The Effect of Diet on Bowel Transit Times

G. O. R. HOLMGREN, M.B., CH.B., B.SC. (BIRM.) AND J. M. MYNORS, CH.M., F.R.C.S., Department of Surgery, Harari Central Hospital, Salisbury, Rhodesia

SUMMARY

A theory has been propounded by Cleave and Campbell\(^2\) that several diseases that are prevalent in Western communities are due to the ingestion of refined-carbohydrate foods. Walker\(^1\) postulated that one of the effects of such a diet is a slowing in bowel transit time.

This theory has been tested in a study where the transit times of 310 subjects with three different types of food have been measured. The study has shown that subjects on a traditional African diet of mainly unrefined carbohydrate have the shortest average transit time (14.5 hours), those on a Western diet with a high refined carbohydrate intake have the longest average transit time (28.4 hours), and those on a mixed diet are in-between (20.6 hours).


Bowel transit times are well known to be related to diet, but this has usually been regarded as due to a sensitivity, an irritating or an infective process. During the past 25 years attention has been focused upon the effects of low-residue diets in slowing transit times.\(^3\)

Cleave and Campbell\(^4\) have expanded the concept to relate the excessive intake of refined carbohydrates to a number of common diseases of civilization. These diseases include appendicitis, diverticulitis coli, peptic ulceration, cholecystitis, haemorrhoids, varicose veins, dental caries, diabetes mellitus and coronary artery disease. Cleave and Campbell maintain that these diseases are rare or non-existent in primitive communities, but are all common in highly developed societies, with intermediate degrees of incidence between the extremes. They state that environmental factors are likely to be of more importance in the aetiology of these diseases than genetic factors, and they postulate that excessive intake of refined carbohydrates is an important aetiological factor, which may be caused either by a reduction of bulk or by an actual excess of absorbed carbohydrate.

One of the effects of an excessive intake of refined carbohydrates is said to be a marked increase in bowel transit times, probably because of its low fibre content. A study was carried out to measure transit times in a number of communities with different diets.

METHOD

A total of 310 subjects from 5 different communities in Rhodesia was chosen for the study. Three of these groups were on a traditional African diet, consisting primarily of thick maize porridge supplemented by a vegetable or meat relish. One group was on a mixed diet with both refined and unrefined carbohydrates. One group was on a typical Western diet with a high intake of refined carbohydrates.

**Group 1:** A group of adult employees (ages ranging from 21 - 52 years) at a mine approximately 60 miles northeast of Salisbury, who were on traditional diet.

**Group 2:** A group of upper primary schoolchildren (ages ranging from 12 - 16 years) at two schools about 60 miles north of Salisbury, also on traditional diet.

**Group 3:** A group of villagers (ages ranging from 15 - 60 years, but mainly young adults) about 60 miles north of Salisbury, who were on traditional diet.

**Group 4:** Trainee teachers (ages ranging from 17 - 31 years, but mainly in their early twenties) at an institute 50 miles north of Salisbury. This group was on a mixed diet with traditional African food supplemented by refined carbohydrates, such as white bread, cakes and various items containing sugar.

**Group 5:** Medical students (ages ranging from 18 - 34 years with the majority in the early twenties) in Salisbury, on a standard Western diet with a high refined carbohydrate intake. The group comprised 25 Caucasians, 16 Africans and 6 Asians.

**Measurement of Transit Times**

Initial transit times were measured using carmine in 0.5 g capsules as the marker. These capsules were swallowed at a standard time (between 1400 and 1500).

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**TABLE I. AVERAGE BOWEL TRANSIT TIMES OF A CARMINE MARKER IN 5 SOCIAL GROUPS**

<table>
<thead>
<tr>
<th>Group</th>
<th>Diet (carbohydrates)</th>
<th>Number of subjects</th>
<th>Average transit times (hours)</th>
<th>Range (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>African mineworkers</td>
<td>Unrefined</td>
<td>46</td>
<td>10.8</td>
<td>3 - 24</td>
</tr>
<tr>
<td>African schoolchildren</td>
<td>Unrefined</td>
<td>73</td>
<td>17.2</td>
<td>9.5 - 31</td>
</tr>
<tr>
<td>African villagers</td>
<td>Unrefined</td>
<td>31</td>
<td>13.8</td>
<td>9.5 - 23.5</td>
</tr>
<tr>
<td>African teacher-trainees</td>
<td>Mixed</td>
<td>113</td>
<td>20.6</td>
<td>6.5 - 54</td>
</tr>
<tr>
<td>Medical students</td>
<td>Refined</td>
<td>47</td>
<td>28.4</td>
<td>7 - 78</td>
</tr>
</tbody>
</table>

*Date received: 3 September 1971.
Each stool passed after ingestion was examined for the appearance of the dye in the faeces, and the time of first appearance was noted.

### RESULTS

The results in the 5 groups are shown in Table I. The results were further grouped into the 3 dietary categories (Fig. 1). It will be seen from this that those subjects on an unrefined diet had an average initial transit time of 14.5 hours, those on a refined diet 28.4 hours, and those on a mixed diet lay in-between with a time of 20.6 hours.

#### TABLE I. AVERAGE BOWEL TRANSIT TIMES OF A CARMINE MARKER IN A MULTIRACIAL GROUP

<table>
<thead>
<tr>
<th>Race</th>
<th>Number of subjects</th>
<th>Average transit time (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>25</td>
<td>30.3</td>
</tr>
<tr>
<td>African</td>
<td>16</td>
<td>28.8</td>
</tr>
<tr>
<td>Asian</td>
<td>6</td>
<td>19.0</td>
</tr>
</tbody>
</table>

#### DISCUSSION

Bowel transit times have been estimated using a number of methods, e.g. radiologically with barium sulphate, or barium impregnated polythene pettes, or other forms of radio-opaque marker; colorimetrically with such substances as carmine; particulate materials such as coloured glass beads; or millet seeds; chemical methods such as chromium sesquioxide; and radio-active substances such as "Cr-labelled sodium chromate.

Carmine was used in the present study. It fulfils the criteria for a marker laid down by Whitby and Lang. It is neither absorbed from, nor chemically altered in the digestive tract; it is nontoxic and does not interfere with the processes of digestion, and it is uniformly dispersed in the faeces. It was found to have one drawback; it was not easily seen in the faeces of subjects with a long transit time.

There have been occasional reports of Salmonella cubana infections following the use of carmine as a marker. Such a complication was not encountered in the present study.

The results of this study show a clear difference in bowel transit times between the various dietary groups. Subjects on a traditional African diet of mainly unrefined carbohydrate had the shortest average transit time (14.5 hours), those on a Western diet with a high refined-carbohydrate intake had the longest transit time (28.4 hours), and those on a mixed diet were in-between (20.6 hours).

There is a wide variation between members of the same community, and in the same person at different times. Mulinos, in a study of young people on a Western diet found transit times varying between 6.5 and 98 hours. He concluded: 'Such extremes of variability among normal young people might lead us to suspect the extremes of diarrhoea on the one hand and dangerous constipation on the other. Nothing could be less true'.

The average times of fairly large groups, as in this study, seem to give reproducible results. They can be compared with a study of 25 normal subjects on a Western diet carried out by Hinton et al. using barium-impregnated polythene pettes as markers. They found initial transit times varying between 9 and 61 hours with an average time of 29.9 hours at the first appearance of the marker. This compares well with the average initial time of 28.4 hours obtained in the present study for the group of medical students on a Western diet.

Many factors have been implicated in the regulation of bowel transit times. Walker stated that the prime factor was the bulk-forming capacity of the diet. He postulated that one of the main causes of unsatisfactory bowel movement in people on a Western diet was the elimination of bran from flour. He maintained that the tribal Africans of South Africa had a higher rate of bowel motility, larger stools and greater frequency of defaecation than the Caucasians. This impression is supported by the observations of Cleave and Campbell and Dodd, also from experience in South Africa.

McCance et al. produced experimental evidence to support the view that a low-residue diet slows transit times. They studied two groups of human subjects, one group of whom were fed on brown bread and the other on white bread; the residue from the subjects on the brown-bread diet was cleared from the colon on average 24 hours sooner than that from the white bread.
One possible explanation for the effect of a bulky high-residue diet has been put forward by Kosterlitz and Robinson. They showed in experimental animals that the sensory receptors which subserve the peristaltic reflex are not responsive to pressure, but are activated by radial stretch. It seems reasonable to postulate that a high-residue diet, such as is found in traditional African food, causes more radial stretch of the gut than a low-residue diet, and so elicits a more powerful peristaltic reflex.

The results of the present study show that genetic racial factors are unlikely to be an important explanation of differences in transit times. The 3 racial groups among the medical students were on identical diets. The Caucasians showed an average time of 30.3 hours, the Africans a time of 28.8 hours, and Asians a time of 19 hours. There is no significant difference between the Caucasian and African students. The low times for the Asian students may be a factor of the small numbers involved (6 students).

Allusion has been made to possible clinical implications of the effects of diet on disease patterns. Diverticulosis is found to be rare in West Africans and Chinese, both of whom have a high residue diet, and it is also very rare in the Africans of Rhodesia. No case of diverticulosis coli has been recorded in Harari Hospital which has 1000 beds, Carlson and Hoelzel showed that rats fed on a low-residue diet developed diverticulosis of the colon associated with a lengthened transit time. This could be prevented by adding roughage in the form of kapok.

Short postulated that the main cause of appendicitis was the removal of much of the cellulose content of food. He showed a relationship between the rapid increase in consumption of white flour, with a consequent decrease in the consumption of coarser flour, and the incidence of acute appendicitis in Britain and North America. This idea has been developed further by Cleave and Campbell.

A relationship has been postulated between cancer of the large bowel and faecal stasis. Any ingested carcinogen is concentrated more in a diminished faecal mass and is in contact with the bowel mucosa for a longer period than in a rapidly emptying intestine. Its carcinogenic action could be increased by a multiple of these two factors.

The theory of Cleave and Campbell could have very important implications in understanding the aetiology of a number of the diseases of civilization and their prevention.

We wish to thank Mr D. P. Burkitt, for stimulating the project; Mr D. M. Surtees for assistance with the preparation of the carmine marker capsules; the Medical Officer of the Trojan Mine, Dr J. S. Cook, the Headmasters of Nzimbo and Musarara Schools, and the Principal of the Howard Teacher Training Institute for their willing co-operation in the organization of this study.

REFERENCES