Occupational Physical Activity and the Degree of Coronary Atherosclerosis in "Normal" Men

A Postmortem Study

By David M. Spain, M.D., and Victoria A. Bradess, M.D.

There is currently considerable speculation concerning the relationship of physical activity to the development of coronary atherosclerosis and ischemic heart disease. Information on this problem has been obtained by animal experimentation, epidemiologic studies on various populations, and clinical investigation of selected patient groups. It has involved studies on the influence of physical activity and "emotional stress" on blood lipids and on the intravascular clotting mechanisms, on the degree of experimentally induced atherosclerosis in animals, and on the relationship of various types of occupations to the morbidity and mortality from coronary "occlusion." Among the reports on the relationship of the different degrees of occupational physical activity to the morbidity and mortality from coronary artery disease are those of Morris et al. in England,1 Biorck et al. in Sweden,2 and Spain and Bradess in Westchester County.3 In all these studies that are based on either mortality records, clinical findings, or postmortem examinations, a positive association was noted between the frequency of ischemic heart disease and the more sedentary types of occupation. This presumptive association has raised several questions. Foremost is the question concerning the phase of coronary artery disease with which sedentary physical activity may be associated. Is the influence of a sedentary life, if any, related to the developmental phase of coronary atherosclerosis (the atherogenic process) or with the precipitation of acute episodes of ischemic heart disease in individuals with advanced coronary atherosclerosis? In a preliminary study, it was noted that apparently healthy white men between the ages of 30 and 60, who had died suddenly as a result of various accidents, showed no differences, at various corresponding age levels, in the degree of atherosclerosis as related to occupational physical activity.4 This report is based upon a continuation of this preliminary study in which more significant numbers of individuals have been evaluated in an attempt to determine the presence or absence of such associations.

Material and Method

Determinations of the degree of coronary atherosclerosis were made on coded hearts from consecutive postmortem examinations on otherwise "normal" white men between the ages of 30 and 60 who had died suddenly and unexpectedly from accident, homicide, or suicide. These cases were studied in the Medical Examiner's Office of Westchester County, New York. This office processes every fatality in the county which results from homicide, suicide, or accident. The approximate population of this county, according to the national 1957 census figure, was 750,000. The county consists of representative suburban areas, moderate-sized cities, towns, and villages. Considerable industry is present, as well as farm areas. Many of the individuals commute daily to work in New York City. The population is stable and, with few exceptions, the autopsied individuals were established residents of this county.

At the end of each postmortem examination the hearts were tagged with a code number and fixed in formalin. The same examiners evaluated the degree of coronary atherosclerosis in the entire study. All estimates of the degree of coronary atherosclerosis were made without any prior knowledge of the age and occupation of the individuals whose particular hearts were being examined. All major branches of the coronary arteries were examined in cross-section at intervals of 3 mm. The degree
of encroachment on the lumen and the extent of surface-area involvement were estimated. For the purposes of this study, the degree of reduction in luminal diameter by the atherosclerotic lesion was used as the basic criteria for grading the degree of coronary atherosclerosis. It has been found previously that the degree of luminal obliteration corresponds closely to the extent of surface-area involvement. Those coronary arteries that only contained flat lipid streaks were graded as plus-minus, diminution in luminal diameter up to 20 per cent was graded as 1+, up to 40 per cent 2+, and up to 70 per cent 3+. Individuals with advanced coronary atherosclerosis, in whom an accident had occurred and in whom insufficient trauma was present to account for death, were excluded because the possibility existed that coronary occlusion might have precipitated the accident. The number of such cases excluded were few and could not significantly alter the findings. The occupations of the individuals were determined by interviews with close relatives, employers of the deceased, insurance records, and the results and records of police investigations.

Those cases in which the findings at autopsy were consistent with diabetes mellitus, chronic renal disease, cirrhosis of the liver, or hypothyroidism were excluded from the study because of the possible influence of such conditions on the atherogenic process. Also eliminated were cases with a proved previous clinical history of hypertension or diabetes mellitus. The final group of cases therefore consisted essentially of white men who had no significant disease process that might, in our present state of knowledge, influence the rate of development of coronary atherosclerosis.

Men in such occupations as accountant, bank clerk, chauffeur, business executive, stenographer, were classified in the sedentary group. Those in such occupations as construction worker, gardener, letter carrier, and plumbcr, were classified in the physically active group. No reliable information was available about the physical activity engaged in during the leisure time of these individuals. Only those cases were included in which it was believed that a reliable occupational history had been obtained.

Results

The degree of coronary atherosclerosis in 207 individuals who met the criteria was determined. One hundred of these were classified, according to their occupations, into the sedentary group, and 107 into the physically active group. In tables 1 and 2 are noted the number of cases in each age group and the degree of coronary atherosclerosis. In each age group the average degree of coronary atherosclerosis is listed in the final column under the heading "Index." In each age group the degree of coronary atherosclerosis in the 2 occupational categories was not significantly different. Figure 1 shows the degree of atherosclerosis in the 2 occupational categories at the various age levels to be similar.

Discussion

The reported greater tendency for individuals in sedentary occupations to have myocardial infarction, and to die of it at younger ages than individuals in physically active occupations cannot be explained by significant

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Table 1

Degree of Coronary Atherosclerosis in Sudden Fatalities from Accident, Suicide, and Homicide (Sedentary Occupations)

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of cases</th>
<th>Degree of Atherosclerosis</th>
<th>Degree of Atherosclerosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>31-35</td>
<td>8</td>
<td>+</td>
<td>0.9</td>
</tr>
<tr>
<td>36-40</td>
<td>2</td>
<td>+</td>
<td>1.36</td>
</tr>
<tr>
<td>41-45</td>
<td>2</td>
<td>+</td>
<td>1.50</td>
</tr>
<tr>
<td>46-50</td>
<td>1</td>
<td>+</td>
<td>1.82</td>
</tr>
<tr>
<td>51-55</td>
<td>0</td>
<td>+</td>
<td>2.33</td>
</tr>
<tr>
<td>56-60</td>
<td>0</td>
<td>+</td>
<td>2.12</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>26</td>
<td>39</td>
</tr>
</tbody>
</table>

*Index figures are the average degree of coronary atherosclerosis as indicated by the number of pluses for the cases in the particular age group.

Table 2

Degree of Coronary Atherosclerosis in Sudden Fatalities from Accident, Suicide, and Homicide (Physically Active Occupations)

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of cases</th>
<th>Degree of coronary atherosclerosis</th>
<th>Degree of coronary atherosclerosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>31-35</td>
<td>8</td>
<td>+</td>
<td>0.77</td>
</tr>
<tr>
<td>36-40</td>
<td>3</td>
<td>+</td>
<td>1.36</td>
</tr>
<tr>
<td>41-45</td>
<td>4</td>
<td>+</td>
<td>1.35</td>
</tr>
<tr>
<td>46-50</td>
<td>2</td>
<td>+</td>
<td>1.9</td>
</tr>
<tr>
<td>51-55</td>
<td>2</td>
<td>+</td>
<td>2.15</td>
</tr>
<tr>
<td>56-60</td>
<td>0</td>
<td>+</td>
<td>2.21</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>24</td>
<td>36</td>
</tr>
</tbody>
</table>

*Index figures are the average degree of coronary atherosclerosis as indicated by the number of pluses for the cases in the particular age group.
ACTIVITY AND CORONARYATHEROSCLEROSIS

differences in the degree of coronary atherosclerosis at comparable age levels, according to
our findings. If these results are valid, reasons are needed other than the degree of coronary
atherosclerosis. Eckstein demonstrated in experimental studies on dogs that partial coronary
occlusion followed by exercise produced a significantly greater degree of intercoronary
collateral anastomoses than the same grade of experimental coronary occlusion in animals
that are not exercised. Lesser degrees of experimental coronary occlusion were associated
with the development of anastomotic channels only when the dogs received sufficient exercise.
These collateral channels were demonstrated in dogs to be anatomically similar to those
observed in the human hearts of individuals who have been subjected to chronic degrees of rela-
tive cardiac anoxia. These experimental findings appear to be pertinent to the currently
reported study. A partial answer to the human problem may be based upon differences in the
collateral myocardial circulation in the more physically active man. Physical activity, as
reflected by the type of occupation, in combination with the gradual atherosclerotic nar-
rowing of the coronary arteries, may stimulate the development of a more efficient collateral
circulation. Therefore, at any time the myocardium of the physically active man is better
able to cope with any sudden or acute disturbance than that of the sedentary man with
the same degree of coronary atherosclerosis, whose collateral vessels have not developed to
the same extent.

This mechanism as a possible explanation for the differences in the age-specific mortality
or morbidity rates from sudden coronary occlusion in different occupational groups must
be considered in any investigation into the various problems concerned with prevention
or treatment of coronary atherosclerosis. Clinical evaluation of so-called anti-atherosclerotic
agents should be made on individuals within the same occupational grouping. Evalu-
ations of incidence of coronary artery disease in different population groups and geographic

areas, or at different periods of times, must also take this factor into account. Differences
in the frequency of ischemic heart disease may be based on the state of the collateral circu-
lation in the myocardium and not on the degree of atherosclerosis. Such differences might
result from variations in the distribution of occupational categories in various areas at dif-
ferent time: what might be considered to be an increase in recent times in the incidence of
coronary atherosclerosis might, to some extent, only reflect a shift in the nature of the work-
ing population from heavy physical labor to more sedentary occupations as a result of
mechanization and automation.

In prior studies on the same series of autopsies, it has been demonstrated that the distribu-
tion of various constitutional body types is not significantly different in the sedentary and
more active occupational groups. Therefore, this cannot be considered as a serious factor
that might significantly influence the conclusions. Confirmation of this concept must
wait postmortem coronary arterial injection studies, in which the anastomoses are quantita-
tively measured, and in which the degree of coronary atherosclerosis has been estimated in
individuals of various age levels in the different occupational categories.
Summary
In autopsies on "normal" white men between the ages of 30 and 60, who died suddenly from accident, homicide, or suicide, there were no significant differences in the degree of coronary atherosclerosis in those engaged in sedentary occupations and those engaged in physically active occupations.

Summario in Interlingua
In le necropsias de "normal" homines de raeia blanc de etates de inter 30 e 60 annos—morte subite mente in accidentes o per homi- o suicidio—nulle significative differentias esseva note in le grado de atherosclerosis coronari inter le subjectos de occupaciones sedentari e le subjectos ingagiate in occupaciones a activitate physic.

We medical men never really think of ourselves as professors because we look upon university connections as opportunities for doing our own work. As for our teaching obligations, as we grow wiser we learn that the relatively small fractions of our time which we spend with well-trained, intelligent young men are more of a privilege than an obligation. For these groups are highly selected, each year more thoroughly prepared, and they force the teacher continually to renew the fundamental premises of the sciences from which his specialty takes off. It keeps us as keen as we are individually able to be, for, in a rapidly moving subject, there is a vis a tergo that keeps pushing us up, and we profit from it most directly through the fresh young blood that is pumped into our brains each year by the eager youngsters who won't stand for pedantic nonsense.

So while we are, technically speaking, professors, we are actually older colleagues of our students, from whom we often learn as much as we teach them. This, and the sense of humility that is constantly forced upon honest investigators by the incompleteness of their own small victories over the secrets of nature, keep us from developing that sense of sacred superiority that is shared by some academicians only with the monkeys of Benares.—HANS ZINSSER. As I Remember Him. Boston, Little, Brown & Company, 1940, p. 293. (Submitted by H. M. Marvin, M.D.)
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