Dietary Fat, Serum Cholesterol Levels and Incidence of Atherosclerosis in Delhi


Very little information is available about the incidence of coronary heart disease in India, or of factors considered responsible for it. In a previous paper, the incidence of atherosclerosis as judged by electrocardiogram, the fat intake, and serum cholesterol levels in 2 low-income groups (industrial and rural) in Delhi were investigated. These data in high-income groups in Delhi have now been studied and the results compared.

There were considerable differences in the findings in the 2 groups.

In a previous paper, the values for dietary fat and serum cholesterol levels for 2 large groups, rural and industrial, in Delhi were presented and the incidence of atherosclerosis in these groups was assessed, purely from electrocardiographic evidence. In this paper, the results of a similar study undertaken in individuals of good social class (viz. professional men, business executives, a group of women medical students) and 2 urban low-socioeconomic groups are presented. The results of these 2 studies are compared.

Material and Methods

High-Socioeconomic Group

Men. The 100 individuals studied were men distributed among the various professions as follows: doctors 14, business executives 21, engineers 28, sportsmen (amateur hockey players) 15, and Sikhs 22. The last group was chosen for study as it was reputed to have a high-fat intake, although all the individuals did not belong to the same profession. They were all of high-socioeconomic status.

Women. Twenty-four women medical students of the Lady Hardinge Medical College were also studied.

Urban Low-Socioeconomic Groups

Included in this group were 26 hospital coolies and 22 gardeners. The oral questionnaire method of taking complete diet histories, thorough physical examination including electrocardiography and fluoroscopy, biochemical investigations for serum total cholesterol level, urinalysis for albumin and sugar, and the criteria for diagnosing coronary atherosclerosis were all employed as described in previous papers.

There was no attempt at selection of population groups and all were random samples of apparently normal people. Only certain individuals from the rural and industrial low-income groups were willing to give blood because of fear of the needle prick and the "draining away of blood" and not for any other reasons.

Results

Incidence of Atherosclerosis

On the sole basis of history of angina or of myocardial infarction there was not one case of ischemic heart disease in the low-income group but in the upper classes there were 2 such patients. On the basis of electrocardiograms there was a 4 per cent (4 out of 100) incidence of abnormal electrocardiograms in the high-income group and a 3 per cent (1 out of 34) in the rural group. The other low-income groups had no abnormality in the electrocardiograms. However, as the electrocardiograms were taken for all the men in the high-income groups and for only 34 out of 222 rural men, and for 28 out of 486 industrial workers studied, the figures were not strictly comparable. Also, of the 4 abnormal electrocardiograms in the high-income group, 2 were definite infarction patterns, one showed left bundle-branch block, and the other right bundle-branch block. In the low-income groups the one abnormality noted was left bundle-branch block.

In a large series that is being studied at present the number of abnormal electrocar-
diagrams was only 8 of 334 (an incidence of 2.4 per cent) in the low-income groups, and 12 of 216 (5.5 per cent) in the high-income groups, which was nearly double the incidence in the former.

Dietary Fat Intake

The men of the high-socioeconomic group had a much higher fat intake, from 47 to 188 Gm. per day (table 1). The percentage of calories derived from fats ranged from 30.7 per cent among the business executives to 35.4 per cent among the engineers, with an average of 32.8 per cent. About two thirds of the ingested fat was from animal sources, being mainly butter, and the remaining one third consisted of vegetable oils, both hydrogenated and nonhydrogenated.

The high-fat intake among the women medical students was due to the lower total consumption of calories, mainly from carbohydrates.

Among the low-socioeconomic groups, the gardeners had the lowest fat intake followed by coolies, industrial workers, rural women, and rural men, in that order.

The range of fat intake was wide in all the groups, being greatest among the industrial workers and rural men.

**Table 1.—Data in the Various Social Groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of cases</th>
<th>Average age yrs. (range)</th>
<th>Average weight lbs. (range)</th>
<th>Daily fat intake in Gm. (range)</th>
<th>Average cal. from fats (%)</th>
<th>Serum cholesterol levels mg. % (range)</th>
<th>Electrocardiographic incidence of atherosclerosis (No. of EKGs done)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-socioeconomic groups (men)</td>
<td>100</td>
<td>(20-65) (102-208)</td>
<td>(146.7-187.9)</td>
<td>106.3</td>
<td>32.8</td>
<td>220.4±57.3 255.8±54.8 (91-337) (94-408)</td>
<td>4% (100)</td>
</tr>
<tr>
<td>Industrial workers (men)</td>
<td>197</td>
<td>(18-70) (88-192)</td>
<td>(2-196)</td>
<td>80.9</td>
<td>24.5</td>
<td>168±33.7 169±36.5 (106-265) (112-270)</td>
<td>Nil (28)</td>
</tr>
<tr>
<td>Rural population (men)</td>
<td>133</td>
<td>(10-75) (84-182)</td>
<td>(0-250)</td>
<td>67</td>
<td>27.5</td>
<td>181±37.5 188±35.5 (95-297) (106-297)</td>
<td>3% (34)</td>
</tr>
<tr>
<td>Coolies (men)</td>
<td>26</td>
<td>(16-60) (95-178)</td>
<td>(0-95)</td>
<td>39.3</td>
<td>17.6</td>
<td>136.5±40.9 290.8±44.3 (81-222) (142-265)</td>
<td>0 (26)</td>
</tr>
<tr>
<td>Gardeners (men)</td>
<td>22</td>
<td>(20-65) (80-127)</td>
<td>(0-82)</td>
<td>25.6</td>
<td>9.2</td>
<td>159.2±17.6 180.0±22.3 (130-188) (148-225)</td>
<td>0 (22)</td>
</tr>
<tr>
<td>Rural population (women)</td>
<td>136</td>
<td>(11-60) (80-176)</td>
<td>(0-124)</td>
<td>38.5</td>
<td>25.1</td>
<td>175±44.0 183±38.5 (72-305) (100-248)</td>
<td>0 (44)</td>
</tr>
<tr>
<td>Medical students (women)</td>
<td>24</td>
<td>(18-23) (90-140)</td>
<td>(30-122)</td>
<td>86.4</td>
<td>40.6</td>
<td>174.1±35.3 ———— (130-261)</td>
<td>————</td>
</tr>
</tbody>
</table>

Serum Total Cholesterol Levels

The difference in serum total cholesterol levels between the high- and low-socioeconomic groups was very striking, there being a difference of at least 39 mg. per cent between the rural men (who had the highest cholesterol levels among the poor classes) and the high-socioeconomic group below the age of 40 (table 1). Above age 40 the smallest difference was 55 mg. The coolies and gardeners, who had lower fat intakes than the rural or industrial group, had correspondingly lower serum cholesterol levels below age 40 but not above.

The various factors that might be responsible for this difference were considered in turn:

**Age (table 2, fig. 1).** Among the high-socioeconomic groups there was a definite increase in serum total cholesterol levels with age, this being most marked after the age of 40; there was a difference of 40 mg. per cent between the fourth and fifth decades. The slight fall after the fifth decade might be partly attributed to the small number of cases in this age group.

Figure 1 demonstrates the differences among the various groups in the cholesterol trends with age. In every age group the
ATHREOSCLEROSIS IN DELHI

Table 2.—Variation in Serum Total Cholesterol with Age

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Industrial workers (men)</th>
<th>Najafgarh rural population (men)</th>
<th>High-income group (men)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of cases</td>
<td>T.S.C.* in mg. % ± std. dev. (range)</td>
<td>No. of cases</td>
</tr>
<tr>
<td>10—19</td>
<td>6</td>
<td>169±30 (131-190)</td>
<td>23</td>
</tr>
<tr>
<td>20—29</td>
<td>87</td>
<td>164±25 (120-220)</td>
<td>49</td>
</tr>
<tr>
<td>30—39</td>
<td>73</td>
<td>174±40 (106-265)</td>
<td>23</td>
</tr>
<tr>
<td>40—49</td>
<td>20</td>
<td>180±40 (130-270)</td>
<td>21</td>
</tr>
<tr>
<td>50—59</td>
<td>11</td>
<td>150±30 (112-155)</td>
<td>17</td>
</tr>
<tr>
<td>Below 40 years</td>
<td>166</td>
<td>168 (106-265)</td>
<td>95</td>
</tr>
<tr>
<td>Above 40 years</td>
<td>31</td>
<td>169 (112-270)</td>
<td>38</td>
</tr>
</tbody>
</table>

T.S.C. = total serum cholesterol.

high-socioeconomic group (men) had a considerably higher serum total cholesterol level.

The rise in the serum cholesterol levels with age was insignificant at any age among the rural men, probably significant \( p = 0.05 \) among the industrial workers from the fourth to the fifth decade,\(^1\) but definitely significant \( p = 0.01 \) among the high-socioeconomic group from the fourth to the fifth decade. In the high-socioeconomic group the serum cholesterol levels between the average ages of 18 and 57 years showed a rise of 2.2 mg. per cent per year of age. Among the rural men and industrial workers between the same ages the rise per year of age was only 0.3 mg. per cent. The difference in the rise per year of age in the high- and low-socioeconomic groups was significant.

Body Weight (table 3, fig. 2). In another paper\(^3\) it was demonstrated that for the same age and height the high-socioeconomic classes had higher body weights than the poor men. The influence of body weight on serum cholesterol levels in the different groups is shown in figure 2 and table 3.

In both groups there was a definite increase of serum total cholesterol levels with increase in body weight. However, for the same body

**Fig. 1** Top left. Variations in serum cholesterol levels with age.
**Fig. 2** Top right. Variations in serum cholesterol levels with body weight.
**Fig. 3** Bottom left. Variations in serum cholesterol levels with daily fat intake.
**Fig. 4** Bottom right. Variations in serum cholesterol levels with percentage of calories from fats.
weight the high-socioeconomic group had a much higher serum total cholesterol level. The higher body weights, i.e., over 150 pounds were infrequent in the low-socioeconomic groups and there were comparatively fewer men with body weights over 130 pounds. In the high-socioeconomic group the lowest body weight recorded was not below 100 pounds, whereas among the rural men there were 25 individuals with body weights of less than 100 pounds.

**Fat Intake.** Figures 3 and 4, and table 4 show the variation in serum total cholesterol levels with fat intake, expressed as fat in grams and as percentage of calories from fats respectively, in the various groups. As already reported in our previous paper the fat intake, when expressed in grams could not be correlated with the serum total cholesterol levels in the low-income groups. The same held good for the high-income groups in the present series. However, when fat intake was expressed as percentage of calories from fats the serum total cholesterol levels showed an upward trend in the case of the high-income groups and not in the poor classes. This discrepancy might be due to the percentage of calories from fats remaining almost the same at all ages in the high-income groups, whereas in the low-income groups the fat intake fell with age (table 5). This fall was due to the poor men being able to afford less food with advancing years instead of more as in the upper classes. The body weight also tended to fall with age in the poor classes and to rise among the rich, probably due to the same reason.

**Other Factors.** Among the other factors considered responsible for the higher serum cholesterol levels in the high-socioeconomic group were total calorie and protein intakes and physical activity. Total calorie and protein intakes were found to have no significant correlation with the total serum cholesterol levels. In the case of physical activity, however, the men of the high-socioeconomic groups were all sedentary (except one subgroup of amateur sportsmen playing hockey), whereas in the low-socioeconomic groups were men who indulged in "medium" activity. When the sportsmen were compared to the other members of high-socioeconomic groups matched for age and weight, there were found to be only 3 individuals who could be so matched. The sportsmen had higher serum total cholesterol levels but their fat intakes were also higher. All these 6 men were aged 32 years or younger. The effect of physical activity could not be separately assessed in the present series.

Twenty-four engineers were matched for age and weight with 24 members of the rural and industrial groups. It was found that the average serum cholesterol levels were at least 40 mg. per cent higher among the engineers; the average values being 176.8 mg. per cent and 218.2 mg. per cent for the poor men and engineers respectively. The average age was 32.2 years and average weight 135 pounds in both groups.
### Table 4.—Variation in Serum Total Cholesterol with Daily Fat Intake

<table>
<thead>
<tr>
<th>Industrial workers (men)</th>
<th>Najafgarh rural population (men)</th>
<th>High income group (men)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat intake (Gm./day)</td>
<td>No. of cases</td>
<td>Total serum chol. in mg. % ± std. dev. (range)</td>
</tr>
<tr>
<td>0—24</td>
<td>48</td>
<td>162±38 (115-205)</td>
</tr>
<tr>
<td>25—49</td>
<td>45</td>
<td>170±40 (106-260)</td>
</tr>
<tr>
<td>50—74</td>
<td>33</td>
<td>163±40 (112-220)</td>
</tr>
<tr>
<td>75—99</td>
<td>26</td>
<td>168±38 (120-265)</td>
</tr>
<tr>
<td>100—124</td>
<td>12</td>
<td>170±41 (135-205)</td>
</tr>
<tr>
<td>125—149</td>
<td>12</td>
<td>160±38 (120-210)</td>
</tr>
<tr>
<td>150—174</td>
<td>8</td>
<td>168 (140-205)</td>
</tr>
<tr>
<td>175—199</td>
<td>6</td>
<td>188 (150-225)</td>
</tr>
<tr>
<td>200—224</td>
<td>4</td>
<td>155 (125-250)</td>
</tr>
</tbody>
</table>

### Discussion

The conclusion that emerged from this study was that the serum total cholesterol levels were significantly higher in the high-income groups than in the low for the same age, body weight, and fat intake. There were, however, differences between the 2 groups in 2 respects. Firstly, with age there was a steady rise in the serum total cholesterol levels in the upper classes particularly after age 40, a feature absent in the low-income groups. Secondly, the effect of an increasing fat intake was also different when the latter was expressed as percentage of calories from fats: there being an upward trend in the case of the high-income groups and not in the low. Expressed as grams of fat this correlation was not present in either group. With regard to body weight there was an upward trend in the groups with increasing body weight but not more so in any social group.

The differences in rise of serum total cholesterol levels with age and fat intake could probably be explained by gain in body weight and increasing fat intake with age among the well-to-do and not among the poor. The reason for the rise in the serum cholesterol levels with body weight is not clear. None of the men in this series could be considered obese. It has been demonstrated elsewhere that during periods of weight gain individuals have elevation of serum cholesterol levels.5

It is quite evident, however, that no single factor by itself, such as age, body weight, or fat intake was responsible for the differences in the serum total cholesterol levels between the 2 classes.

Our observations with regard to the differences in serum cholesterol in the high- and low-socioeconomic groups resemble those of Keys, in Spain8 and in Italy,7 among rich and poor classes and those of Bronte-Stewart et al. in South Africa,8 and of Gopalan et al. among the rich and poor men in Coonoor,9 who found a considerable difference in serum cholesterol levels between groups living on
In the high-income group the total serum cholesterol levels showed an upward trend with age and with increasing fat intake, both of these features being absent in the poorer classes. In both groups the serum cholesterol levels rose with increase in body weight.

The findings in the high-income groups with age were similar to the findings in Western countries among the well-to-do.

ACKNOWLEDGMENT

We are grateful to Mr. R. K. Lakhanpal, dietitian, Mr. Y. K. Bakshi, biochemist, and Miss Kalavathy, technician, for their help in the investigations.

SUMMARIO IN INTERLINGUA

In un studio comparative de gruppos socio-economici alte in Delhi, il esseva trovate che le indicationes electrocardiographic de atherosclerosis, le ingestion de grassia dietari, e le nivellos seral de cholesterol total esseva plus marcato in le gruppos de stato economic superior.

In le gruppos de stato economic superior, le nivellos seral de cholesterol total monstrava un tendentia de crescer con le etate del subjectos e con augmento del ingestion de grassia. Ambe iste factores esseva absent in le gruppos economicamente inferior. In ambe situaciones le nivellos seral de cholesterol montava con le augmento del peso corpore.

Le constatationes in le gruppos de stato economic superior esseva simile al constatationes in gruppos prospere de paizes occidentali.

REFERENCES

4. KEYS, A., ANDERSON, J. T., ARESU, M., BIROCK, G., BROCK, J. F., BRONTE-STEWART, B., FIDANZA, F., KEYS, M. H., MALMROS,


Direct-vision coronary endarterectomy with resection of an almost totally occluding thickened intimal core from 1 or more of the main coronary vessels was performed in 5 patients with severe angina pectoris without myocardial infarction. In all cases blood flow was reestablished through the previously occluded vessel at the time of operation. One patient died of asystole developing near the completion of the operation. Of the 4 surviving patients 2 have been greatly improved. In all instances marked improvement has been noted in the electrocardiograms taken during exercise. The operation was devised on the premise that the patient with severe angina pectoris was likely to have an occlusive process near the aortic origin of at least 1 of the 3 major vessels and that the distal coronary tree beyond the occlusion was likely to be patent and supplied by blood through collateral anastomotic channels that had attained their maximum state of development. The results indicated that it was technically feasible to perform definitive endarterectomy in the major coronary arteries and to reestablish blood flow in such previously obstructed vessels.

Sagall
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