Mortality Risk of Exercise Associated Coronary Events Compared with Those Occurring at Rest

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SUMMARY: This paper examines the total incidence of coronary events in British Army males in a five year period and shows that, whether diagnostic criteria are strict or lax, the mortality rate for coronary events occurring during strenuous exercise is no greater than that for such events occurring at rest.

Introductions

During exercise myocardial oxygen demand is increased. Coronary artery occlusion occurring by chance at this time might be expected to be associated with an increased risk of mortality via, for example, an increase in infarct size. While anecdotes abound, the author is unaware of any work specifically orientated to this topic. The major difficulties in a study such as this are the problem of retrospective confirmation of the accuracy of the diagnosis in a large population and the completeness of recording of the patient's activity at the time of the coronary event. The quality and completeness of Army records make this study possible.

Subjects and Methods

Only British Army males were considered (thus excluding the Brigade of Gurkhas and the Women's Services) who had suffered a coronary event between 1 January 1973 and 31 December 1977. During that period strenuous activity after a coronary event was actively discouraged. There were 582 such events of which 156 were fatal. The diagnosis of a fatal coronary event was made or confirmed at post mortem in 137 cases. Of the 19 cases not so confirmed nine had clinical and electrocardiographic evidence of acute infarction at demise and a further 10 had a history of previous infarction of whom seven had chest pain as a terminal symptom. These 156 deaths were culled from the records of the medical statistics branch of the Ministry of Defence. That they were the total number of deaths in that period was confirmed by reference to the Casualty List, compiled separately by another branch of the Ministry. Examination of the medical records of these 156 deaths revealed information on the deceased's activity within six hours of demise in 98 cases (62%). In a further 19 cases the deceased had a serious illness likely to preclude strenuous exercise (16 had a previous myocardial infarction, two occurred in the post-operative period, and one was an asthmatic on treatment). Thus in 117 cases (75%) a clear statement could be made as to whether or not the deceased had undertaken strenuous exercise within six hours of demise. The actual number who had was 22 (Table 1).

It is, and has been, Army policy that any suspected coronary event, of whatever nature, is assessed in hospital. No cases are treated at home. With our youthful population, and a high percentage of youthful, inexperienced Army doctors as general practitioners, and Regimental Medical Officers, it is likely that this policy was complied with fully. Nevertheless, it can be seen that admission to hospital is inherent in the definition of a coronary event.

Table 1
Deaths from coronary heart disease in relation to strenuous exercise.

No	Age	Activity	Dominant Lesion
1	25	football	thrombotic occlusion
2	40	football	thrombotic occlusion
3	34	rugby	thrombotic occlusion
4	39	three mile run	thrombotic occlusion
5	25	brawling	thrombotic occlusion
6	29	climbing	thrombotic occlusion
7	35	circuit training	thrombotic occlusion
8	35	football	thrombotic occlusion
9	43	training run	thrombotic occlusion
10	41	football	atheromatous occlusion
11	35	climbing	atheromatous occlusion
12	36	football	severe stenosis
13	34	three mile run	severe stenosis
14	31	training run	severe stenosis
15	45	running	severe stenosis
16	32	cross country run	severe stenosis
17	37	marching	severe stenosis
18	42	cycling	severe stenosis
19	30	running	severe stenosis
20	34	rugby	moderate stenosis
21	41	lifting weights	necropsy data not available
22	49	tennis	necropsy not carried out

The number of non-fatal coronary events which occurred, and the number of patients in whom they occurred, were taken from the hospital discharge summaries received by the medical statistics department which receives reports of hospital admissions as well. These admission figures were used to assess the completeness of the discharge reporting. Hospital discharge reports are received for 89% of all hospital admissions, including those to civilian hospitals, the frequency of reporting varying with the severity of the condition and the length of stay in hospital (by reason of military exercise, billet accommodation etc, the Army admits many minor cases to hospital). Coronary Heart Disease (CHD) is not separately recorded in admission reports, being lumped under Circulatory Diseases (Chapter VI of the International Classification of Diseases, 8th revision), but the report rate for similarly serious diseases such as neoplasia, psychiatric illness, and acute appendicitis is 100%.

Only cases reportedly due to CHD were investigated to ascertain the minutiae of the diagnosis. Thus no check was made on all other diagnostic categories to find cases of CHD which had been missed. The diagnosis of CHD was made in all cases by hospital physicians. 426 such episodes (non-fatal) were reported.

Such was the quality of the records that the likelihood of the physician's diagnosis being accurate could be assessed. Four categories of probability were used (Table 2). The diagnosis of myocardial infarction could be verified in 195 cases by a history of typical chest pain and unequivocal electrocardiographic evidence of acute transmural infarction in all cases. Supporting evidence (usually cardiac enzyme levels, but also in some cases

Table 3	
Criteria for probable coronary event	
T wave flat or inverted in S1 lead of ECG	17
Inferior MI diagnosed on inferior Q waves or transient T change on ECG with no rise in enzymes	7
Transient ST elevation or depression	2
Positive exercise test	5
Left ventricular failure with past proven CHD	4
Left ventricular failure with CHD proven at post mortem	3
Ventricular tachycardia or ventricular fibrillation with previously proven myocardial infarction	4
Intermittent atrial fibrillation with previously proven myocardial infarction	1
Q waves in lead S1 of the ECG with elevated enzymes	1
Chest pains only with acute myocardial infarction two months later	1
Coronary bypass surgery as the only record	1
Equivocal ECG and elevated enzymes	1
ECG – Electrocardiogram	
MI – Myocardial infarction	

Table 2

Categories of diagnostic probability of CHD in survivors.

Category	Diagnosis	Associated with strenuous exercise	Not associated with strenuous exercise	Total
1	Myocardial infarction	26	169	195
2	Angina	14	36	50
3	Probable CHD	8	39	47
4	Doubtful CHD	12	62	74
	Not CHD	–	–	16
	Missing data	–	–	9
	Investigative admissions	–	–	35
	Total	60	306	426

Strenuous exercise is defined as any exercise likely to induce shortness of breath in a normal individual, ie. anything more vigorous than a brisk walk on the flat.

thallium scan or angiography) was also available in all but 43 cases. The typical history of angina in 50 cases was supported by a positive maximal exercise test in 15, angiography in 11, ischemic electrocardiogram in five, previous infarction in eight, and subsequent infarction in 11. Probable CHD was diagnosed when there was typical chest pain (typical of myocardial ischemia) with other abnormalities suggestive of CHD but not amounting to transmural infarction (Table 3). The criteria used to diagnose doubtful CHD are detailed in Table 4. A further 60 episodes recorded as coronary events are excluded from further discussion. These are 16 events labelled as CHD in which there were data to confirm conditions associated with, or likely to mimic, but none to incriminate CHD itself (Table 5), 35 admissions which were for further investigations and not for the coronary event, and nine cases in which the central medical file could not be obtained.

Of the 366 episodes in these four categories, 74 were second or subsequent episodes and the subjects were therefore unlikely to have been taking strenuous exercise. Of the remaining 292 in whom a single event occurred during the period of study, 23 had had a coronary event prior to this time, and these too were unlikely to have been exercising. There remain 269, in whom a history of exercise was available in 125 and a history of rest in 95, leaving only 49 (13%) in whom no such data were available (Table 6). Of the 125 in whom a history of exercise was given, only 60 were indulging in strenuous exercise (Table 7). In the other 65 cases the patient was said to have exercise associated chest pain without the type of exercise being specified. Almost all of these fell into the angina or doubtful CHD diagnostic

Table 4
Doubtful cases of Coronary Heart Disease

Previous infarction. Little evidence of a new event	13
ECG changes during non-CHD illness or surgery	8
Chest pain unsupported by other evidence of an event	19
Chest pain with equivocal ECG or exercise test	18
Chest pain with normal ECG but raised cardiac enzymes	7
Chest pain with positive ECG or exercise test but with negative thallium scan or angiogram	8
Abnormal ECG only	1
	74

Table 5
Conditions wrongly diagnosed as Coronary Heart Disease

1. Mitral leaflet prolapse
2. Hypertension
3. Atypical chest pain. Bad family history
4. Hypertension. Intermittent claudication
5. Chest pain. Psychiatric discharge
6. Femoral aneurysm
7. Hypertrophic cardiomyopathy
8. Computer error
9. Intermittent atrial fibrillation
10. Abnormal ECG. Normal angiogram
11. Pneumonia and myopericarditis
12. Exercise associated chest pain
13. Renal artery stenosis. Hypertension. Left ventricular failure.
14. Hypertension. Diabetes. CVA. Claudication
15. Chest pain. Equivocal ECG. Positive exercise test. Hypoplastic circumflex coronary artery without atheroma.
16. Unable to pass basic fitness test.

CVA – Cerebrovascular accident

categories and carried a bald statement such as “the patient complained of chest pain on exertion”, often with a remark on duration eg: “for six weeks”. Under these circumstances it was thought likely that the exercise was an exaggeration of normal activity rather than strenuous. Also it was felt that the severity of exertion would influence the patient’s statements and so those of the recorder. Finally, since exercise associated non-fatal events are the denominator, the use of the smaller figure ensures than any error will exaggerate the mortality rate from exercise related events.

Results

Of 582 episodes diagnosed as coronary events, 60 (all non-fatal) were excluded for reasons already explained. Of the remaining 522 coronary events, 156 had a fatal

outcome (30%). Twenty-two of the fatal (Table 1) and 60 of the non-fatal (Table 7) coronary events were associated with strenuous exercise, giving a mortality rate for exercise-related events of 27%, which is not significantly different. When only proven transmural infarction is considered, and assuming that all deaths from CHD had, or would have had, transmural infarction, then there were 156 deaths from transmural infarction and 195 survivors, giving an overall death rate of 44%. Twenty-two fatal (Table 1) and 26 non-fatal (Table 7A) transmural infarctions were related to strenuous exercise, giving an exercise associated mortality of 46%.

There were 292 non-fatal events in the proven and probable categories (Table 2) giving an overall mortality for those likely to have had a coronary event as 35% (Table 8). Forty-eight of those non-fatal events were exercise related (Table 7A, B, C), giving an exercise associated mortality of 31% (Table 8).

Discussion

In 13% of non-fatal events an exercise history was not recorded. The effect of any further exercise associated cases in this group would have been to lower mortality from exercise associated events. Similarly, in 65 cases where the record merely stated “chest pain on exertion” the exercise was assumed not to be strenuous. Any error resulting from this assumption would lower exercise mortality still further. No exercise data were available in 39 of the 156 fatalities. A plausible reason for this is that no connection with exercise existed. In any case it is likely that the proportion of exercise deaths in this group was smaller than in the main group. But even if it was

Table 6
Breakdown of activity data.

Total events	582
Deaths	156
History of strenuous exercise	
History of normal activity	
History of serious illness	
No exercise data available	
Survivors	426
Wrong diagnosis	
Investigative readmissions	
No CHD data available	
History of strenuous exercise	
History of unspecified exercise	
History of normal activity	
History of previous coronary event within the study period	
History of previous coronary event outwith the study period	
No exercise data available	

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Table 7

Survivors a coronary event during strenuous exercise.

A. Myocardial Infarction

No	Age	Activity
1	33	circuit training
2	47	squash
3	39	hockey
4	38	6-a-side football
5	31	12 mile route march
6	47	walking the dog
7	34	3 mile run
8	43	3 mile run
9	42	one mile run
10	34	3 mile run
11	43	hockey
12	42	mowing the lawn
13	36	mountaineering
14	40	squash
15	36	4 mile run
16	25	swimming
17	41	lifting a weight
18	43	stoking a boiler
19	26	3 mile run
20	42	moving house
21	35	football
22	29	3 mile run
23	51	golf
24	47	tennis
25	43	walking steep hill
26	44	lifting boxes

B. Angina

No	Age	Activity
1	34	road running
2	39	walking uphill
3	37	3 mile run
4	44	lifting boxes
5	33	playing football
6	35	stoking boiler
7	37	3 mile run
8	38	cross country run
9	38	coitus
10	33	dancing
11	37	swimming
12	49	climbing stairs
13	41	40 step-ups
14	46	walking uphill

Table 7 cont

C. Probable CHD

No	Age	Activity
1	33	running
2	39	running
3	43	tennis
4	45	gardening
5	36	5-a-side football
6	47	running
7	41	gardening
8	45	climbing stairs

D. Doubtful CHD

No	Age	Activity
1	42	walking uphill
2	35	swimming
3	33	running
4	39	running training
5	40	hill walking
6	28	rugby
7	35	3 mile run
8	40	marching
9	36	walking uphill
10	43	cycling
11	29	one mile run
12	35	half mile run

Table 8

Mortality rate for coronary events

	OVERALL	STRENUOUS EXERCISE
Crude Mortality	$\frac{156}{582} = 27\%$	$\frac{22}{82} = 27\%$
Corrected Mortality	$\frac{156}{522} = 30\%$	$\frac{22}{82} = 27\%$
Mortality from proven transmural infarction	$\frac{156}{351} = 44\%$	$\frac{22}{48} = 46\%$
Mortality from proven and probable coronary events	$\frac{156}{448} = 35\%$	$\frac{22}{70} = 31\%$

the same, this would add another four deaths to the 22 already discovered and raise the exercise mortality to 30% which is identical to the overall mortality figure. Thus it can be seen that the mortality from coronary events occurring during strenuous exercise is no greater than that from those occurring at rest and this conclusion remains valid whether diagnostic criteria of a coronary event are strict or lax.