Heart rate, employment status, and prevalent ischaemic heart disease confound relation between cereal fibre intake and blood pressure

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SUMMARY Cross sectional data from a survey of 2512 men aged 45–49 years were used to examine the confounding effects of heart rate, employment, and ischaemic heart disease (IHD) on the relation between cereal fibre intake and blood pressure. Daily cereal fibre intake (g/day) was associated with systolic pressure ($r = -0.053$, $p<0.01$), diastolic pressure ($r = -0.057$, $p<0.01$), and heart rate ($r = -0.071$, $p<0.01$). The associations were strengthened in employed men and inapparent in unemployed men. Unemployed men had more IHD than employed men. Persons with any manifestation of IHD had significantly higher blood pressure and heart rates but ate less cereal fibre ($7.0 v 7.9$ g/day, $p<0.001$) than those without IHD, regardless of employment status. In employed men, after adjustment for age, body mass index, prevalent IHD, and heart rate, systolic pressure changed $-0.186$ mmHg (95% CI $= -0.362$, $-0.009$) and diastolic pressure changed $-0.111$ mmHg (95% CI $= 0.228$, $0.005$) for each gram of cereal fibre eaten daily. The association between cereal fibre intake and blood pressure was inapparent in unemployed men. Heart rate, employment, and prevalent IHD confound the association between cereal fibre intake and blood pressure. Future work concerning this relationship will have to account for the effects of these variables.

It is necessary to discover the determinants of blood pressure because blood pressure is a principal risk factor for ischaemic heart disease (IHD). Even those determinants having a small effect are important since a reduction in a population's mean blood pressure of 2–3 mmHg could potentially save as many lives as current antihypertensive therapy.1 Factors having a small effect on blood pressure may be difficult to detect because of their low order correlations with blood pressure or confounding relations with other variables.

Cereal fibre has been postulated to be a determinant of blood pressure. Some studies have shown an inverse relation between cereal fibre intake and blood pressure,2–4 others have not.5,6 The relation between these two factors may have been missed in some studies because they were too small. Alternatively, the apparent link between the two factors is really non-causal and the association arises from confounding variables related to both cereal fibre and blood pressure.

The opportunity was taken to examine data from a large survey to see whether a relation could be found between cereal fibre and blood pressure, and then to see whether any such relation could be explained by employment, prevalent ischaemic heart disease, and heart rate. Our hypothesis was that employed healthier individuals would have lower blood pressures and heart rates but also would eat diets with more cereal fibre.

Methods

The Caerphilly heart disease study is based on a cohort of 2512 men aged 45–49 years in South Wales. Details of the study aims, methods, and cohort assembly have been published.7

Blood pressure, heights, weights, and electrocardiograms (ECG) were obtained and questionnaires were completed at evening clinics. Body mass index was calculated as kg/m2. Blood pressure was measured by one observer using either a random-zero or regular mercury sphygmomanometer. A single blood pressure recording was taken from the straightened left arm with the person seated. Daily cereal fibre intake was estimated from a food
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frequency questionnaire which had been previously validated against weighed dietary records.8

IHD was characterised as "none" or "any manifestation". To have "any manifestation" a subject had to have (a) angina pectoris or possible myocardial infarction from the London School of Hygiene and Tropical Medicine Chest Pain Questionnaire, and/or (b) major or minor Q waves, ST and T wave changes, or left bundle branch block on ECG (Minnesota codes 1·1 to 1·3, 4·1 to 4·4, 5·1 to 5·3, and 7·1).7

Correlation coefficients were used to examine relations between continuous variables.9 Relations between variables and cereal fibre intake were then examined by stratification, presentation of means and standard deviations. Differences between means were compared using an unpaired t test. Multiple linear regression was used to examine the relation between cereal fibre, confounding variables and blood pressure.9

Results

Daily cereal fibre intake estimates were calculated for 2421 subjects. Of these, 2404 had their employment status noted. These groups form the basis for the analysis. Missing values account for slight differences in totals in the tables.

The correlation coefficients between cereal fibre intake, systolic pressure, diastolic pressure, and heart rate for the whole cohort are presented in table 1. Cereal fibre intake was associated with systolic pressure, diastolic pressure, and heart rate. Age and body mass index were correlated with systolic blood pressure (r = 0·166 and 0·220 respectively, p < 0·0001) but not with cereal fibre intake (r = −0·026 and −0·023 respectively). Energy intake (kcal/day) was correlated with cereal fibre intake (r = 0·303, p < 0·0001) but not with systolic or diastolic pressure (r = −0·019 and −0·028 respectively).

Table 1 Correlation matrix for cereal fibre intake, blood pressure, and heart rate (r values) N = 2421

<table>
<thead>
<tr>
<th>Cereal fibre intake</th>
<th>Systolic blood pressure</th>
<th>Diastolic blood pressure</th>
<th>Heart rate (beats/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>-0·053**</td>
<td>0·684****</td>
<td>0·071***</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>0·072***</td>
<td>0·183****</td>
<td>0·166****</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>**p&lt;0·01</td>
<td>*****p&lt;0·0001</td>
<td>*****p&lt;0·0001</td>
</tr>
</tbody>
</table>

Table 2 Mean (SD) systolic pressure, diastolic pressure, and heart rate stratified by quintile of cereal fibre intake

<table>
<thead>
<tr>
<th>Quintile cereal fibre intake (g/day)</th>
<th>Systolic blood pressure (mmHg)</th>
<th>Diastolic blood pressure (mmHg)</th>
<th>Heart rate (beats/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Mean (SD)</td>
<td>N Mean (SD)</td>
<td>N Mean (SD)</td>
<td>N Mean (SD)</td>
</tr>
<tr>
<td>4.0</td>
<td>487 142.1 (19.8)</td>
<td>487 89.9 (13.4)</td>
<td>486 72.9 (11.4)</td>
</tr>
<tr>
<td>4.1 – 6.0</td>
<td>508 141.0 (19.5)</td>
<td>507 88.4 (12.5)</td>
<td>510 72.0 (11.4)</td>
</tr>
<tr>
<td>6.1 – 8.0</td>
<td>459 141.9 (19.7)</td>
<td>459 88.5 (12.9)</td>
<td>460 71.3 (12.3)</td>
</tr>
<tr>
<td>8.1 – 10.4</td>
<td>482 140.4 (18.9)</td>
<td>481 88.5 (12.9)</td>
<td>482 71.2 (11.8)</td>
</tr>
<tr>
<td>10.5</td>
<td>483 138.8 (18.7)</td>
<td>483 87.8 (12.9)</td>
<td>483 70.22 (12.1)</td>
</tr>
<tr>
<td>Total</td>
<td>2419 140.8 (19.3)</td>
<td>2417 88.7 (12.9)</td>
<td>2421 71.5 (12.2)</td>
</tr>
</tbody>
</table>

Table 3 Mean (SD) systolic pressure, diastolic pressure, heart rate, and cereal fibre intake by employment status

<table>
<thead>
<tr>
<th>Employment status</th>
<th>Systolic blood pressure (mmHg)</th>
<th>Diastolic blood pressure (mmHg)</th>
<th>Heart rate (beats/min)</th>
<th>Cereal fibre intake (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Mean (SD)</td>
<td>N Mean (SD)</td>
<td>N Mean (SD)</td>
<td>N Mean (SD)</td>
<td>N Mean (SD)</td>
</tr>
<tr>
<td>Employed</td>
<td>1968 141.1 (19.3)</td>
<td>1968 88.8 (12.8)</td>
<td>1968 71.2 (12.1)</td>
<td>1917 7.8 (4.6)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>515 139.3 (19.8)</td>
<td>513 87.6 (13.5)</td>
<td>517 73.1 (13.3)</td>
<td>487 7.1 (4.2)</td>
</tr>
<tr>
<td>Total</td>
<td>2483 140.7 (19.4)</td>
<td>2481 88.5 (12.9)</td>
<td>2485 71.6 (12.4)</td>
<td>2404 7.3 (4.5)</td>
</tr>
</tbody>
</table>

**p < 0·01

Table 4 Mean (SD) systolic pressure, diastolic pressure, heart rate, and fibre intake by prevalent IHD

<table>
<thead>
<tr>
<th>Prevalent IHD</th>
<th>Systolic blood pressure (mmHg)</th>
<th>Diastolic blood pressure (mmHg)</th>
<th>Heart rate (beats/min)</th>
<th>Cereal fibre intake (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Mean (SD)</td>
<td>N Mean (SD)</td>
<td>N Mean (SD)</td>
<td>N Mean (SD)</td>
<td>N Mean (SD)</td>
</tr>
<tr>
<td>None</td>
<td>1958 139.7 (18.3)</td>
<td>1857 87.7 (12.6)</td>
<td>1860 71.2 (12.1)</td>
<td>1802 7.9 (4.6)</td>
</tr>
<tr>
<td>Any manifestation</td>
<td>625 143.7 (22.1)</td>
<td>624 90.9 (13.7)</td>
<td>625 72.7 (13.0)</td>
<td>602 7.0 (4.2)</td>
</tr>
<tr>
<td>Total</td>
<td>2483 140.7 (19.4)</td>
<td>2481 88.5 (12.9)</td>
<td>2485 71.6 (12.4)</td>
<td>2404 7.7 (4.5)</td>
</tr>
</tbody>
</table>

**p < 0·01
Table 2 presents mean systolic pressure, diastolic pressure, and heart rate stratified by quintile of cereal fibre intake. Moving from the lowest to the highest quintile, mean systolic pressure decreased 3-3 mmHg, mean diastolic pressure decreased 2-1 mmHg, and mean heart rate decreased 2-7 beats/min.

The mean blood pressure, heart rates, and cereal fibre intakes for employed and unemployed groups are shown in table 3. Blood pressures were similar for the two groups. The unemployed had significantly higher heart rates and lower cereal fibre intakes.

Unemployed men tended to have more illness than employed men. The prevalence of IHD was 38% in the unemployed compared with 21% in the employed group. The effect of prevalent IHD is shown in table 4. Persons with any manifestation of IHD had significantly higher blood pressure and heart rates but ate significantly less fibre. The association between employment, prevalent IHD, and cereal fibre intake is shown in table 5. The unemployed men with prevalent IHD ate an average of 1-5g cereal fibre less than employed men without IHD.

The effects of the confounding factors on the association between cereal fibre intake and blood pressure are shown in table 6. For the whole cohort, after adjustment for age alone, systolic pressure apparently changes $-0.221$ mmHg (95% CI $-0.338$, $-0.054$) and diastolic changes $-0.163$ mmHg (95% CI $-0.276$, $-0.050$) for each gram of cereal fibre eaten daily. After further adjustment for body mass index, prevalent ischaemic heart disease, employment status, and heart rate the effect attributable to fibre diminishes to $-0.153$ mmHg systolic (95% CI $-0.315$, $0.010$) and $-0.104$ mmHg diastolic (95% CI $0.212$, $0.005$) for each gram of cereal fibre eaten daily. If the regression coefficients are examined by employment status the association is strengthened slightly in employed men and is non-existent among the unemployed (table 6).

### Discussion

The evidence relating blood pressure to cereal fibre intake is conflicting. Significant negative associations were shown in 94 volunteers, in 117 men, and in 300 health-food shoppers. Furthermore, a controlled trial among 57 subjects showed a fall in blood pressure with a vegetarian diet which included a high cereal fibre intake. On the other hand, no relation was found in 337 busmen and bank clerks, or in 112 male industrial workers, while a controlled trial showed no effect of cereal or other fibre on blood pressure in 62 subjects.

One explanation of these conflicting findings is that previous studies have been too small to detect consistently a small relation between cereal fibre and blood pressure. A randomised trial of cereal fibre supplementation would require about 850 subjects in both the control and intervention groups to have an 80% chance of detecting a 3 mmHg change in systolic blood pressure. Such a weak relation may be potentially important, however, since small reductions of blood pressure affect the risk of death and disability, and moderate amounts of cereal fibre may have fewer side effects than antihypertensive drug therapy.

An alternative explanation for the inconsistent findings is the effect of confounding factors, associated (positively or negatively) with both blood pressure and cereal fibre intake. For example, the level of physical conditioning is associated negatively with blood pressure and positively with cereal fibre intake, since the people who select whole grain foods tend to be more health-concious than others. Thus vegetarians tend to be leaner than omnivores and probably take more exercise on average. Since diet is an integral part of a person’s way of life, it is very difficult to separate its action from that of other factors associated with it. The larger the study, the greater the possibility is of distinguishing between the
Heart rate, employment status, heart disease confound relation between cereal fibre intake and blood pressure

effects of dietary and other elements in the subjects’ lives. The Caerphilly Study provided an opportunity to examine data from nearly 2500 men obtained during a survey of a town in South Wales.

Resting heart rate is an index of physical conditioning. Its relation to blood pressure and cereal fibre might reflect a tendency for health-conscious people to eat more fibre. If this were the sole explanation of the connection between blood pressure and cereal fibre, we might expect this association to disappear when heart rate is included in the multiple regression analysis. The association was no longer statistically significant in all subjects together when heart rate was included, but the relation reappeared when employed men were examined separately, that is, there was still a significant negative relation between cereal fibre intake and systolic blood pressure, independent of heart rate, in employed men. The absence of such a relation in the unemployed men may be attributed to their higher heart rates and greater prevalence of IHD. These non-dietary factors have a substantial effect on blood pressure and obscure any action of cereal fibre.

This study does not provide conclusive evidence as to whether cereal fibre affects blood pressure. The cross-sectional nature of the survey cannot account for any temporal relations between the two factors. For example, dietary habits may have changed in response to health or employment problems. The small correlation coefficients show that if the relation is causal it explains less than 1% of the variation in blood pressure within the population. The interrelations with heart rate and employment status provide a warning that there may be other confounding variables not considered in this study.

In spite of these problems, the relation between cereal fibre and blood pressure may still be important. Although small, the association was strengthened in employed men and persisted after adjustment for age, body mass index, prevalent IHD, and heart rate, Future investigations of this association will have to account for the effects of employment, heart disease, and heart rate. Randomised trails, larger than those previously conducted, are needed to determine if the cereal fibre/blood pressure link is causal.

References

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doi: 10.1136/jech.40.4.330

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