	3	9	5	6	7	6	7	10	71
Arteriosclerotic and degenerative heart disease (B26)	31	35	45	99	132	162	156	173	179	103	89	96	1300
Other diseases of heart (B27)	50	69	66	123	137	189	168	181	133	81	76	60	1333
Hypertensive heart disease (B28)	6	4	7	5	7	16	14	15	7	13	4	4	102
Pneumonia (B31)	34	68	48	82	75	98	124	149	124	92	49	80	1023
Senility without mention of psychosis, ill-defined and unknown causes (B45)	62	96	90	150	154	207	365	553	980	1013	1432	3019	8121
All other accidents (B48)	107	143	103	118	76	95	89	73	44	26	29	28	931
Total deaths from heart disease													2935

The above figures are reproduced from *Annual Epidemiological and Vital Statistics*, 1959 issued by the World Health Organization—Geneva (1962).

that the fat content of diets varied with the economic levels of families, and the respective fat intakes were 38.4, 50.7, and 89.9 g. It appears that the fat consumption of patients with ischæmic heart disease is similar to that of the population at large and has changed little since 1949. Compared with Western figures of 130 to 150 g., this figure is extremely low: 56 (28%) patients consumed less than 40 g. and 140 (70%) less than 70 g. That dietary fat plays any role in the development of ischæmic heart disease in Ceylon therefore seems very unlikely; nor does it account for the increasing incidence of the disease.

In a study of serum cholesterol levels in the U.S.A., Orvis *et al.* (1961) found that the levels in patients suffering from coronary artery disease were considerably higher than those in normal controls. Moreover in patients with coronary disease, the level was raised to about the same degree irrespective of age; whereas in the normal groups, there was a gradual rise with increasing age. The mean cholesterol value for patients was 275 mg./100 ml., and for controls 222, 242, and 259 mg./100 ml. for the fourth, fifth, and sixth decades. The mean serum cholesterol of patients in this series, 234 mg./100 ml., was higher than the normal control group, 212 mg./100 ml. These figures are low by American standards. Table V shows that only 56 patients (28%) had a serum cholesterol above 250 mg./100 ml. Thus, before serum cholesterol values can be used as an index of possible ischæmic heart disease in any given country it is important to establish a national

norm for that particular country. In this investigation too, in the normal group there was a gradual rise with increasing age, while in the patient group the serum cholesterols were highest in the fourth and fifth decades, and showed a slight fall in the sixth and seventh decades. Further, there was a significant difference between the serum cholesterol levels of patients in the lower and upper income groups. The serum cholesterol of patients increased with income and fat consumption.

That serum cholesterol levels vary with fat consumption and age among the normal population, and also vary from country to country is fairly well established. It is also known that patients with ischaemic heart disease, especially in the younger age-groups, have higher serum cholesterol levels than normal controls. What actually causes this has yet to be established.

These results indicate that ischaemic heart disease is common in Ceylon despite the low dietary fat consumption. To believe that dietary fat plays any significant part in the causation of ischaemic heart disease is therefore difficult.

SUMMARY

The fat consumption of 200 patients suffering from ischaemic heart disease in Ceylon was estimated and found to be low compared with Western standards. The amount of fat consumed by these patients was similar to that noted in a survey on the normal population in Ceylon in 1949, and was likewise found to vary with income levels. It was thought that dietary fat did not play an important role in the aetiology of ischaemic heart disease which is common in Ceylon.

The serum cholesterol levels of the male patients were compared with those of a normal control group. The mean level of the patients was found to be significantly higher than that of the controls in the fourth and fifth decades, and varied with fat consumption and income levels. The serum cholesterol levels in Ceylon were, however, far below American figures. Indeed, a serum cholesterol level high for Ceylon would be considered low by American standards. There is, therefore, a need for establishing mean normal serum cholesterol levels for each country. It is thought that the raised serum cholesterol levels of patients, as compared with controls, cannot be explained by differences in fat consumption; the exact cause has yet to be determined. There is no evidence to support the theory that dietary fat causes ischaemic heart disease. On the contrary, it is difficult to believe that dietary fat plays any significant part in its causation.

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