The Johannesburg cardiac rehabilitation programme

A. G. DIGENIO, J. G. M. SIM, K. KRIGE, A. STEWART, R. MORRIS, R. J. DOWDESWELL, G. N. PADAYACHEE

Summary

Cardiac rehabilitation has become a generally accepted mode of treatment for patients suffering from coronary artery disease. The Johannesburg cardiac rehabilitation programme was started in 1982 and has rapidly grown to become one of the largest programmes in southern Africa.

This paper describes the 387 patients admitted to the unit between June 1986 and July 1988 and evaluates the effects of a combined exercise training and lifestyle modification programme.

The mean age on admission was 55 years for males and 58 years for females. Most patients were from social classes I and II. Myocardial infarction, coronary artery bypass graft and a combination of both were the most common reasons for admission (35,4%, 23% and 21,2% respectively). On admission 72,9% of patients were smokers, 26,3% had hypertension and 34,3% had hypercholesterolaemia.

A 50% drop-out rate within 12 months of starting the programme was noted. An increase in peak oxygen uptake, weight and skinfold thickness reduction, and improvement in the lipogram were seen after 6 months in patients who complied well with the programme.

Cardiac rehabilitation is a secondary preventive strategy that can complement traditional medical and surgical therapies.

S Afr Med J 1991; **79:** 183-187.

Cardiac rehabilitation, including supervised exercise therapy, has become a generally accepted mode of treatment for patients suffering from coronary artery disease (CAD).[1-4] Functional capacity,[2-5] psychosocial well-being[1,5,6] and plasma lipoproteins[7,8,9] have been favourably modified by aerobic training in cardiac rehabilitation programmes.

In addition, a recent meta-analysis of 10 randomised clinical trials by Oldridge *et al.*[10] showed a 24% reduction in general mortality and a 25% decrease in cardiovascular mortality in patients undergoing cardiac rehabilitation.

In 1980 about 50 000 South Africans suffered a myocardial infarction and of these approximately 25% were fatal. Many of the possible 37 000 survivors could have been candidates for cardiac rehabilitation programmes if these had been available.[11]

In terms of the Health Act of 1977 rehabilitation is the statutory responsibility of local authorities, and cardiac rehabilitation was the first rehabilitative endeavour undertaken in Johannesburg by the City Health Department, as cardiovascular disease was deemed a priority in the area.

The Johannesburg City Health Department Cardiac Rehabilitation Centre was established in September 1982. Designed as a pilot scheme, it has rapidly grown to become the largest rehabilitation programme of this kind in southern Africa.

The programme serves as a phase III community-based rehabilitation programme for sufferers from coronary artery disease, beginning 8 - 12 weeks after hospitalisation. It includes supervised exercise training sessions and a lifestyle modification programme aimed at risk factor modification.

The aim of this study was to describe all patients admitted to the Johannesburg Cardiac Rehabilitation Centre over a 2-year period (June 1986 - July 1988) with reference to socio-demographic characteristics, risk factors for coronary artery disease and medical condition on admission, and to evaluate the effects of a combined health education and exercise training programme on these patients' functional capacity, body mass and lipid profile.

Subjects and methods

All patients (387) admitted to the Centre between June 1986 and July 1988 were used as subjects in this study. They were all medically referred and included: (*i*) patients with known CAD (those who had had myocardial infarction (MI), coronary artery bypass graft surgery (CABG) or percutaneous transluminal coronary angioplasty (PTCA), and those with chronic stable angina); (*ii*) patients with major coronary risk factors only; and (*iii*) patients who had undergone surgery for valvular or congenital heart disease.

Initial evaluation

On admission to the programme all patients underwent a full medical evaluation, which included a complete medical history followed by a comprehensive cardiovascular examination, a resting ECG and a multistage symptom-limited exercise test. A flow volume loop was obtained from a forced expiratory manoeuvre. Anthropometric evaluation included the calculation of the body mass index and the percentage body fat.

The Chung protocol[12] was used on admission in most cases, reserving the Bruce protocol[13] with its inherently high metabolic requirements for fitter patients, usually after they had been on the programme for at least 6 months. Patients unable to walk on a treadmill owing to physical disability were tested on a bicycle ergometer according to the World Health Organisation protocol.[14]

Continuous ECG, respiratory gas analysis and blood pressure monitoring at each stage of the exercise test were carried out, with ECG and blood pressure monitoring continued during recovery. Oxygen uptake, minute volume and the respiratory quotient were measured using the Jaeger Sprint metabolic cart.

Exercise end-points used included exhaustion, development of severe angina, ST-segment depression of more than 3 mm,

Cardiac Rehabilitation Centre, Johannesburg City Health Department
A. G. DIGENIO, M.B. B.CH.
K. KRIGE, B.SC. (NURSING)
A. STEWART, B.SC. (PHYSIO.), D.P.E.
R. MORRIS, M.D., M.R.C.P.
R. J. DOWDESWELL, F.C.P. (S.A.)
G. N. PADAYACHEE, M.B. B.CH., D.T.M. & H., M.MED. (COMM. HEALTH)
National Institute for Virology, Johannesburg
J. G. M. SIM, M.B. B.CH., B.SC., D.T.M. & H.

sustained ventricular tachyarrhythmias and a drop of more than 10 mmHg in systolic blood pressure.[15]

Plasma lipoprotein analysis included the determination of total cholesterol (TC), triglycerides, low-density lipoprotein (LDL), high-density lipoprotein (HDL) and the TC/HDL ratio.

All patients were classified into one of five social classes according to the Registrar-General system from the UK.[16]

All patients completed the following self-report psychological scales: the Jenkins Activity Survey,[17] the Institute for Personality and Ability Testing (IPAT) Anxiety Scale,[18] the Beck Depression Inventory,[19] the Anger Expression Scale,[20] and the Hostility and Direction of Hostility Scale.[21]

Rehabilitation programme

The intensity of exercise was set using the heart rate achieved at the ventilatory threshold during the initial stress test (70 - 85% of the maximal heart rate). The ventilatory threshold was defined as the point where the ventilation diverges from the oxygen uptake on the ventilation/oxygen uptake graph. Patients were required to exercise at this prescribed intensity 3 times a week for 30 - 45 minutes of continuous activity. The unit favours walking, walk-jogging or jogging where possible. Cycling was prescribed in the high-risk group or when weight-bearing exercise was contraindicated.

During the first 6 months of the programme all patients were carefully monitored by the staff during their exercise sessions. They were also encouraged to attend weekly discussions on risk factor modification, diet, aspects of heart disease, stress management and the exercise programme.

After the initial 6-month period, patients were subjected to re-assessments which included an exercise test and psychometric testing. They were gradually encouraged to assume more and more responsibility for their own rehabilitation, until eventually after 18 months they were placed onto a maintenance exercise programme (phase IV rehabilitation). These patients followed a suggested exercise regimen at home in their own time, and reported to the unit once a month. Patients still considered to be at high risk continued to exercise at the unit.

Data collection

Each patient's compliance with the programme was monitored on a daily basis in terms of attendance at exercise sessions and the intensity of exercise, i.e. the percentage of training heart rate achieved. All assessment and compliance data were captured on a computer.

For the purposes of this study percentage attendance was used as a measure of compliance and patients were classified into the following compliance categories: 80 - 100%, 60 - 79%, 40 - 59% and less than 40% attendance.

Data analysis

Sociodemographic, medical, anthropometric, exercise test and lipoprotein profile data recorded on admission are described for all patients. The effects of the intervention on anthropometric, exercise test and lipoprotein measurements were evaluated after 6 months using the Student's *t*-test for paired samples. Any subject who had missing values for certain variables was excluded from the analysis for those variables.

The information regarding the effects of our programme on psychological well-being is still being processed and analysed.

Results

Patient profile

Of the 387 patients admitted to the programme, 167 (43,2%) were referred by private cardiologists. The mean age on admission was 55 years for males and 58 years for females (Fig. 1). The male/female ratio was 8:1 (344 v. 43). Most of the patients were from social class I (43,1%) and II (41,1%), with only 15,8% from social classes III and IV.

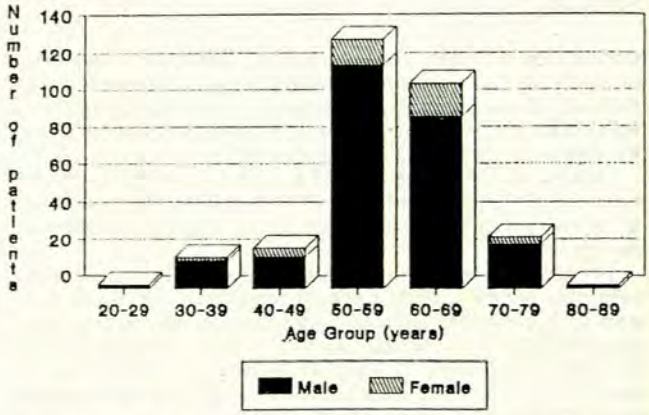

Fig. 1. Age distribution of patients admitted to the Centre between June 1986 and July 1988.

The most common conditions were MI, accounting for 35,4% of total admissions, CABG, accounting for 23%, and a combination of both, accounting for 21,2%; 8,6% of patients were referred after PTCA and 11,8% had stable angina or major coronary risk factors or had undergone cardiac surgery other than coronary artery bypass (Fig. 2).

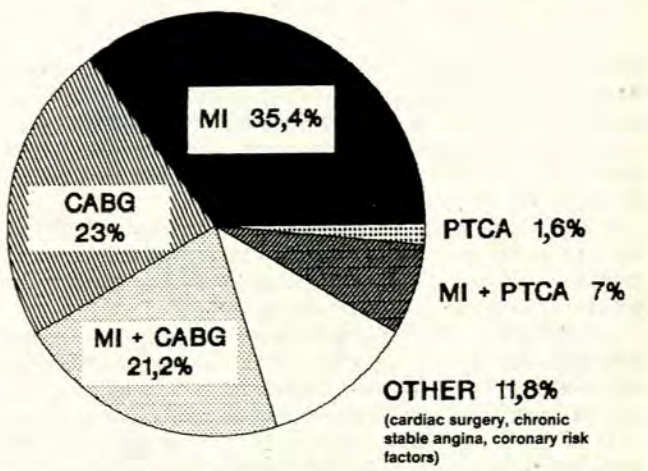

Fig. 2. Medical conditions referred to the Centre between June 1986 and July 1988.

Smoking as a risk factor was present in 72,9% of patients on admission; of these 6% were still smoking while on the programme. Twenty-six per cent (26,3%) of patients admitted had a history of hypertension and were on treatment for it, while 34,3% had severe hypercholesterolaemia (above the 80th percentile as defined by the Consensus Conference on Hypercholesterolaemia and Coronary Artery Disease in South Africa)[22] (Fig. 3).

Most patients admitted (49,3%) had a single major risk factor for coronary artery disease, 32,8% had two major risk

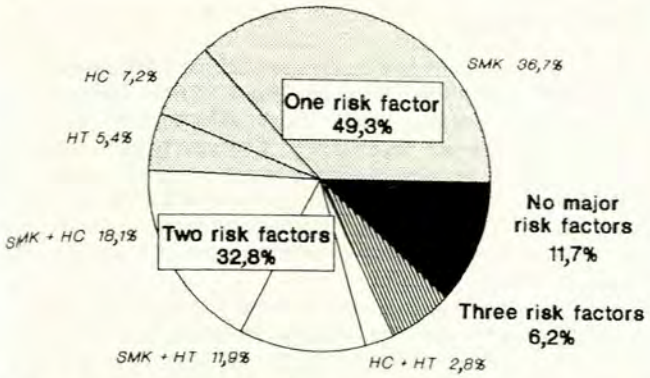

Fig. 3. Major risk factors on admission to the Centre between June 1986 and July 1988 (SMK = smoking; HT = hypertension; HC = hypercholesterolaemia).

factors, 6,2% had all 3 major risk factors, and only 11,7% had no major risk factors.

The number of patients who stopped attending the programme increased gradually over time, and at 12 months 50% of patients had left the programme. Of those who remained on the programme for 6 months, 75,1% attended more than 40% of the possible sessions (Fig. 4). By 12 months on the programme this figure was reduced to 51,3%, with a similar profile by 18 months.

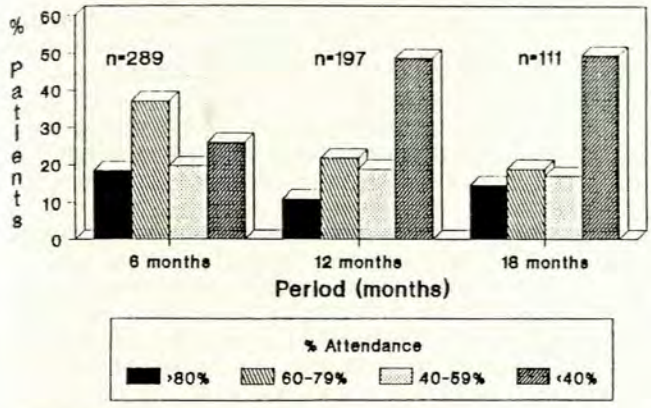

Fig. 4. Distribution of patients by compliance category.

Changes with the intervention programme

The patients who attended more than 40% of the possible sessions improved their peak oxygen uptake (VO_2) significantly ($P < 0,01$), with increases ranging from 16,21% to 21,65%. Those who attended less than 40% of the possible sessions did not show any significant improvement in functional capacity (Table I). No difference in the improvement in functional capacity was found between patients who had had an MI and those who had undergone CABG.

Weight reduction in the first 6 months on the programme was significant only in the two higher compliance categories (Table I). A significant reduction in skinfold thickness was only achieved by patients who had attended between 60% and 79% of the possible sessions (Table I).

The same trend as for weight loss was seen in serum triglyceride levels, with significant reductions in the top two compliance categories (Table II).

All the rest of the lipogram variables moved in a positive direction in the high-compliance group after 6 months, but only the TC/HDL ratio showed a statistically significant change (Table II).

TABLE I. MEAN CHANGES (±SD) IN FUNCTIONAL CAPACITY, WEIGHT AND SKINFOLD MEASUREMENTS AFTER 6 MONTHS OF REHABILITATION, ACCORDING TO COMPLIANCE CATEGORY

	Attendance											
	>80%			60 - 79%			40 - 59%			<40%		
	Adm.	6 mo.	No.	Adm.	6 mo.	No.	Adm.	6 mo.	No.	Adm.	6 mo.	No.
VO_2 (ml/kg/min)	24,57 ± 4,93	29,69 ± 6,17 $P < 0,01$	47	25,59 ± 5,76	30,15 ± 7,68 $P < 0,01$	90	24,69 ± 5,61	28,30 ± 5,83 $P < 0,01$	32	28,26 ± 6,47	29,78 ± 8,34 NS	7
Weight (kg)	77,10 ± 12,5	75,39 ± 10,8 $P < 0,01$	47	78,30 ± 12,6	77,12 ± 12,6 $P < 0,05$	90	80,42 ± 13,0	79,89 ± 12,5 NS	32	78,38 ± 11,2	78,57 ± 12,5 NS	7
Skinfold	45,52 ± 11,8	43,46 ± 14,5 NS	47	51,71 ± 15,5	48,50 ± 15,8 $P < 0,01$	90	54,13 ± 20,0	54,05 ± 21,7 NS	32	44,46 ± 20,5	44,87 ± 19,7 NS	7

Adm. = admission; NS = not significant.

TABLE II. MEAN CHANGES (± SD) IN LIPOPROTEIN PROFILE AFTER 6 MONTHS OF REHABILITATION, ACCORDING TO COMPLIANCE CATEGORY

	Attendance											
	> 80%			60 - 79%			40 - 59%			< 40%		
	Adm.	6 mo.	No.	Adm.	6 mo.	No.	Adm.	6 mo.	No.	Adm.	6 mo.	No.
TCO (mmol/l)	6,21 ± 1,01	5,91 ± 0,93 NS	35	6,27 ± 1,31	6,09 ± 0,99 NS	62	7,23 ± 1,78	6,91 ± 1,22 NS	29	6,32 ± 1,13	5,79 ± 1,30 NS	3
Trig. (mmol/l)	1,79 ± 0,68	1,55 ± 0,58 $P < 0{,}01$	33	2,30 ± 1,65	1,87 ± 1,07 $P < 0{,}05$	60	2,35 ± 1,07	2,18 ± 1,09 NS	28	1,83 ± 1,07	1,92 ± 1,43 NS	3
HDL (mmol/l)	1,04 ± 0,26	1,09 ± 0,26 NS	34	1,03 ± 0,19	1,06 ± 0,21 NS	56	0,99 ± 0,25	0,95 ± 0,22 NS	27	0,94 ± 0,02	1,03 ± 0,08 NS	3
LDL (mmol/l)	4,32 ± 1,04	4,10 ± 1,00 NS	34	4,28 ± 1,06	4,17 ± 0,90 NS	58	4,98 ± 1,32	4,85 ± 1,05 NS	28	4,55 ± 0,72	3,88 ± 0,30 NS	3
TC/HDL ratio	6,32 ± 1,86	5,73 ± 1,73 $P < 0{,}05$	35	6,08 ± 1,38	5,83 ± 1,23 NS	58	7,67 ± 2,70	7,69 ± 2,29 NS	29	6,75 ± 1,24	5,62 ± 0,65 NS	3

Adm. = admission; NS = not significant; Trig. = triglycerides.

Discussion

Data from death certificates show that at least 500 people die from CAD every year in Johannesburg. On the basis of the assumption that approximately 75% of subjects who suffer an MI survive,[11] it can be estimated that approximately 2 000 people are potential candidates for cardiac rehabilitation every year in Johannesburg. However, between June 1986 and July 1988 only 387 patients were admitted to the unit. This figure indicates under-utilisation of the unit by CAD sufferers in Johannesburg.

The majority of patients admitted were from social classes I and II, a point of some concern, since it has been well established that social class may predict risk after MI, the lower social classes having a poorer prognosis.[23]

The most common medical condition for which patients were referred was MI. A large percentage of patients who had undergone CABG were admitted, but over the years more patients have been referred after PTCA. There is no doubt that after CABG patients also benefit from a programme of supervised exercise and CAD risk factor modification.[2,3] PTCA is now an established form of treatment for selected patients with CAD. A recent study from Ben-Ari and colleagues[24] showed that although after PTCA patients benefit from a cardiac rehabilitation programme in terms of improving their functional capacity and lipoprotein profiles, these modifications were not associated with a reduction in the rate of restenosis, since this usually occurs during the first few months after the procedure.

A history of cigarette smoking was the most common risk factor seen at our centre. The majority of patients have stopped smoking by the time they are admitted, but 6% remained resistant smokers.

Our compliance figures were comparable with those of other cardiac rehabilitation programmes, where an approximate 50% drop-out rate within 12 months of starting a programme has been described.[1]

A previous study in this unit demonstrated that an increased drop-out rate was associated with younger age, current smoking and certain psychological characteristics on admission to the cardiac rehabilitation programme.[25] Compliance-enhancing strategies should be considered in order to reduce the drop-out rate and maximise the benefits of a cardiac rehabilitation programme.

We have seen significant changes in the measured physiological scores in patients who complied well with our cardiac rehabilitation programme. All patients who attended more than 40% of the sessions showed a significant increase in peak Vo_2 in only 6 months, achieving a fitness level compatible with most recreational and occupational activities. Our results are similar to those reported by other cardiac rehabilitation programmes in that a programme of supervised physical exercise can be expected to increase a patient's functional capacity after an MI by an average of 15 - 25%.[2,5] Similar improvements in functional capacity were seen in post-CABG patients after a training programme, which has also been the experience of other cardiac rehabilitation programmes.[5,26]

In the experience of the unit, obesity has been difficult to reduce. Since July 1987 a structured weight reduction programme has begun and weight loss figures have improved with the top two compliance categories showing significant weight loss. The Framingham study[27] has demonstrated that obesity is an independent risk factor for CAD. This association may be due in part to an adverse pattern of plasma lipoproteins in obese people, in particular a low concentration of HDL-cholesterol.[28] Wood *et al.*[9] reported that fat loss through dieting or exercising produces comparable and favourable changes in plasma lipoprotein concentrations.

Plasma triglycerides were significantly reduced after 6 months but their atherogenic role remains controversial.[29] The TC/HDL ratio showed a significant decrease after 6 months

in patients who attended more than 80% of the possible sessions. Although the other lipogram variables moved in a positive direction, the serum cholesterol concentrations in the rehabilitated patients still remained high. Patients are all given dietary advice, from the first day and the importance of reducing body weight, the percentage of energy derived from fat in the diet, especially saturated fat, and daily cholesterol consumption is stressed. We are not in a position to prescribe medication to lower cholesterol values, because the City Health Department has a preventive policy and we do not practise pharmacotherapy, which is left to the patient's doctor.

Epidemiological, genetic and experimental pathological studies have produced evidence of a cause/effect relationship between high cholesterol levels and CAD.[30] More direct evidence was produced by the Lipid Research Clinics Coronary Primary Prevention Trial,[31,32] which showed a 19% reduction ($P < 0,05$) in the rate of fatal and non-fatal CAD associated with a decrease in cholesterol levels.

Exercise training has been shown to improve the lipoprotein profile significantly, but changes in body weight during exercise training may confound observed serum lipid and lipoprotein level changes.[8] A meta-analysis by Tran and Weltman[8] suggested that reductions in cholesterol and LDL were greatest when exercise training was combined with body weight loss. It has also recently been suggested that some of the training influence may be due to acute changes following physical activity rather than to chronic adaptations.[33] A recent report from the Helsinki Heart Study strongly suggests that elevating HDL-cholesterol levels may be at least as effective as lowering LDL-cholesterol levels in the prevention of coronary artery disease.[34] The long-term exercise training programme, the possible acute effects of repetitive exercise sessions, the weight loss and the emphasis on a low-cholesterol diet may account for the reduction in the TC/HDL ratio.

Exercise as a medical treatment has been shown to be an economically effective measure in phase 3 cardiac rehabilitation.[35] The real benefit of cardiac rehabilitation must also include improvements in psychosocial well-being and quality of life.

Conclusions

Patients attending the Johannesburg Cardiac Rehabilitation Unit have shown a significant reduction in coronary risk factors and a significant improvement in their physical work capacity after 6 months. Adequate compliance is essential in order to benefit from a programme of this kind.

Cardiac rehabilitation is a secondary preventive strategy that can complement traditional medical and surgical therapies. The facilities and services offered by the Johannesburg Cardiac Rehabilitation Unit are not as yet fully utilised by patients who could potentially benefit.

The authors wish to acknowledge the help of the following staff members of the City Health Department, without whom publication of this paper would have not been possible: B. G. Winters and Dr B. R. Richard for supporting the unit since its initiation; D. Charleston, L. Daly, D. Huntley and H. Joughin for their care of the patients; A. Carstens for typing the manuscript; J. Addington for his computer services; and Professor H. S. Hurwitz, Medical Officer of Health, for permission to publish.

REFERENCES

1. Oldridge NB. Cardiac rehabilitation programme: compliance and compliance-enhancing strategies. *Sports Med* 1988; **6:** 42-55.
2. Greenland P, Chu JS. Efficacy of cardiac rehabilitation services: with emphasis on patients after myocardial infarction. *Ann Intern Med* 1988; **109:** 650-663.
3. Greenland P, Chu JS. Cardiac rehabilitation services. *Ann Intern Med* 1988; **109:** 671-673.
4. Noakes TD. Rehabilitation through exercise after acute myocardial infarction. *S Afr J Cont Med Educ* 1988; **6:** 79-86.
5. Thompson PD. The benefits and risks of exercise training in patients with chronic coronary artery disease. *JAMA* 1988; **259:** 1537-1539.
6. Shephard RJ, Kavanagh T, Klavora P. Mood state during post coronary cardiac rehabilitation. *J Cardiopulm Rehabil* 1985; **5:** 480-484.
7. Wood PD, Haskell WL, Blair SN *et al.* Increased exercise level and plasma lipoprotein concentrations: a one-year randomized, controlled study in sedentary middle-aged men. *Metabolism* 1983; **32:** 31-39.
8. Tran ZV, Weltman A. Differential effects of exercise on serum lipid and lipoprotein levels seen with changes in body weight. *JAMA* 1985; **254:** 919-922.
9. Wood PD, Stefanick ML, Dreon DM *et al.* Changes in plasma lipids and lipoproteins in overweight men during weight loss through dieting as compared with exercise. *N Engl J Med* 1988; **319:** 1173-1179.
10. Oldridge NB, Guyatt GH, Fischer EM *et al.* Cardiac rehabilitation after myocardial infarction: combined experience of randomised clinical trials. *JAMA* 1988; **260:** 945-950.
11. Steyn K. Cardiac rehabilitation: is it beneficial? *J Cardiac Med* 1989; **18:** 6-7.
12. Chung EK. *Exercise Electrocardiography: Practical Approach.* 2nd ed. Baltimore: William & Wilkins, 1983: 119-131.
13. Bruce RA, Kusumi F, Hosmer D. Maximal oxygen uptake and nomographic assessment of functional aerobic impairment in cardiovascular disease. *Am Heart J* 1973; **85:** 546-562.
14. World Health Organisation Standard Programme. In: *Dynavit Meditronic 40 Operating Instructions.* Kaiserslautern, Germany: Keifer Dynavit, 1982.
15. Detrano R, Froelicher VF. Exercise testing: uses and limitations considering recent studies. *Prof Cardiovasc Dis* 1988; **31:** 173-204.
16. General Register Office. *Classification of Occupations.* London: HMSO, 1960.
17. Jenkins CD, Rosenman RH, Friedman M. Development of an objective psychological test for the determination of coronary prone behaviour pattern in employed men. *J Chronic Dis* 1967; **20:** 371.
18. Cattell RB, Scheier IH. *The IPAT Anxiety Scale.* Champaign, Ill.: Institute for Personality and Ability Testing, 1976.
19. Beck AT, Ward CH, Mendeson M, Mock MJ, Erbaugh J. An inventory for measuring depression. *Arch Gen Psychiatry* 1961; **4:** 561-571.
20. Spielberger CD, Johnson EH, Jacobs GA. *The Anger Expression Scale.* Tampa, Fla: Human Resources Institute, University of South Florida, 1982.
21. Foulds GA. *Personality and Personal Illness.* London: Tavistock Publications, 1965.
22. Rossouw JE, Steyn K, Berger GMB *et al.* Action limits for serum total cholesterol. *S Afr Med J* 1988; **73:** 693-700.
23. Marmot MG. Socio-economic and cultural factors in ischaemic heart disease. *Adv Cardiol* 1982; **29:** 68-76.
24. Ben-Arie, Rothbaum DA, Linnemeir TJ *et al.* Benefits of a monitored rehabilitation programme versus physician care after emergency percutaneous transluminal coronary angioplasty: follow-up of risk factors and rate of restenosis. *J Cardiopulm Rehabil* 1989; **7:** 281-285.
25. Digenio AG, Stewart A, Padayachee GN, Sim JMG. Compliance at the Johannesburg Cardiac Rehabilitation Unit: predictors of drop-out. *Cardiovascular J S Afr*, (in press).
26. Froelicher V, Jensen D, Sullivan M. A randomized trial of the effects of exercise training after coronary artery bypass surgery. *Arch Intern Med* 1985; **145:** 689-692.
27. Hubert HB, Feinleib M, McNamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular disease; a 26-year follow-up of participants in the Framingham Heart Study. *Circulation* 1983; **67:** 968-977.
28. Glueck CJ, Taylor HL, Jacobs D *et al.* Plasma high-density lipoprotein cholesterol: association with measurements of body mass: the Lipid Research Clinics Program Prevalence Study. *Circulation* 1980; **62:** suppl IV, 62-69.
29. Austin MA. Epidemiologic associations between hypertriglyceridemia and coronary heart disease. *Semin Thromb Hemost* 1988; **14:** 137-142.
30. Consensus Conference. Lowering blood cholesterol to prevent heart disease. *JAMA* 1985; **253:** 2080-2086.
31. Lipid Research Clinics Program: The Lipid Research Clinics Coronary Primary Prevention Trial Results: I. Reduction in incidence of coronary heart disease. *JAMA* 1984; **251:** 351-364.
32. Lipid Research Clinics Program: The Lipid Research Clinics Coronary Primary Prevention Trial Results: II. The relationship of reduction in incidence of coronary heart disease to cholesterol lowering. *JAMA* 1984; **251:** 365-374.
33. Kaminsky LA, Nequin ND, Lesmes GR *et al.* Cholesterol, lipoproteins, and triglyceride before, during, and after an ultramarathon road race. *J Cardiopulm Rehab* 1989; **7:** 263-267.
34. Manninen V, Elo MO, Frick MH *et al.* Lipid alterations and decline in the incidence of coronary heart disease in the Helsinki Heart Study. *JAMA* 1988; **260:** 641-651.
35. Shephard RJ. Exercise in secondary and tertiary rehabilitation: costs and benefits. *J Cardiopulm Rehab* 1989; **9:** 188-194.