A Descriptive Study of Selected Health and Fitness Characteristics of a Factory Population.

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Master of Science (M.Sc.), St Andrews University,

1993

DECLARATION

I,Gabriel James Docherty, hereby certify that this thesis has been composed by myself,that it is a record of my own work,and that it has not been accepted in partial or complete fulfilment of any other degree or professional qualification.

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Date 29th May, 1993

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Acknowledgements

The assistance received from the following people is gratefully acknowledged :-

Martin Farrally, John Newton and Andrew Lyon.

In addition I would like to acknowledge everyone of the Vale of Leven Health Promotion Project especially Tom McGlew, Stewart Harper, Sharon MacIlwraith, Alex Stewart, Helen White, Lucy Murie and Ann-Marie Kinch.

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ABSTRACT

This study reports the results of a coronary artery disease risk factor identification programme which was offered to all employees of one of the largest manufacturers in the West of Scotland. The initiative was part of a much larger programme of health promotion activities which were run previous to and in conjunction with the risk factor identification programme. These activities included the running of 'health weeks', the provision of healthier food in the canteen and the provision of exercise opportunities. These activities had been running for up to two years and a half years before the risk factor identification programme began. A series of exercise classes had also been running for the six months prior to the initiative and they continued throughout its duration. The exposure of each subject to the health promotion programme was not recorded.

In total, 1190 employees representing 87% of the workforce were assessed for coronary artery disease risk factors. Blood pressure, height, weight, serum cholesterol, body composition and cardiorespiratory fitness were assessed. Smoking, dietary and physical activity habits were ascertained as was family and personal medical history. The results were compared with findings from other studies. They were then studied in relation to participation in vigorous physical activity, cardiorespiratory fitness and coronary artery disease risk.

The mean values of peak oxygen uptake (peak $\dot{V}O_2$) for men in this study ranged from 46.2 ml/kg/min for those aged less than 20 years to 30.5 ml/kg/min for those aged greater than 50 years.The mean values of peak $\dot{V}O_2$ for women ranged from 36.7 ml/kg/min for those aged less than 20 years to 27.2 ml/kg/min for those aged greater than 50 years.

The data revealed that over 80% of men aged less than 30 years possessed an adequate level of cardiorespiratory fitness to optimise protection from coronary artery disease. The figure for men aged greater than 50 years was less than 20%.

The mean values of percentage bodyfat of men ranged from 15% for men aged less than 20 years to 26.3% for men aged greater 50 years.The mean values of percentage bodyfat for women ranged from 25.8% for women aged less than 20 years to 36.2% for those aged greater than 50 years. The mean values of percentage bodyfat were lower in this study when compared to similar factory populations.

The mean values of cholesterol for men in this study ranged from 4.07 mmols/l for men aged less than 20 years to 6.19 mmols/l for men aged over 50 years. For women, the mean values ranged from 4.97 mmols/l for those aged less than 20 years to 6.47 mmols/l for those aged over 50 years. Over 33% of men and over 31% of women aged over40 years possessed a level of cholesterol which was greater than 6.5 mmols/l. These figures compare favourably to the Scottish population where 42% of men and 49% of women have a similar level of cholesterol.

Investigations into the level of participation in vigorous physical activity showed that over 50% of men aged less than 30 years participated in adequate activity to benefit health and that 11% of men aged over 50 years participated in a similar level of activity. For women, less than 33% of those aged less than 30 years participated in adequate vigorous physical activity to benefit health whilst 14% of those aged over 50 years participated in a similar level of activity.

The differences between men and women in this study, compared to those in other studies, is not easy to explain. It is possible that the factory in this study operated a stringent recruitment procedure which favoured healthier and fitter individuals. However it is also possible that the overall health promotion programme run in the factory may have had an effect on the variables.

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CHAPTER ONE : INTRODUCTION

1.1 Research Framework

The research fieldwork described took place between August 1986 and July 1987. It was part of a much larger programme of activities of the Vale of Leven Health Promotion Project (Vale Project), a charitable trust founded in 1986 and funded jointly by the Scottish Office, the Scottish Health Education Group and private industry. The main aim of the Vale Project was to reduce the prevalence of coronary artery disease risk factors within the population of the Vale of Leven. The Vale Project intended to achieve this aim by firstly encouraging whole population change and secondly by targeting individuals who were at risk from coronary artery disease.
The Vale Project was innovative in that it was the first health promotion scheme anywhere to use local industry as a means of initiating programmes into the community at large.

This study reports the results of a coronary artery disease risk factor identification programme which was offered to all employees of the largest manufacturing factory in the area. The programme was offered during the course of a larger health promotion initiative within the factory. This initiative involved general and more focussed health promotion activities. The general activities included canteen changes, 'health weeks' and healthy food promotions whereas the more focussed activities included the provision of fitness assessment and regular exercise classes. The former activities began in 1983 and the latter in March, 1986. The data was collected over an eleven month period and it is possible that those who were assessed towards the end of the initiative may have altered their lifestyle as a result of being influenced by those who had already been assessed. (It should be highlighted that it was not possible to ascertain the amount of intervention which each individual who participated in the programme received). The data derived from the study was not baseline data.

The sections which follow describe the problem of coronary artery disease in Scotland and in the Vale of Leven area, provide reasons for this study and culminate in a statement of the aims and objectives.

1.2 Coronary Artery Disease : Scotland

Scotland has one of the worst records of mortality from coronary artery disease in the world. Tables 1.1a and 1.1b present the age standardised mortality from ischaemic heart disease for men and women respectively in 1985 (Kazuo & Zbynek,1988). The tables show that Scotland has the highest and second highest mortality from coronary artery disease for men and women respectively.

COUNTRY	MORTALITY PER 100,000 POPULATION AGED 30-69 YEARS
N. Ireland	406
Scotland	398
Finland	390
Eire	339
England/Wales	318
Norway	252
U.S.A.	235
Canada	230
Italy	138
France	94
Japan	38

Table 1.1.a : Age standardised mortality from ischaemic heart disease : Men (Kazuo & Zbynek,1988)

COUNTRY	MORTALITY PER 100,000 POPULATION AGED 35-69 YEARS.
Scotland	132
N. Ireland	130
Eire	104
England/Wales	94
U.S.A.	80
Finland	79
Canada	66
Italy	33
France	20
Japan	13

Table 1.1.b : Age standardised mortality from ischaemic heart disease : women (Kazuo & Zbynek, 1988)

Scotland is trailing other industrialised nations in reducing mortality from coronary artery disease. Figure 1.1 shows the difference in national trends in mortality between 1967 and 1985. It can be seen that Scotland's mortality rate has reduced minimally in comparison to other industrialised countries with high risk. Figures show that countries such as Finland and the United States of America which had high rates of mortality in 1967 have reduced their rates respectively by 48.1% and 23% for men and by 48.1% and 31.1% for women by 1985. Scotland's rates have only reduced by 11.2% and 5.2% for men and women respectively (Kazuo & Zbynek,1988).

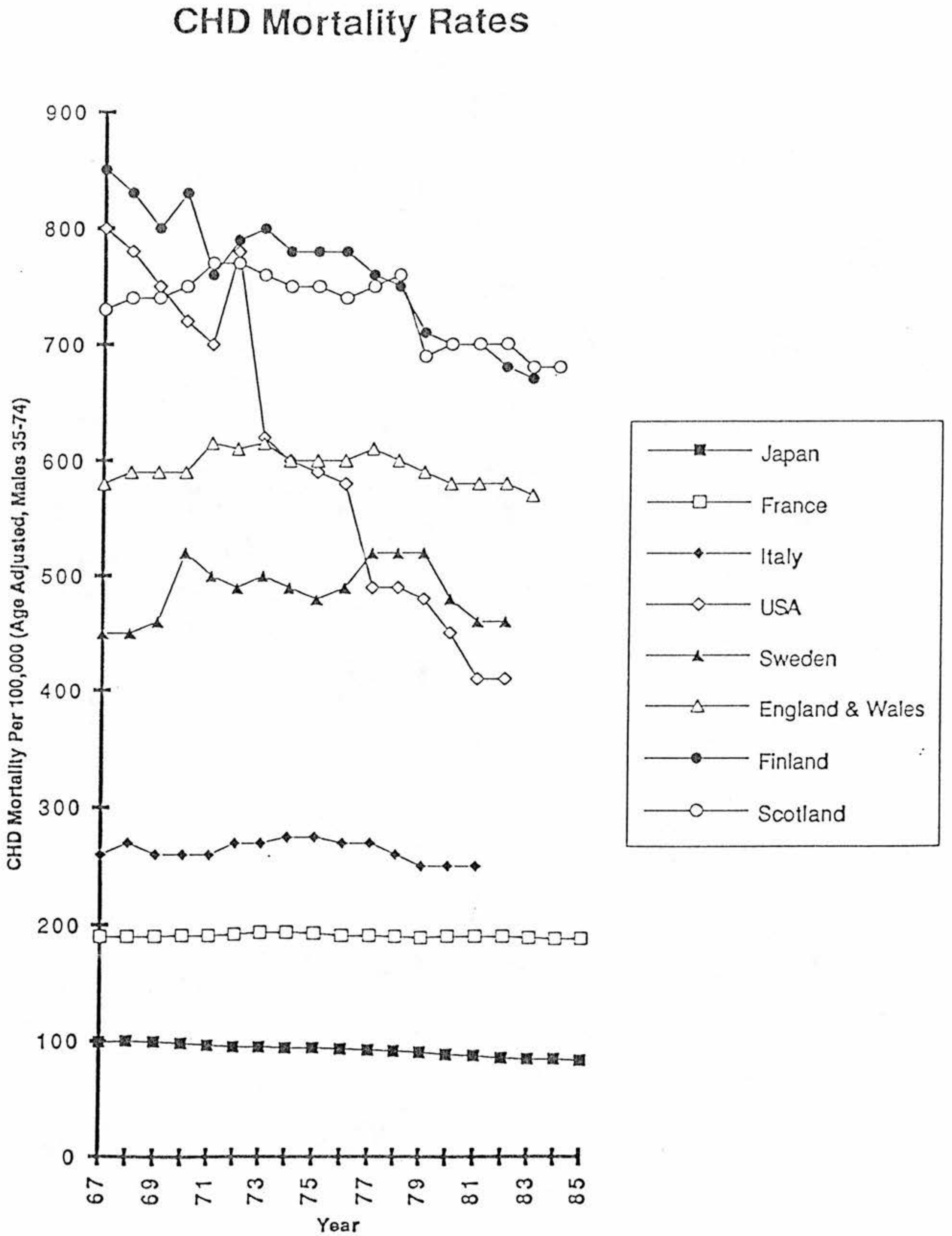

Fig 1.1 : National trends in mortality from coronary artery disease between 1967 and 1985 (Kazuo & Zbynek, 1988)

1.3 Coronary Artery Disease : Vale of Leven

Although Scotland has one of the worst records for coronary artery disease in the world there are substantial variations in the prevalence of the disease throughout the country. The Scottish Heart Health Study (Tunstall-Pedoe et al, 1989, Smith et al, 1987,1989) examined geographical variations in the prevalence of the disease and found there to be significant differences between rural and urban areas and also between 'deprived' and 'affluent' areas (deprivation was assessed by employment, housing status and social class). Although there are areas in Scotland with higher prevalence of coronary artery disease, the Vale of Leven is an example of a Scottish area which is in decline and in which there is a high prevalence of coronary artery disease compared to more 'affluent' Scottish areas.

The Vale of Leven is situated in the Strathclyde Region of the West of Scotland. It is a conglomerate of several small towns:- Alexandria,Jamestown and Balloch Haldane, Renton, Bonhill. The latter three towns have been designated as areas of priority treatment by Strathclyde Region. The area has a population of almost 24,000 people.

Before the nineteenth century it was an agricultural area with farming being the main form of employment (Dilke et al, 1959). The Industrial Revolution made a significant impact on the area and the population increased rapidly. There was an influx of people from the Highlands of Scotland and from Ireland, many of whose descendants still live in the area. The main industries which arose were those of chemical and printing. At one stage the St Rollox Chemical Works were the largest in the world (Smout,1969). After the first world war these industries went into decline as a result of competition from Asia (Smout,1969). The main form of employment was then to be found in the shipyards of the River Clyde. These yards excelled until foreign competition pushed them into decline. By the 1980's unemployment was a major feature in the area. Approximately 18% of the population were unemployed (Government Statistical Office,1988). The main sources of employment were found in the whisky industry, the public service sector and the photographic industry.

Table 1.2. shows the percentage of deaths in the Vale of Leven due to coronary artery disease, malignant neoplasms and lung cancer for men and women respectively. It is evident that coronary artery disease is the major cause of mortality in the area for both men and women.

Cause of Death	% of Total Mortality	
	men	women
coronary artery disease	37	23
malignant neoplasms	27	19
lung cancer	11	03

Table 1.2 : Percentage of total mortality in the Vale of Leven due to coronary artery disease, lung cancer and malignant neoplasms: men and women (Argyll & Clyde Health Board,1990)

Table 1.3 illustrates how the mortality from coronary artery disease in the Vale of Leven compares to Scotland as a whole. It can be seen that women in the Vale of Leven are slightly more at risk while men are slightly less at risk.

Area	Percentage of Mortality due to Coronary Artery Disease	
	men	women
Vale of Leven	37%	23%
Scotland	38%	20%

Table 1.3 : Percentage of mortality in men and women due to coronary artery disease by area. (Registrar General Scotland, 1990)

1.4 Rationale

The European Atherosclerosis Society (1987) stated that one of the highest priorities in preventive medicine is to significantly reduce the incidence of coronary artery disease. To achieve this the Society advocates the reduction of the prevalence of coronary artery disease risk factors. This strategy is also advocated by other major medical bodies (Coronary Prevention Group (Scientific Medical Advisory Committee, 1987), British Hyperlipidemia Association (Shepherd et al, 1987)). The Scottish Office (1991) have adopted the recommendations of these bodies and have identified the reduction of coronary artery disease as a major priority for health improvement in Scotland.

Shaper et al (1985) identified the workplace as an ideal location for the promotion of health in order to combat the disease. The workplace can provide a 'captive ' environment in which programmes aimed at reducing the prevalence of coronary artery disease risk factors can be implemented.

Numerous initiatives have been carried out worldwide, particularly in North America, to promote and also to investigate the health and fitness of factory populations (Work, 1989; Bertera, 1990; Hollander, 1988; Fielding, 1982). There have been several studies, such as the European Multifactorial Preventive Trial of Coronary Artery Disease (WHO European Collaborative Group, 1974), which have addressed coronary artery disease risk factors in British workplace populations. However, relatively few have investigated the role of cardiorespiratory fitness and of participation in physical activity in relation to coronary artery disease. One notable study which attempted to address these issues was the Cadbury-Schweppes study (Tuxworth et al, 1986). This study has provided information on selected health and fitness characteristics of a British factory population. It should be highlighted that this was a cross-sectional study and did not attempt to address the effect of cardiorespiratory fitness or participation in physical activity on coronary artery disease.

It seems reasonable to state that there was, and still is, a need for more studies in this area. Providing information on the health and fitness characteristics of factory populations should greatly assist the planning of future factory based health initiatives. The people planning these initiatives can utilise the information from these studies to identify priorities for health and fitness interventions.

In Scotland, the opportunity to investigate health and fitness characteristics of a factory population arose when the management of a major manufacturing factory in the Vale of Leven committed the factory to an initiative to promote the health of employees.

This factory was a subsidiary of an American Corporation which produced cameras, photographic film and sunglass lens. (A detailed description of the factory is given in Appendix 1). The initiative which the Company committed itself to was the Vale of Leven Health Promotion Project (Vale Project). This project was a multi-disciplinary, longitudinal initiative towards promoting health, especially the reduction of the prevalence of coronary artery disease risk factors amongst the population of the Vale of Leven. It aimed to achieve this by targeting lifestyle change within the whole community and by identifying individuals at high risk to the disease and encouraging these people to alter their lifestyle.

It was a two phase project with the initial phase centring on the health needs of the employees of the manufacturing factory. The second phase was aimed at the health needs of the local community, especially those living in areas of priority treatment. The Project had an intervention strategy which centred on four areas :-

i) provision of a coronary artery disease risk factor identification programme.

ii) provision of health related activities such as exercise and smoking cessation groups.

iii) introduction of health policies such as no smoking and healthy eating.

iv) mass education programmes via newsletters and poster campaigns.

A detailed description of the Project can be found in Appendix 2.

1.5 Aims and Objectives

The coronary artery disease risk factor identification programme run by the Vale Project in the manufacturing factory provided the focus for the study. This initiative assessed cardiorespiratory fitness, body composition, weight, cholesterol, blood pressure and ascertained lifestyle in relation to smoking, diet, alcohol consumption and physical activity.

AIM :

To describe selected health and fitness characteristics of a factory population and to examine the findings in relation to other populations and in relation to protection from coronary artery disease.

OBJECTIVES :

i. to measure selected health and fitness characteristics which have been shown to be risk factors of coronary artery disease.

ii. to compare the findings to those of other studies.

iii. to ascertain the percentage of the workforce who participated in adequate vigorous physical activity to optimise protection from coronary artery disease.

iv. to ascertain the percentage of the male workforce who had an adequate level of cardiorespiratory fitness to optimise protection from coronary artery disease.

vi. to examine the relationships between variables , controlling for the effects of age.

vii. to present findings and make recommendations for further study.

1.6 Research Hypotheses

Four key questions were identified which could be answered using the data from the initiative :-

1. Are selected health and fitness characteristics of the Vale of Leven factory population different from other populations, given that the factory population had been subject to some form of intervention ?

2. Do employees of the factory participate in sufficient vigorous physical activity to optimise protection from coronary artery disease ?

3. Do male employees possess adequate cardiorespiratory fitness to optimise protection from coronary artery disease ?

4. What are the relationships between selected health and fitness characteristics ?

From these four questions the following null hypotheses were constructed which would be tested in this thesis :-

1. There are no differences between selected health and fitness characteristics of the Vale of Leven factory population and other populations.

2. Employees of the factory do not participate in vigorous physical activity to optimise protection from coronary artery disease.

3. Male employees do not possess adequate cardiorespiratory fitness to optimise protection from coronary artery disease.

4. The relationships between selected health and fitness characteristics of this population are no different from those of other populations.

CHAPTER TWO : LITERATURE REVIEW

2.1 Reasons For Intervention

The European Atherosclerosis Society (1987) stated that one of the highest priorities in preventative medicine is to significantly reduce the incidence of coronary artery disease. The Society enlisted the assistance of 19 experts from various European countries to formulate a policy statement regarding the reduction of coronary artery disease. A strategy combining whole population initiatives (e.g. mass education programmes) and individual 'high risk' initiatives (e.g. screening for those who are deemed to be most at risk) was advocated.

The recommendations of the European Atherosclerosis Society have been adopted by the Scottish Office (1991) in their policy statement on health education. The Scottish Office proposes that the prevention of coronary artery disease should involve a population approach by educational initiatives and an individual approach whereby General

Practitioners identify people at risk and take appropriate action. The Scottish Office highlights the benefits of participation in regular vigorous physical activity and intends to encourage increased participation.

The Scientific Medical Advisory Committee of the Coronary Prevention Group (1987) has also recommended a combined strategy of mass population and individual centred initiatives to combat the disease.It also recommends that people should have access to appropriate advice and facilities in order to facilitate lifestyle change.

The British Hyperlipidemia Association (Shepherd et al,1987) recommends that all people have their blood lipids measured on at least one occasion and that the nutritional guidelines of the National Advisory Committee on Nutrition Education be adopted nationally (N.A.C.N.E.,1983).

2.2 Community and National Surveys of Coronary Artery Disease Risk Factors and Health Intervention Programmes.

There have been many studies worldwide to investigate or combat the prevalence of coronary artery disease risk factors within populations. Programmes such as the World Health Organisation's Monica Project (WHO 1988), the British Regional Heart Study (Shaper et al,1985) and the Scottish Heart Health Study (Smith et al,1989,1987) have investigated the presence of coronary artery disease risk factors within populations. Other initiatives such as the North Karelia Project (Puska,1983), the European Multifactorial Preventative Trial (WHO European Collaborative Group,1974) and the Multiple Risk Factor Intervention Trial (M.R.F.I.T.) (Neaton et al,1984,Benfari et al,1989) were aimed at reducing the number of those with the disease risk factors. The latter study and other North American studies have been reviewed by McGlew (1984).

The World Health Organisation (WHO) Monica Project (WHO,1988) was established to measure trends in mortality and morbidity from coronary artery disease and to assess the relationship to known risk factors. The Project studied men and women aged between 35 and 64 years in 27 countries.

The study has yet to fully report.Interim results suggest that increasing levels of hypertension are linked to an increasing risk of coronary artery disease. This study should provide baseline information which researchers in the future may use to assess interventions. If resources had been available, it could have been improved if it had taken the opportunity to assess the effect of participation in vigorous physical activity on the disease. A strong body of evidence exists to show that participation in vigorous physical activity is inversely linked with the incidence of coronary artery disease.

The British Regional Heart Study (Shaper et al 1981,1985) aimed to assess the prevalence of risk factors within the British population and to assess the relationship of these factors to the incidence of the disease over an eight year period. A random sample of 7,735 British men,aged between 40 and 59 years, underwent an assessment of blood pressure, body mass index,serum lipids, smoking habits and personal medical history. The study concluded that there were strong links between the risk factors and the incidence of disease. It recommended that the population be screened for the presence of risk factors and appropriate action taken, if necessary.

This study has added to the evidence of the need to take action to prevent coronary artery disease. There were, however, limitations to the study. For example, no attempt was made to exclude individuals with pre-existing disease and this may have affected the conclusions drawn about the relationship of the risk factors to the disease. The study did not try to assess the effects of participation in vigorous physical activity on the disease. By omitting this risk factor it is possible that may also have affected the conclusions drawn about the disease. The information would also have been more complete if men and women of all ages had been included in the study.

In 1991 further findings from the study were reported which did examine the relationship of physical activity to coronary artery disease (Shaper & Wannamethee, 1991). The study found that men, with no pre-existing coronary artery disease, who regularly participated in a moderate level of physical activity experienced half as many heart attacks as inactive men.

The Scottish Heart Health Study (Tunstall-Pedoe et al,1989, Smith et al 1987,1989) was designed to investigate mortality from coronary artery disease. It aimed to assess the relative contribution of each of the risk factors to the prediction of the incidence of the disease and to try to explain geographical variations in coronary artery disease mortality. The study involved 10,359 men and women aged between 45 and 64 years from 22 districts which were representative of the Scottish population in terms of geography, social class and coronary artery disease mortality. The overall compliance was 74%.

The study involved the assessment of height, weight,blood pressure, serum cholesterol and of smoking,dietary, alcohol consumption and physical activity habits. The results found that mean serum cholesterol levels were high in comparison to British and international standards. The study also discovered that 38% of women and 39% of men smoked and that physical activity levels were generally low. Major differences in coronary artery disease mortality were found to exist between those living in 'deprived' areas and those living in 'affluent' areas. Those in the former areas had higher mortality levels.(Areas were classified in accordance to levels of employment,house ownership and social class status). The study found that levels of cigarette smoking in the 'deprived' areas were significantly higher than in the 'affluent' areas.

This study has provided baseline information which future researchers can utilise. For example, it has established population norms, for those aged between 45 and 64 years, for variables such as height,weight, cholesterol and blood pressure. In addition, some of its test procedures and data collection methods can be utilised. For example, its lifestyle and medical history questionnaires were used, in an adapted form, in the Vale Project's coronary artery disease risk factor identification programme.

The North Karelia Project was a ten year community based initiative to control coronary artery disease in the County of North Karelia in Finland (Puska et al,1983,Kottke et al,1984). Reductions in smoking, serum cholesterol and blood pressure were the main objectives of the programme. The Project used both population and individual centred initiatives to address the problems. A population wide health education programme using the mass media was initiated. Practical services such as blood pressure monitoring were made available. A matched reference area was chosen for control purposes. No efforts were made to promote participation in physical activity.

The Project succeeded in significantly reducing smoking habits, serum cholesterol levels, blood pressure and the incidence of the disease. However the decline in the incidence of coronary artery disease did not significantly differ from the control area nor from Finland as a whole. This may have been due to the Project's inability to prevent the 'contamination' of the control area. This is a problem which faces all community based programmes. The mass media, for example, often crosses boundaries and this may cause behaviour change in the control population as well as in the study population. Due to this problem it is not possible to draw conclusions about the effectiveness of the North Karelia Project.

The World Health Organisation (WHO) implemented large controlled preventive trials of coronary artery disease in five European countries:- Italy, Belguim, Britain, Poland and Spain. The study was known as the European Multifactorial Preventative Trial of Coronary Artery Disease (WHO European Collaborative Group,1974). The purpose of the study was to investigate whether or not risk factors could be identified and modified to reduce the incidence of coronary artery disease. It was conducted in 44 pairs of factories which employed 63,000 men aged between 40 and 59. The paired factories were randomly allocated for either 'intervention' or 'control'. The British study (Rose et al,1980,Heller et al,1984) involved 24 factories representing light,medium and heavy industry. Over 18,000 men participated in the study which lasted for six years. All participants underwent an initial screening programme consisting of the measurement of blood pressure, serum cholesterol and weight. Smoking and physical activity habits were assessed by the use of a questionnaire. No attempt was made to assess cardiorespiratory fitness. Those who were most at risk from the disease were recalled for up to four counselling sessions by each company's occupational health service. The remaining subjects were encouraged by a mass educational initiative which included personal correspondence, poster campaigns and film shows.

All participants were followed for a six year period and the incidence of coronary artery disease was recorded. The results from the study found that the intervention had no significant effect on either coronary artery disease mortality or myocardial infarction. Although no definitive reason could be given for these findings, it was suggested by the authors that British workers were reluctant to change their lifestyle. Some centres reported more encouraging results, particularly the Belgian Centre (Kornitzer et al,1980) which reported reductions of over 20% in the overall relative risk of coronary artery disease in both the high and low risk groups. The British study concluded that, on the evidence of the Belgian study, this type of intervention was of worth providing the problem of acceptance of advice by British workers could be overcome.

This view may be over-simplistic as there may have been other reasons why the British results differed from the Belgian. The Belgians, for example, may have had better facilities at their place of work and in the community which enabled them to make lifestyle change more easily than the British.

The British study could have been more effective if efforts had been made to improve the environment within the factories. For example, canteen changes could have been implemented, recreation facilities made available and policies to improve health implemented. It is now widely accepted that educational campaigns on their own are not sufficient to foster a change in lifestyle patterns (Downie et al, 1991). Downie et al advocate that individuals be given the opportunity to make lifestyle change. This may necessitate the introduction of policies to promote health. For example, a workplace which operates a healthy eating policy provides an environment in which an individual can chose to eat healthily. A factory which offers recreational facilities and employs suitably qualified exercise leaders may encourage more of its employees to participate in vigorous physical activity than those in a factory without such facilities.

It is noticeable that in all these studies, apart from the Scottish Heart Health Study, the British Regional Heart Study and the European Multifactorial Preventive Trial of Coronary Artery Disease, no attempt has been made to assess the effects of participation in vigorous physical activity on coronary artery disease. Participation in vigorous physical activity both at work and in leisure has been shown to be effective in the prevention of coronary disease (Paffenbarger et al, 1975, 1984, 1986; Morris et al 1973,1980; Brand et al 1987). Evidence that the association was causal was confirmed in an analytical review of over 40 studies (Powell et al, 1987). A comprehensive review of this relationship can be found in statement documents of the British Heart Foundation (Hardman) and of the Health Education Authority and Sports Council (Fentem et al, 1988).

None of the studies attempted to assess the effects of cardiorespiratory fitness on coronary artery disease. This is not a criticism of these studies as the relationship of cardiorespiratory fitness to the disease is not clear. Recent studies have shown there to be an increased risk of mortality for those of low cardiorespiratory fitness compared to those of high fitness (Blair et al, 1989, Ekulund, 1988). It seems reasonable to state that future longitudinal studies of the relationship between coronary artery disease and its risk factors could be enhanced if the effects of cardiorespiratory fitness on the disease were investigated.

2.3 Employee Health and Fitness Studies.

A study examining physical activity and health characteristics of male employees was carried out at the Cadbury-Schweppes factory in Birmingham (Tuxworth et al, 1986). Every male employee aged between 35 and 60 years was invited to participate in the programme and 1394 men, representing 70.5% of the total male workforce, accepted the invitation.

In order to minimise the risks associated with participating in an exercise test, the participants completed a medical questionnaire, which included information on smoking habits, and they underwent a medical examination conducted by a physician. Although this was a very stringent selection process only 5.5% of the population were totally excluded from the trial. On satisfactory completion of the medical examination each person was assessed for cardiorespiratory fitness, height, weight, blood pressure and body composition and also completed a lifestyle physical activity questionnaire conducted by an interviewer.

The protocol used to predict maximum oxygen consumption was a modification of the submaximal bicycle ergometer procedure pioneered by Wahlund (1948) and developed by Astrand (1954).Achieving consistency in cycling cadence is a problem with this form of test and to overcome this an electrically braked ergometer was utilised. Subjects were not habituated to the test. The test administrators made efforts to reassure and relax subjects so as to reduce anxiety levels.Each person was permitted to view the assessment of a colleague. The physical activity questionnaire sought information on activity at work, the amount of walking carried out per week ,leisure time physical activity and on attitude towards diet and exercise.

The study found that overall levels of fitness were low and inadequate to provide health benefits. The authors concluded that employers should make extensive efforts to promote the fitness levels of their employees by improving access to facilities and expanding the role of occupational health services to provide appropriate advice on suitable exercise.

This study was innovative in that it was the first to investigate fitness and health characteristics of the employees of a British factory. The medical support given to the study permitted the inclusion of many people with medical conditions who normally would have been excluded. This lessened the 'bias' towards healthy individuals in the selection process and as a result the sample may be more representative than those used in other studies which did not have this medical support. The efforts made to encourage a 'relaxed' atmosphere possibly improved compliance and encouraged individuals to complete the sub-maximal cycle ergometry test.

This study has set standards for similar initiatives within British industry.Although the study was designed to assess men aged between 35 and 60 years old, it would seem reasonable to suggest that,to further the information available on the health and fitness of British workers, men and women of all working ages should be assessed in future studies.

Morris et al (1973) in a longitudinal study examined the relationship between participation in vigorous exercise and the incidence of coronary artery disease in over 16,000 male 'white collar' civil servants aged between 40 and 64 years. Participants completed a record of their physical activity habits in five minute blocks on two days, Friday and Saturday. The selected days were unannounced and records were completed by recall so that behaviour would not have been influenced by the study. The participants were followed for a period of up to three years and the researchers were notified of those who suffered from clinically determined coronary artery disease.

Those with coronary artery disease were matched with two control subjects who showed no clinical signs of the disease. Physical activity levels were compared and it was found that those who reported participation in vigorous physical activity requiring an energy output of at least 7.5 kcal/minute were three times less likely to suffer from coronary artery disease than those who did not. Morris et al (1980) followed the same group seven years later and came to a similar conclusion.

There were several limitations to this study and many of them have been acknowledged by the authors. There were problems with the classification of activities. For example, the intensity of one person's brisk walking may have differed greatly from another's however both were analysed as though they were similar.

The study could have been improved if it had gathered information on subject's activity on a mid-week day. The exclusion of this information may have resulted in many participants,who were active during the week,being categorised as not participating in vigorous exercise. The researchers did attempt to test the reliability of the data by short term follow up studies of participants in London offices where they repeated the test procedure using Sunday and Monday as test days as well as Friday and Saturday. The results showed consistency between both sets of days in those reporting vigorous exercise.

Paffenbarger and Hale (1975) studied work activity and coronary artery disease mortality among 6351 longshoremen aged between 35 and 74 years at the point of entry into the study.This was a longitudinal study which followed subjects for a period of up to twenty two years.The researchers estimated the energy and oxygen cost for all 49 longshoring jobs. A decision was made to exclude leisure time activities from the study as an initial health examination found that there were no differences in leisure time activities between those employed in jobs requiring light, moderate or heavy energy outputs. Longshoremen who died from coronary artery disease were classified according to the position which they held for the six months previous to their death. This was to overcome possible bias caused by people being moved to light work due to their health in the few months prior to their deaths. Those who retired early were classified as being engaged in light work. The study found that the death rate of those involved in heavy work was 50% less than that of those who were not involved in heavy work.

The analysis of leisure time activity would have enhanced the quality of the information on participation in vigorous exercise. In the 22 years after the initial decision not to include it the public's attitude to exercise may have changed and it is possible that there were differences in leisure time activity between those employed in the three categories of work.

Employee health and fitness programmes are commonplace in North America. Many of them have been reviewed by Fielding (1982),Farrally (1984),Work (1989),Bertera (1990),Hollander (1988),Warner (1988),Knadler (1987) and Peepre (1990). A selective review of both North American and European workplace programmes can be found in a review document by the Work Research Centre (Wynne,1989).

2.4 Conclusions

This literature review has provided evidence of the worth of coronary artery disease risk factor identification programmes. Several respected advisory bodies such as the European Atherosclerosis Society and the Coronary Prevention Group have advocated the use of such initiatives in order to combat coronary artery disease. The Vale Project were guided by the recommendations of these bodies. The provision of a coronary artery disease risk factor identification programme for employees of the manufacturing factory became one of the key objectives of the Vale Project. In addition, many of these bodies have highlighted that the identification of individuals at high risk from the disease is not an end in itself and that efforts should be made to enable individuals to make lifestyle change. The Vale Project was aware of this need and decided that a programme of lifestyle change activities would be offered in conjunction with the programme.

The experiences and findings from workplace and from community health and fitness studies were invaluable to the

Vale Project in the planning of the coronary artery disease risk factor identification programme. The Cadbury-Schweppes study provided a model by which cardiorespiratory fitness could be assessed.The European Multifactorial Preventative Trial of Coronary Artery Disease alerted the Vale Project to the possible problem of workers being unwilling to accept health advice.The work of Morris (1973,1980) and Paffenbarger (1975) highlighted the problem of objectively quantifying the intensity of reported physical activity. The Vale Project also utilised the data collection methods of studies such as the British Regional Heart Study and the Scottish Heart Health Study. For example,questions relating to smoking status from the latter study were included in the Vale Project's questionnaire.

Although the Vale Project utilised the experiences of other studies in the design of the coronary artery disease risk factor identification programme,it was decided that the initiative be piloted in order to identify any potential problems.

CHAPTER THREE : PILOT PROJECT

3.1 Introduction

The first phase of the Vale Project was to promote health within the manufacturing factory.The Management of the factory were committed to promoting the health of employees and were willing to consider health initiatives recommended by the Vale Project. The members of the Vale Project decided to offer every employee the opportunity to be assessed for coronary artery disease risk factors and to participate in a programme of activities which would promote health. The risk factor identification programme would highlight individuals at high risk from the disease and the follow-up programme of activities would assist them to make lifestyle change. In addition, individuals who were deemed not to be at risk, would be assessed and encouraged to participate in a lifestyle which would enhance protection from the disease.

The initiative was developed by the management and staff of the Vale Project. (The components of the programme are fully described in Chapter 4). A series of meetings took place over a period of four months in which the programme was discussed. The management of the factory agreed in principle to allow the assessment to be completed in company time, providing that it did not affect productivity.

Before the programme could be offered it was necessary to complete a pilot study. Due to the magnitude of the initiative, responsibility for the completion of the pilot study was allocated to three members of the Vale Project. The responsiblity for piloting the lifestyle questionnaire and the method of cholesterol and of blood pressure measurement was allocated to the Evaluation Officer and the Medical Officer respectively. Their efforts will not be reported in this thesis. The author was given responsibility for piloting the methods of assessment of cardiorespiratory fitness and of body composition. In addition,the author was responsible for the implementation of the 'follow-up' exercise programme and also for assessing whether or not the loss of personnel from the production line for the period of the assessment was detrimental to productivity. The remainder of this chapter describes the author's work in these areas.

3.2 Pilot Study Objectives

The following objectives were established for the pilot study:-

i) to identify a suitable method of assessment of cardiorespiratory fitness and to assess compliance.

ii) to identify a suitable method of body composition assessment and to assess compliance.

iii) to assess whether or not the loss of personnel from the production line was detrimental to productivity.

iv) to assess the compliance rates to the programme of follow-up exercise activities.

3.3 The Effect of the Programme on Factory Productivity Levels.

Although the Management of the factory were committed to improving the health of the employees,their main priority was the production of cameras, film and sunglass lens. Management were concerned that the loss of those workers employed on production lines for a period of time would affect productivity figures.

A series of meetings were arranged with management to discuss this concern. An agreement was reached in which the Vale Project would limit each assessment to a 45 minute period. The Vale Project also agreed to provide the supervisor of the employee to be tested with 48 hours notification of the appointment. The supervisor's right to cancel an appointment at any time was also acknowledged. In return the company agreed to assess the effect of the programme on production and to ensure the co-operation of supervisors. The company operated a sophisticated method of production surveillance and were able to monitor levels on an hourly basis.

3.4 Recruitment

All employees were given the opportunity to participate in the programme. After the final health week in 1984 the company's occupational health staff had compiled a list of names of people who had expressed an interest in participating in future health promotion activities. Every individual on this list was written to and invited to participate in the pilot initiative. In addition,a poster campaign was mounted throughout the factory encouraging people to take part.

After assessing the implications of workload for the author it was decided that a maximum of 100 individuals would be invited to participate in the pilot study.Volunteers were selected on a 'first come,first served' basis. This was closely monitored and generally adhered to except in the latter stages of recruitment when preference was given to applicants from divisions within the factory which were not already well represented. Due to the popular demand of the programme 114 individuals were allowed to participate (a decision was taken to increase the number of participants so as to foster good relations with the company). All divisions within the factory were represented.

3.5 Test Battery

A small battery of tests were selected (The rationale for selection and methodology for each test will be discussed in Chapter 4). Cardiorespiratory fitness was assessed using a modified version of the sub-maximal cycle ergometer test designed by Wahlund (1948) and developed by Astrand (1960). This protocol is recommended by the Council of Europe's

Committee on Physical Education and Sport (Tuxworth,1985). The results of the test were modified to predict peak VO2. Height,without shoes, and weight were measured using a callibrated stadiometer and set of Seca scales respectively. Body composition was assessed according to the protocol recommended by Durnin and Womersley (1974) using Harpenden skinfold callipers.

3.6 Exercise Programme

On completion of the assessment programme, the individual was given the opportunity to participate in a series of exercise activities. This involved an introductory course on health related exercise which was both practical and educational in nature. Participants were expected to attend three sessions per week for three weeks. Each class lasted for 45 minutes. Group members were taught about the benefits of exercise and were given practical experience of key activities such as warming up, warming down and how to modulate the intensity of exercise. For many of the subjects this was their first exposure to formal exercise since leaving school and careful efforts were taken to ensure that this was a satisfactory and enjoyable experience.

On completion of the course, participants were given the opportunity to take part in a choice of further activities. These included aerobics, weight training and group jogging sessions. The focus of these groups was aerobic exercise and they adhered to the guidelines of the American College of Sports Medicine (1978). Classes were timetabled to accomodate the different shift patterns of work within the factory.If an individual could not attend a class they were given the opportunity to have a personal exercise programme designed to meet their needs.

3.7 Data Collection

Administration

Each individual and the respective supervisor were contacted using the internal communication system and an appointment was made which was suitable to all parties.If an individual did not appear within 5 minutes of the allocated appointment time,efforts were made to contact the person concerned in order to remind them of the appointment. If the person was unable to attend,another time was allocated.

Procedure

Each person was encouraged to appear ten minutes before their appointment.They were advised to wear loose baggy clothing and flat footwear. Before the programme was administered each person completed a medical history questionnaire, which had previously been developed by the Vale Project. They also completed a 'Par-Q' questionnaire (Department of Health,British Columbia,1980) which was used to assess suitability for participation in the sub-maximal cycle ergometer test.People were excluded from participating in this part of the assessment using the recommendations of the American Heart Association (Committee on Exercise, 1972). Those on medication such as beta-blocking agents were also excluded. In addition, the company Medical Officer was familiar with many of the participants medical history and was able to adjudicate when necessary. This resulted in 7% of the volunteers being excluded from the assessment of cardiorespiratory fitness. They were not excluded from the whole programme.

The programme was then administered. Immediately after each assessments was completed, the individual was counselled. This involved discussion of the result of each assessment and analysis of lifestyle in relation to participation in vigorous physical activity. Once this was completed the person was invited to participate in the programme of 'follow-up' exercise activities.

Data Processing

A systems file was created on S.P.S.S.-P.C..All data was coded and entered into the system. The accuracy of the procedure was checked by comparing a print out of the data from the computer with the raw data. Any errors were rectified.

Results

Appendix 3 shows the mean, standard deviation and the number in the sample for each measure by age group and gender. It was not the purpose of this pilot study to discuss the physiological results from the battery of tests. They have been discussed elsewhere (Farrally et al,1988). Participation in the assessment procedure and subsequent exercise programmes however were of interest.

Table 3.1 shows the breakdown of participation in the programme by age group and by gender. All subjects took part in at least one aspect of the assessment, 74 of whom (66%) completed all measures.This will be discussed in section 3.8.

Table 3.2 shows the percentage of men and women who took part in the peak V02 and bodyfat assessments. Only 72% of men and 60% of women took part in the cardiorespiratory fitness assessment. The percentage of men who were assessed for body composition was higher with 92% complying whereas in women only 64% underwent the assessment. Table 3.3 shows that 92% of women and 87% of men participated in the initial exercise programme and attended at least 75% of the classes. Table 3.4 shows the percentage of subjects who participated in at least 75% of the ten week follow-up exercise classes. Compliance to the aerobic classes was lowest with 37% attending the specified percentage of classes. Compliance to the weight training and jogging programmes was higher with 67% and 75% attending at least 75% of the classes.

GENDER	AGE GROUP (Years)				TOTAL
	<30	30-39	40-49	>50	
men	9	12	23	6	50
women	11	16	26	11	64

Table 3.1: Participants in the pilot study by age group and gender.

Assessment	% Participation	
	Men	Women
Peak Vo2	72%	60%
%Bodyfat	92%	64%

Table 3.2 : Percentage of Men and Women Who Were Assessed for Peak Vo2 and %Bodyfat.

Gender	% Participation
Men	87%
Women	92%

Table 3.3 : Percentage of Men and Women Who Participated In the Initial Exercise Programme.

Activity	% Compliance	Number at Start
Aerobics	37	43
Weight Training	67	43
Jogging	75	20

Table 3.4 : Percentage of Participants who complied to at least 75% of the Follow-Up Exercise Classes.

3.8 Discussion

The management of the factory monitored the effects of loss of personnel to production and found that there was no overall loss of productivity. They welcomed similar future initiatives as long as they retained the right to cancel an appointment and as long as each consultation was limited to a 45 minute period. In the pilot study the author had ensured that an appointment did not overrun this allotted time. On several occasions when an individual needed extra counselling, a further appointment had to be made.This appointment usually took place during a lunch break. Management were consulted on this issue and they agreed that in future they would allow additional time for employees to attend a follow-up session if deemed necessary.

Obtaining this level of support from management was crucial to the Vale Project. It enabled the implementation of the coronary artery disease risk factor identification programme and also provided the opportunity for the Vale Project to provide further intervention for those deemed to be at high risk from the disease. For example,an individual with a high level of cholesterol could be recalled for further surveillance.

Only 72% of men and 60% of women were assessed for cardiorespiratory fitness. Considering that the study population consisted solely of volunteers, this level of participation was low when compared to the Cadbury-Schweppes study (Tuxworth et al,1986) in which 96% of those taking part in the study participated in the cycle test.

The author informally attempted to ascertain why so many individuals did not participate in the asessment. Many of the men,particularly office workers, stated that they did not participate due to the fact that they did not want to become 'hot and sweaty' before returning to their place of work. Others felt that their level of fitness was too low and as a result did not wish to undergo the test. The responses from women varied greatly and the author suspected that he was receiving 'polite' excuses for not taking part. An experienced nurse from the occupational health department was recruited to try to elicit 'accurate' reasons for non-compliance.The nurse found that there were several reasons why many women did not take part. Some were not comfortable with a male tester whilst others found that their uniform did not promote 'modesty' on the cycle ergometer.

The nurse also questioned many of the women who did not undergo the assessment of %Bodyfat.Many of them stated that they were conscious of their body shape and were uncomfortable with a man performing the test.

These findings were of concern to the members of the Vale Project. To counteract the problem of men becoming 'hot and sweaty' it was agreed that in future initiatives, men would be encouraged to wear a change of clothing whilst undergoing assessment. An area for changing and showering was identified. The problems relating to women were addressed and it was agreed that women be advised not to wear their uniform for the assessment and would also be given access to changing facilities.It was also decided that, provided funding could be obtained, a woman be recruited to carry out the main assessment. It was felt that this would improve compliance levels amongst women and not affect those for men.

Participation in the initial introductory health related exercise course was high with 87% of men and 92% of women attending at least 75% of the sessions. Compliance to at least 75% of the follow-up activies over a ten week period varied between 37% and 75% with an average of 57%. It is probable that two factors influenced compliance. Firstly it may have been positively encouraged by other health promotion initiatives which were organised at the same time as this study. The company sponsored a fun run, introduced a five minute exercise break each afternoon and organised an 'open' day which included a health fayre. In addition the Vale Project organised the national Walkaboutabit campaign for the local area.Compliance may have been adversely affected by the massive increase in overtime hours which occured soon after the commencement of the programme. Overtime hours for the whole factory rose by 500%.Classes were timetabled directly at the end of a shift and as result of overtime many people were unable to attend.

Although the study population consisted of volunteers the compliance to the exercise programme was still encouraging and it was hoped that a similiar level of compliance could be achieved when the main programme was offered to the whole workforce.

3.9 Conclusions

The experience and findings of the pilot study were invaluable in the planning and implementation of the main coronary artery disease risk factor identification programme. The management of the factory were convinced of the worth of such initiatives and pledged full support and co-operation for the main programme.

The pilot study showed that the assessment of cardiorespiratory fitness and body composition by sub-maximal cycle ergometry and by skinfold measurement respectively were feasible. It highlighted potential problems with these assessments.To overcome these problems it was agreed that a female tester be employed and that changing facilities be made available.

Even though the subjects were all volunteers, the participation levels in the exercise programmes were encouraging. The members of the Vale Project were satisfied with this level of participation. It was agreed that a similiar programme of activities be offered with the main initiative as facilitating, as well as encouraging, lifestyle change was crucial to the overall success of the Vale Project.

CHAPTER FOUR: TEST SELECTION & METHODOLOGY for MAIN STUDY

4.1 Questionnaire

The Vale Project wished to obtain information regarding family and personal medical history and certain aspects of lifestyle as these entities have been shown to be related to the incidence of coronary artery disease. To this end, a questionnaire was designed. The experience and expertise of several large heart health studies such as the Scottish Heart Health Study (Smith et al, 1989), the British Regional Heart Study (Shaper et al,1985) and the Framingham Study (Kannel et al,1978) were utilised in the construction of the questionnaire. This section will highlight the problems associated with the use of questionnaires, identify the information which was gathered and the reasons for collection of such data.

A major problem associated with any questionnaire is whether or not the information obtained is valid. Validity is determined by whether or not the question actually measures the variable that is of interest. Establishing the validity of responses in lifestyle questionnaires is difficult.

Biological responses can be used to validate questionnaires. In terms of physical activity, technology such as self-contained telemetry systems, which monitor and record heart rates, can be utilised to validate reported activity. This can be achieved by comparing the reported activity with corresponding heart rate levels. There are problems with such techniques. For example, information cannot be obtained retrospectively. It was not possible to validate the responses to questions relating to physical activity in this study and therefore the information obtained should be interpreted with caution.

Although using technology to validate questions relating to physical activity was not feasible in this study, technology was used in other areas. For example, information obtained about smoking habits was crudely validated by the use of a carbon monoxide monitor. This piece of equipment provided an indication of carbon monoxide levels in the lungs and it was possible to identify whether or not a person smoked. It should be highlighted that the equipment was not sensitive enough to identify the amount of cigarettes which an individual smoked.

Due to its role as a risk factor in coronary artery disease, questions relating to participation in vigorous physical activity were included in the questionnaire. The problem which faced the members of the Vale Project was to elicit a response which accurately represented an individual's physical activity lifestyle.

Attempts have been made to quantify the intensity and duration of exercise required to provide protection from coronary artery disease. Notable contributers to this area have been Morris et al (1973), whose work has been discussed earlier, and Paffenbarger et al (1975). These authors classified activities according to energy expenditure and duration of the activity and identified those in which an optimal energy expenditure level to provide protection from the disease was achieved. The problem with such an approach was that energy expenditure in activities may vary between individuals. Some may expend the expected amount of energy whereas others may not. This makes analysis by activity alone problematic. Some indication of intensity must be included. The Vale Project was aware of this problem. To overcome it, criteria regarding the intensity of exercise were utilised in the analysis of reported physical activity. Individuals were asked to identify only those activities which elicited a certain physiological response.

There was debate within the Vale Project regarding the criteria to be used to quantify an optimal level of intensity of physical activity to enhance protection from coronary artery disease.Part of the Vale Project team wished to adopt the criteria used in the Scottish Heart Health Study so that direct comparisons could be made to the Scottish population whereas others wished to use the recommendations of the American College of Sports Medicine (1978). After much debate it was decided to use the former's criteria to define vigorous physical activity :-

'an activity which leaves you short of breath and perspiring at the end of 20 minutes'

Subjects were asked if they currently participated in activity which elicited the above physiological response. If the response was positive, the activity was identified and the duration and frequency of the exercise was ascertained. The tester took great efforts to ensure that the subject was accurately describing the intensity of the reported activity.

Family and personal history of coronary artery disease are recognised risk factors (Platt,1963,Shaper et al,1985).

Details of both were obtained via the questionnaire. 'Family' was defined as parents, brothers or sisters.

Smoking has long been established as a risk factor in coronary artery disease (Neaton et al,1984;Pooling Project Research Group,1978;Shaper et al 1985). Smoking habits were ascertained by using questions previously piloted by the Vale Project.

Diet and alcohol consumption play a role in coronary artery disease. They are related to obesity and cholesterol levels which have been shown to be major coronary artery disease risk factors (Royal College of Physicians, 1983). Dietary and alcohol consumption habits were ascertained in the questionnaire using questions derived from the Scottish Heart Health Study.

As previously stated the questionnaire was piloted by the Vale Project's Evaluation Officer. When this was completed and appropriate changes made, the questionnaire was included in the assessment procedure. A copy can be found in Appendix 4.

4.2 Anthropometric Measures

Height and Weight

Height, without shoes, was measured using a stadiometer. Subjects stood straight against an upright surface, touching it with heels, buttocks and and back. The head was orientated with the upper border of the ear opening and the lower border of the eye socket on a horizontal plane. Their hands hung relaxed at their sides. The stadiometer's horizontal calliper was lowered onto the highest point of the head and a measure was taken.

Weight, with clothing, was measured using Seca scales. Subjects stood on the scales, looking straight ahead. A reading was then taken and an estimate of the weight of garments (usually 3lbs, in accordance with the recommendations of the Metropolitan Life Company,1960) was subtracted.

Body Composition

Obesity has been shown to be a risk factor in coronary artery disease (Shaper et al,1985; Keys et al,1953; Kagan et al 1963; Kanel & Gordon,1980; Black et al,1983; Royal College of Physicians,1983). Members of the Vale Project were concerned about using weight or body mass index as indicators of obesity as these measures did not take body composition into account. Numerous studies have shown that many people classified as being overweight, were in this category due to the abundance of muscle tissue in their bodies and not fat tissue (Behnke, 1947, 1969;McArdle et al,1981; Franklin, 1980). Due to this, their diagnosed weight 'problem' was not a risk to their health. In contrast, 'normal weight range' tables which are commonly used to assess whether an individual is overweight can under-estimate obesity. An individual's weight may be within a satisfactory weight range yet he/she may be obese.

Assessment of body composition provides information on the proportion of various tissues in the body. Assessment by non-invasive techniques is still not a precise science and further research is required in this area. Several methods of assessment were available :- hydrostatic/underwater weighing, skinfold thickness measurement, ultrasound, computed tomography and electical impedance. All these techniques have been reviewed by Brodie (1988a,b).

On studying Brodie's review of the methods of assessing body composition it is evident that there are errors with all these techniques. There is no 'gold standard' by which other methods can be compared. This view is also held by Martin and Drinkwater (1991) who also reviewed methods of non-invasive assessment of body composition.

The Vale Project was faced with the problem of selecting a method which was financially and practically feasible. On reviewing the methods available, all, apart from the skinfold method,were rejected on account of equipment costs and of the respective protocols, which were deemed unsuitable for this type of programme. The skinfold method was the only feasible method available.

The protocol as advocated by Durnin & Womersley (1974) was chosen for the programme as it required inexpensive equipment and could be executed over a short period of time. Measurements were taken at four sites (biceps, triceps, sub-scapula and supra-iliac) using Harpenden skinfold callipers. The subject stood in a relaxed position with arms hanging at the side and palms facing forward. The skinfold was rolled between the thumb and forefinger to exclude any underlying muscle tissue. The callipers then gripped the skinfold and a reading was taken when the pointer needle changed from moving quickly to slowly. The measurement was repeated until three consistent readings were obtained. The exact place of measurement at the four sites are described :-

Biceps : over the mid-point of the muscle belly with hands hanging at the side with palms facing forwards.

Triceps : over the mid-point of the muscle belly,mid-way between the olecranon and the tip of the acromion,with the arms hanging at the side and palms facing forwards.

Sub-scapula : minimally below the tip of the inferior angle of the sub-scapula at an angle of 45 degrees to the spinal column.

Supra-iliac : one inch above the supra-iliac crest in the mid-axillary line.

4.3 Blood Pressure

Hypertension is a major risk factor in coronary artery disease (Kanel et al,1969; American Heart Association,1978; Shaper et al 1985). The British Regional Heart Study (Shaper et al,1985) estimated that men with a systolic blood pressure greater than or equal to 148 mmHg had a twofold risk of coronary artery disease compared to those with a systolic blood pressure below this level. Those with a diastolic blood pressure greater than or equal to 93mmHg had three times the risk of suffering from the disease compared with those with levels below 72mmHg.

Hypertension can be detected by measuring blood pressure and this measurement was included in the programme. It was measured using a calibrated sphygmomanometer with the subject seated, elbow resting on a table and using the fifth phase diastolic measure.

4.4 Blood Lipids

Cholesterol is one of the body's main serum lipids. The other serum lipids are phospholipids, triglycerides and free fatty acids. Serum lipids are mainly transported in the bloodstream by bonding to lipoproteins (serum albumin transports free fatty acids). Very low density lipoproteins (VLDL's) are major transporters of triglycerides. Low density lipoproteins (LDL's) carry approximately 70% of total serum cholesterol. High density lipoproteins (HDL's) are believed to remove excess serum cholesterol from the tissues and return it to the liver for excretion.

Cholesterol is a vital constituent of cell membranes. The body produces approximately 75% of its cholesterol in the liver whilst the remaining 25% is believed to be obtained from dietary fats.

Elevated total serum cholesterol has been identified as a major risk factor in coronary artery disease. This has been shown in numerous major studies (Kanel et al,1969; Shaper et al,1985; Rose et al,1980; Neaton et al,1984). The role of lipoproteins, especially HDL's as a risk factor in coronary artery disease is less clear. The Framingham (Kanel et al,1969) studies found that those with lower levels of HDL's had an increased risk of coronary artery disease.However an overview of four prospective studies in the United States (Gordon et al,1987) has shown the relationship to be weaker than that shown in the three afore-mentioned studies. In a review paper Betteridge (1989) concluded that measuring HDL concentration in conjunction with total serum cholesterol would provide the most comprehensive information about coronary artery disease risk.

On the basis of the evidence presented it would seem that both total serum cholesterol and HDL's are risk factors of coronary artery disease. The former,however seems to be the better indicator of the disease. On the basis of it being a better indicator of the disease and the financial and practical problems associated with measuring HDL's, it was decided to include only the measurement of total serum cholesterol in the programme. (HDL measurement involves the subject fasting for 12 hours and a venous blood sample being taken which is then sent to the laboratory for analysis at a cost of £6 per test)

There were two options available to measure total serum cholesterol (cholesterol) :- venous blood sampling and finger prick analysis using a Reflotron system.

The venous blood sampling method was rejected because the protocol, which involved venous blood sampling and laboratory analysis,was too time consuming,expensive and required the recalling of individuals for counselling.The Company could not afford to lose an individual from production for a second period nor did the Vale Project have the resources to provide additional counselling.

The method of analysis by the Reflotron system was selected because results and appropriate counselling could be given within minutes of the assessment. The cost of the analysis was also substantially less than that of venous blood sampling. Providing a strict protocol is observed, this method has been shown to accurately produce results to within +/- 0.5 mmols/l of those achieved by venous blood sampling (Harper et al,1990).

The protocol involved pricking a fingertip with a needle using an Autoclix Lancet,drawing a small sample of blood with a pipette and placing the sample on a reagent strip. The strip was then inserted into the Reflotron for analysis of total serum cholesterol concentration. The procedure took around 4 minutes to execute. (The protocol is fully descibed in the Reflotron manual (Boehringer)).

4.5 Cardiorespiratory Fitness

Several large scale studies have shown that participation in regular vigorous physical activity is inversely linked with the incidence of coronary artery disease.(Paffenbarger et al,1975, 1984,1986; Morris et al 1973,1980; Powell et al,1987). The relationship of cardiorespiratory fitness to the disease is less clear due to the problems in quantifying aerobic capacity.

Peak oxygen uptake (peak Vo2) provides information on the capacity of the aerobic energy system. However other factors such as genetics (Laporte et al,1985), skill and efficiency in an activity, psychology and environment (Astrand,1986) and the number of muscle fibres, capilliaries and enzymes (Holloszy & Coyle,1974), can affect a person's capacity. (The contribution of these factors to aerobic capacity have been reviewed by Astrand (1986)).

The most effective measurement of peak VO2 is by a maximal test. Protocols for this form of measurement vary (Froelicher et al,1984; Nagle et al,1973) and often require specialised, expensive laboratory equipment. The aim of these tests is to push the subject to the limit of aerobic capacity. This can often lead to great distress in the subject, especially those who are not used to vigorous exercise. Consequently this mode of testing is not advocated for use with the general population (Hammond & Froelicher, 1984).

Tests which predict peak VO2 have been devised to overcome the problems of maximal testing. Peak VO2 can be predicted using information gained from sub-maximal running, stepping, or from cycle ergometry tests (Astrand & Rhyming,1954, Wyndham 1967,Fox,1973,Gitin,1974,Cooper,1968). The protocols for such tests are simple to administer and require limited equipment.

There are considerable potential sources of error with this mode of testing (Nagle 1973;Rodahl et al, 1974;Rhyming, 1953;Astrand,1986). Doubts have been raised on the assumption of the linearity of the heart rate/oxygen consumption relationship,the prediction of maximum heart rate,the assumption of a fixed 'mechanical' efficiency and on variations in cardiac output (Astrand,1986)

The members of the Vale Project were aware of the shortcomings of sub-maximal tests in the prediction of peak VO2. The selection of a maximal test was not a feasible option and subsequently a sub-maximal cycle ergometer test was selected for the programme. This mode of sub-maximal testing was chosen as it has been shown to have the best validity and reliability (McArdle,1986).

The test protocol chosen was that recommended by the Council of Europe's Committee on Physical Education and Sport (Tuxworth,1985). This is a modified version of the procedure devised by Wahlund (1948) and adapted by Astrand (1960). The protocol for children is described in the Eurofit

Handbook (Tuxworth, 1985). The protocol was adapted for use with adults.

The test was administered on a Monark 864 cycle ergometer which was mechanically braked by a friction belt, tensioned by suspended weights. The subject was required to pedal continuously at a cadence of 60 revolutions per minute for a period of 6 minutes. Efforts were made to ensure uniformity of cadence throughout the assessment as achieving this was a crucial component of the protocol. An arrow was placed on the dial of the pedal revolution meter at the 60 revolution per minute position to assist the subject. Before the test commenced the individual was allowed to practice pedalling at this cadence. If the subject had difficulty in achieving uniformity in pedalling at this pace, a battery operated metronome,adjusted to the correct frequency, was switched on to provide assistance. The tester would also spend time 'coaching' the subject during pedalling if problems were still being encountered. Whilst the subject was undergoing the assessment the tester frequently checked the revolution meter to ensure that the correct cadence was being observed.

During the 6 minute period of the assessment the workload was increased twice, at two minute intervals, so that by the end of the test the subject's heart rate was within 10 beats of 85% of the predicted maximum heart rate (Predicted maximum heart was calculated using a formula developed by Astrand (1968)).

Adjusting the workload at the end of each two minute work interval required great practice and efficiency from the tester. The heart rate, which was monitored by a Sports Tester PE3000 heart rate monitor, was measured with 15 seconds of the work interval remaining. The tester then read off the required next workload from tables adapted from the Eurofit manual (Tuxworth,1985) and made the appropriate adjustment to the suspended weight basket.

To achieve the adjustment in such a short period of time required practice. To overcome this difficulty the tester underwent an intensive training programme (This will be discussed in detail later). The tester practiced the procedure on 30 subjects and was also given written instructions relating to the adjustment of workloads which enabled further 'mental' practice of the technique.

On successful completion of the assessment, the workload required to achieve the target heart rate was observed directly or calculated. The latter was achieved by plotting a graph of heart rate against workload, using the data from the second and third work intervals, and extrapolating the graph so that the workload necessary to achieve the desired heart rate could be assessed. (It should be noted that the target heart rate was never exceeded and only extrapolation of the data was necessary). Once this workload was assessed it was divided by the value of the subject's bodyweight so that a measure of work capacity per kilogram of bodyweight could be obtained.

For the purposes of comparison with other studies the data from the test was utilised to enable peak VO2 to be predicted. To convert from a measure of work capacity to a measure of oxygen uptake, body mass and metabolic rate must be taken into account. This was achieved by designing a computer programme, based on formulae devised by Shepherd (1970) for the solution of the Astrand nomogram and for the calculation of body surface area.

The procedure for this assessment is described as follows :-

1. The subject was encouraged to attend ten minutes before the assessment and was seated in a waiting room which had a variety of reading materials available for perusal.

2. The subject completed the 'Par-Q Readiness to Exercise' questionnaire.Family and personal medical history was ascertained as were present medication intake habits. Using the guidelines of the American Heart Association (1972), the tester decided whether or not the subject was suitable to participate in the assessment. If a person was excluded on these grounds a referal, with the consent of the subject, was made to the company physician who took the final decision as to whether or not the person should be excluded. If such a subject was allowed to undergo the assessment it was completed with the medical officer in attendance.

3. A general overview of the test was given as the subject could not be habituated to the assessment. Every effort was made to ensure that the atmosphere was friendly and relaxed so as to try to reduce anxiety levels.

4. The saddle was adjusted so that the knee was only slightly flexed when the pedal was in the bottom position with the ball of the foot resting on the pedal.

5. The Sports Tester PE3000 heart rate monitor was attached and checked for function.

6. The initial workload was established arbitrarily by the tester who used body weight, predicted %Bodyfat and self reported levels of participation in vigorous physical activity to assist her decision. The loading usually varied between 0.75 and 1.5 watts per kilogram of body weight.

7. The subject commenced pedalling and once a cadence of 60 revolutions per minute was consistently established, the load was administered for the initial work intensity phase (W.I.1) and the test began.

8. The heart rate was recorded within the last 15 seconds of the initial two minute work phase and the workload (W.I.2) for the second period of the test was calculated using the guidelines shown in Table 4.1.a.

9. The second workload was then administered and its value recorded.

10. Procedures (8) and (9) were repeated in relation to the third work phase (W.I.3) using the guidelines shown in Table 4.1.b.

11. At the end of W.I.3, the heart rate was recorded and if the heart rate was at the target rate or within ten beats below the target, the subject warmed down with a light workload for a period of between 2 and 3 minutes. A drink of water was then offered. If the subject did not reach the target heart rate or within ten beats of it, a fourth workload was administered following the procedures outlined for the third work phase.

During the test the Tester talked to the subject giving re-assurance and also checked for signs of undue distress. In addition, the cadence of cycling was constantly monitored.

ESTABLISHING 2nd WORK INTENSITY (W.I.2)	
Heart rate at the end of W.I.1	% Increase of Load
<58% of target heart rate	70%
59-65% " " " "	60%
66-70% " " " "	50%
71-76% " " " "	40%
77-88% " " " "	30%
89-95% " " " "	10%

Table 4.1a : Establishing 2nd Work Intensity

ESTABLISHING 3rd WORK INTENSITY (W.I.3)		
Heart Rate at end of W.I.2		% Increase of Load
<76%	of target heart rate	70%
77-82%	' " " "	50%
83-88%	" " " "	30%
89-85%	" " " "	10%

Table 4.1b Establishing 3rd Work Intensity

4.6 Data Collection

Personnel

Initially it was intended that the author would carry out the assessment proceedure. The experience of the pilot study, however indicated that a women tester would be more appropriate. To this end a State Registered Nurse,who had previous experience of heart health screening,was employed.It was felt that her nursing skills and experience would benefit the programme and improve compliance. The option of employing several part-time personnel was considered but was rejected as it was felt that test reliability might have been affected. The nurse underwent a 70 hour training programme which was supervised by the author. The nurse carried out the assessment on 30 subjects and was given intensive tuition on the execution of the sub-maximal cycle ergometer test procedure. The programme began when the nurse could administer the whole programme with accuracy and repeatability.

Due to the logistical problems involved in recruiting subjects an appointments administrator was employed. The company volunteered the services of an experienced member of their personnel staff who was well known within the factory. His knowledge of the factory was invaluable in achieving the high participation rate.

Quality Control

All aspects of the programme were subject to rigorous quality control procedures which were supervised by the author.

The Reflotron was calibrated daily. This involved inserting a reagent strip with a known level of total serum cholesterol concentration into the machine and checking that the measurement by the machine matched the known measurement. In addition, the Vale Project participated in a quality control programme run by the Wolfson Laboratory in Nottingham. This involved measuring an unknown concentration of cholesterol on a monthly basis and sending the result to the afore- mentioned laboratory who checked the accuracy of the reading. On all occassions the concentration level was accurately read to within $\pm$ 0.5 MMols/l.

The Seca scales were calibrated weekly using a 10 kg weight to check readings.

The cycle ergometer,which was self calibrating, was checked by placing a checked 5 kg weight on the hanging basket and ensuring that the basket elevated between 1 and 2 cm above its lower stop position. This method is recommended by the British Association of Sports Sciences (1988). In addition,the cycle was regularly seviced and cleaned. Particular attention was paid to the cleaning and smooth operation of the friction belt.

The aneroid sphygmomanometer was checked daily. The mercury and the glass were scrutinised to ensure that they were clean. Tubes were checked for leaks. The mercury reading was observed to ensure it was at the zero position when the cuff was exposed to the atmosphere.

The Sports Tester PE3000 was checked by measuring heart rate directly from the chest using a stethoscope and comparing the reading to that of the Sports Tester.

Unfortunately the Vale Project did not have access to the technology required to check the tension of the Harpenden skinfold callipers on a daily basis. The equipment was regularly cleaned and serviced by a company technician.

Recruitment

All managers,supervisors and members of the Vale Project's Employee Advisory Committee were invited to participate in the programme before it was offered on a factory wide basis. This was not a 'perk' for these people but a strategic attempt to influence them about the benefits of the programme and to gain their cooperation in encouraging their staff to participate. It was also felt that these people would highlight any potential problems which may arise with the workforce.

Employees were invited to participate on a departmental basis.When a department was about to be screened a meeting was held with the respective supervisor and an appointment rota established. A photographic display,describing the whole process,was then placed in a prominent position within the department.Vale Project staff were made available to deal with any problems which arose. In addition,a publicity campaign was mounted throughout the factory.The programme was heavily featured in the Vale Project's quarterly newsletter and occasional articles were printed in the local newspapers. An update was also given in the factory's monthly team briefing sessions which all employees attended. Poster and leaflet campaigns were held throughout the factory. Promotions were also held in the factory's canteen.

An appointment and information leaflet,which explained the programme,was sent to each employee. A 'tear-off' slip was attached to the leaflet which was returned only when an individual could not attend at the designated time. If this happened another appointment was automatically made. If a person did not turn up 10 minutes before the appointment, the administrator immediately made contact to remind the individual of the appointment.If the person had to cancel, another appointment was made. The administrator kept a list of people who were available to attend at short notice.If an appointment became available these people were contacted and were invited to utilise the appointment.

Assessment Procedure

Each person was encouraged to appear ten minutes before their appointment and was seated in a waiting room. They were encouraged to wear loose clothing with flat shoes. If individuals wished to change into more appropriate clothing they were directed to a changing room. The programme was administered as described earlier. All data were recorded in a booklet as shown in Appendix 4. The individual was appropriately counselled about the results of the assessment. The nurse carried out all of the counselling and she was trained on exercise counselling by the author. If she encountered a problem in this area, the subject was refered to the author.

Subjects were given the opportunity to enrol in exercise, quit smoking and healthy eating classes. If this was declined then they were offered appropriate leaflets on personal exercise programmes, healthy eating and smoking cessation. A recall programme was initiated for those who were deemed to have a high level of cholesterol (≥6.5mmols/l). Individuals in this category were recalled after four weeks to have their levels monitored.After three recall visits they were referred to a dietitian if their cholesterol level remained high.

Data Processing

A systems file was created on SPSS-PC.All data were coded, if necessary, and entered into this file by secreterial staff.

On completion of the whole programme the data were checked by the author. Those measures which deviated from the acceptable range were checked against the paper file. Approximately 95% of the errors were due to human error when entering the data into the file. Those that were not caused by human error were investigated and a decision was taken on whether or not to include them in the analysis.

The data was then analysed and the results are described in Chapter 5.

CHAPTER FIVE : RESULTS

5.1.Introduction

In this chapter the sample will be examined to ascertain whether or not it is representative of the factory population and of the adult population of working age. The distribution of each variable will then be scrutinised to establish whether or not the distribution could be regarded as being normal. Once this issue is resolved, descriptive statistics will be derived by age group and by gender. The relationships between key coronary artery disease risk factors, controlling for the effects of age,will then be examined. Finally, the physical activity habits and the cardiorespiratory fitness of employees will be investigated.

The study was cross-sectional in nature and the relationships which will be examined reflect the study population only at the particular period when the data was collected. The effects of time on variables are not studied and therefore conclusions drawn about relationships between variables have to be treated with utmost caution.

5.2 Representative Nature of the Sample

The first stage in the analysis was to ascertain whether or not the sample was representative of the factory population and, secondly, whether or not the sample was representative of the adult population of working age.

The sample was not randomly selected as all employees of the company were given the opportunity to participate. In total 1,190 people took part in the programme representing 87% of the total workforce. Table 5.1 shows the distribution of participants by age group and by gender.

Age Group (years)	Number in Sample	
	Men	Women
16-20	20	36
21-29	119	144
30-39	132	215
40-49	159	197
>50	114	54
TOTAL	544	646

Table 5.1 : Number in the Sample by Age Group and by Gender.

(Factory total : Men =621; Women = 747)

The representative nature of the non-participants was examined to find out if they caused the sample to be biased in some form. Age, gender and job type were used as indicators of representation within the factory and this revealed that the sample could be considered representative of the factory population.

Physical parameters were investigated to find out if the factory population was similiar to that of the adult population of working age. Comparisons of body mass index can be found in Table 5.2. It can be seen that the measures for both populations were close together although there seemed to be a small difference between those aged between 16 to 29 years. It was hoped to investigate other physical parameters but little other comparative data exists for the whole age range of this sample. Socio-economic factors and their relationship to health were examined and it was concluded that the factory sample could not be considered as being representative of the adult population of working age.

Age Group (years)	Population			
	*British		Factory	
	$\bar{x}$ BMI		$\bar{x}$ BMI	
	men	women	men	women
16-29	21.0	21.4	23.4	22.8
30-39	25.2	23.3	24.6	23.7
40-49	25.2	24.4	25.5	24.8
>50	25.1	24.2	25.2	25.3

Table 5.2: Comparison of body mass index (BMI) between this factory sample and the British population : men and women. ($\bar{x}$ = mean)

*** Office of Population Census and Surveys(1984)**

5.3 Distribution of Each Variable

The distribution of each variable, for both men and women was examined to ascertain whether or not certain statistical techniques, which require a variable to be normally distributed, could be used in the analysis of the data. A histogram of the frequency distribution of each of the following variables for both men and women can be found in Appendix 5 (Figures 5.1a to 5.1n :- height, weight, cholesterol, percentage bodyfat (%Bodyfat), systolic blood pressure(SBP),diastolic blood pressure (DBP) and predicted peak oxygen uptake (peak $\dot{V}O2$)).

On visual inspection it is evident that, with a few departures, the distribution of each variable is close to the expected. Only the distribution of SBP in men and DBP in women showed large variance from the expected distribution. This may have been due to the phenomenon of favoured readings of blood pressure (British Hypertension Society,1990).

The extent of skewness of each variable was assessed. In order to achieve this the mean, median and mid-quartile of each variable were calculated and examined. These are listed for men and women in Tables 5.3a and 5.3b respectively.

Variable	Mean	Median	Mid-quartile
weight (kg)	75.9	75.0	75.0
height (cm)	176	176	176
cholesterol (mmols/l)	5.70	5.60	5.60
%Bodyfat (%)	22.3	22.5	22.5
SBP (mmHg)	123.8	120.0	120.0
DBP (mmHg)	77.6	80.0	80.0
peak $\dot{V}O2$ (ml/kg/min)	36.6	35.0	35.0

Table 5.3a: Mean,median and mid quartile of each variable : men

Variable	Mean	Median	Mid-Quartile
weight (kg)	60.9	59.5	59.5
height (cm)	161.9	162.0	162.0
cholesterol (mmols/l)	5.60	5.50	5.50
%Bodyfat (%)	30.6	31.0	31.0
SBP (mmHg)	117.0	118.0	118.0
DBP (mmHg)	74.2	75.0	75.0
peak $\dot{V}O2$ (ml/kg/min)	31.5	30.9	30.9

Table 5.3b :Mean,median and mid-quartile of each variable : women.

Examination of these measures for all variables shows that in all cases they are close to one another. The relationship of mean, median and mid-quartile to each other is a stronger indicator of skewness than that of visual inspection of the distribution histograms. It seems reasonable to conclude that the distribution of each variable for both men and women is close to the expected normal distribution and that each can be statistically analysed as though they are normally distributed.

5.4 Mean,Standard Deviation and Range of Each Variable by Age Group and by Gender

The mean,standard deviation and range of each variable by age group and by gender can be found in Tables 5.4a to 5.4g.

WEIGHT (kg)						
Age Group	Men			Women		
	n	$\bar{x} \pm$ S.D,	Range	n	$\bar{x} \pm$ S.D.	Range
<20	20	66.9 ± 9.0	54.0-92.2	36	56.9 ± 7.0	40.0-73.0
20-29	119	72.6 ± 10.9	49.5-108.0	144	57.3 ± 9.1	40.0-73.0
30-39	132	78.5 ± 12.5	51.5-129.0	215	61.3 ± 9.3,	41.0-105.8
40-49	159	77.8 ± 11.3	53.0-117.0	197	63.3 ± 10.9	37.8-99.0
>50	114	75.6 ± 9.9	51.5-113.0	54	63.6 ± 10.2	45.6-91.0

Table 5.4a : Number in Sample (n),Mean ($\bar{x}$),Standard Deviation (S.D.) and Range of Weight (kg) by Age Group (years) and by Gender

HEIGHT (cm)						
Age Group	Men			Women		
	n	$\bar{x} \pm$ S.D.	Range	n	$\bar{x} \pm$ S.D.	Range
<20	20	178.3 ± 5.1	168-189	36	163.8 ± 4.3	155-171
20-29	119	177.7 ± 6.4	165-197	144	162.6 ± 6.4	148-178
30-39	132	176.4 ± 6.3	161-190	215	162.2 ± 5.7	148-176
40-49	159	175.7 ± 6.5	152-193	197	160.9 ± 6.4	150-178
>50	114	173.3 ± 6.1	159-191	54	161.9 ± 6.1	150-178

Table 5.4b : Number in Sample (n),Mean ($\bar{x}$),Standard Deviation (S.D.) and Range of Height (cm) by Age Group(years) and by Gender.

%BODYFAT						
Age Group	Men			Women		
	n	$\bar{x} \pm$ S.D.	Range	n	$\bar{x} \pm$ S.D.	Range
<20	20	15.0 ± 4.1	8.1-31.1	33	25.8 ± 4.8	16.4-37.2
20-29	116	17.2 ± 4.9	8.1-35.5	132	26.9 ± 4.9	16.9-39.1
30-39	125	22.0 ± 4.3	12.2-31.5	188	30.3 ± 4.6	17.0-42.1
40-49	152	24.6 ± 5.3	10.3-40.7	169	33.7 ± 4.7	17.9-43.9
>50	105	26.3 ± 5.5	11.0-39.0	44	36.2 ± 5.5	20.8-46.2

Table 5.4c : Number in Sample (n),Mean ($\bar{x}$),Standard Deviation (S.D.) and Range of Predicted percentage bodyfat (%Bodyfat) (%) by Age Group and by Gender

CHOLESTEROL (mmols/l)						
Age Group	Male			Female		
	n	$\bar{x} \pm$ S.D.	Range	n	$\bar{x} \pm$ S.D.	Range
<20	20	4.1 ± 0.8	3.0-6.1	34	5.0 ± 1.1	2.8-7.3
20-29	115	4.9 ± 1.0	2.8-7.9	141	5.2 ± 0.9	3.0-7.8
30-39	128	5.8 ± 1.3	2.7-9.8	211	5.3 ± 0.9	2.8-9.4
40-49	156	6.1 ± 1.1	3.3-9.3	192	6.0 ± 1.0	2.6-10.3
>50	112	6.2 ± 1.0	4.3-9.7	54	6.5 ± 1.1	3.7-9.1

Table 5.4d : Number in Sample (n),Mean ($\bar{x}$),Standard Deviation (S.D.) and Range of Cholesterol (mmols/l) by Age Group and by Gender

PEAK $\dot{V}O2$ (ml/kg/min)						
Age Group	Men			Women		
	n	$\bar{x} \pm$ S.D.	Range	n	$\bar{x} \pm$ S.D.	Range
<20	20	46.2 ± 7.0	35.1-61.3	27	36.7 ± 7.3	24.0-50.0
20-29	114	43.7 ± 8.4	25.1-63.9	117	33.8 ± 7.1	14.9-68.1
30-39	123	36.1 ± 10.1	22.2-62.9	154	31.7 ± 7.8	14.2-58.9
40-49	147	34.3 ± 8.2	16.9-64.3	127	29.3 ± 7.4	13.7-56.2
>50	96	30.5 ± 8.0	16.4-58.1	30	27.2 ± 7.3	12.0-49.4

Table 5.4e : Number in Sample(n),Mean($\bar{x}$),Standard Deviation(S.D.) and Range of Peak $\dot{V}o2$ (ml/kg/min) by Age Group and by Gender

SYSTOLIC BLOOD PRESSURE (mmHg)						
Age Group	Men			Women		
	n	$\bar{x} \pm$ S.D.	Range	n	$\bar{x} \pm$ S.D	Range
<20	20	116.2 ± 9.1	95.0-130.0	36	114.9 ± 9.2	98.0-135.0
20-29	119	118.9 ± 11.8	98.0-155.0	144	112.3 ± 11.3	90.0-162.0
30-39	132	122.6 ± 13.3	90.0-175.0	215	113.8 ± 11.0	95.0-150.0
40-49	159	124.3 ± 13.9	98.0-168.0	197	122.0 ± 15.4	98.0-172.0
>50	114	131.0 ± 18.7	98.0-185.0	54	125.5 ± 15.3	100.0-172.0

Table 5.4f : Number in Sample(n),Mean($\bar{x}$),Standard Deviation(S.D) and Range of Systolic Blood Pressure(mmHg) by Age Group & Gender

DIASTOLIC BLOOD PRESSURE (mmHg)						
Age Group	Men			Women		
	n	$\bar{x} \pm$ S.D.	Range	n	$\bar{x} \pm$ S.D.	Range
<20	20	69.6 ± 10.2	55.0-85.0	36	68.4 ± 11.5	50-92.0
20-29	119	71.9 ± 11.1	50.0-105.0	144	69.5 ± 10.5	46.0-120.0
30-39	132	78.1 ± 8.9	58.0-105.0	215	73.1 ± 9.3	55.0-90.0
40-49	159	80.0 ± 9.0	50.0-102.0	197	78.7 ± 9.4	58.0-110.0
>50	114	81.0 ± 10.0	58.0-103.0	54	77.9 ± 11.6	50.0-104.0

Table 5.4g:Number in Sample(n),Mean($\bar{x}$),Standard Deviation(S.D) and Range of Diastolic Blood Pressure(mmHg) by Age Group & by Gender

Examination of these tables showed that, for both sexes, the mean value of peak $\dot{V}O2$ was lower in each age group than the mean value of peak $\dot{V}O2$ in the age group which immediately preceded it. The mean value of cholesterol, %Bodyfat and diastolic blood pressure, in both men and women, and for systolic blood pressure for men, was higher in each age group than the mean value of each respective variable in the age group which immediately preceded it.

The mean value of systolic blood pressure in women aged 20 to 29 years was lower than the mean value for those women aged less than 20 years. The mean values for the age groups from 30 years onwards followed a pattern similiar to that of men.

The mean value of height, in both men and women, was lower in each age group than the mean value of height for the age group which immediately preceded it, however, the mean value for the 50 plus group was higher than mean value for the 40 to 49 year age group. The mean value of weight of women in each age category was higher than the mean value for the age category which immediately preceded it.

The mean value of weight for men aged between 20 and 29 years was higher than the mean value for those aged less than 20. For the age categories from the age of 30 onwards the mean value of weight for mean was lower than the mean value for the age category which immediately preceded it.

These results suggest that there may have been some form of age related trend within each variable however the nature of the study does not allow for such inferences.This study was cross-sectional in nature and the effects of time on the sample were not examined. It is possible that factors other than the ageing process may be responsible for differences between the age groups. For example, recruitment policy may have changed over the years and caused differences. Socio-economic and cultural standards may also have changed and resulted in diffferences between the various age groups. Some form of longitudinal study would be required to investigate whether changes in the variables could be attributed to the ageing process.

5.5 Relationships Between Variables Controlling For the Effects of Age

The first stage in the analysis was to construct scatter diagrams of the data in order to investigate the relationships between the variables being examined. Of the variables measured it was decided to investigate the relationships between the following : - weight, cholesterol,peak $\dot{V}O_2$,SBP,DBP and percentage bodyfat (%Bodyfat). Height was excluded from the analysis as there is no documentary evidence to show that, for the normal population, height affects any of the above-mentioned variables or contributes to the incidence of coronary artery disease. (Height may play a role in the disease only at the extremes of its range). Scatter diagrams can be found in Appendix 6. Inspection of these diagrams showed that in many cases, such as the relationship between weight and percentage bodyfat, a linear relationship may be present. In other cases it was not possible to determine the nature of the relationship however the possibility of a linear relationship could not be excluded.

Calculating the coefficient of correlation would enable the strength of a relationship between two variables to be investigated. However this method does not allow for the effects of other variables on the two being investigated. It is possible that a strong correlation between two variables may be due to their dependence upon another. For example, Tables 5.4c and 5.4e show that the mean values of bodyfat increased with age whilst those of peak $\dot{V}O2$ decreased. Age affects both these variables therefore an investigation into the strength of the relationship between these two variables would be relatively worthless unless age is corrected for. On studying the means of the other variables it would seem reasonable to state that age may affect each variable and therefore it would seem reasonable to control for its effects when examining relationships. (It must be highlighted that variables other than age may also affect relationships. However,in the first instance,it was decided to only investigate relationships between variables controlling for the effects of age).

The calculation of the partial correlation coefficient was chosen as the method to eliminate the effects of a third variable on the relationship between two other variables.This method holds the third variable constant so that only the two variables being investigated are included in the correlation. The partial correlation coefficient between variables was calculated using the statistical package, S.P.S.S.-P.C.

Tables 5.5a and 5.5b show the partial correlation coefficient between each of the afore-mentioned variables for men and women respectively.(Note : an F statistic was calculated and the correlation in each case was significant at a level of at least $p<0.05$.)

Correlation Variables	Partial Correlation Coefficient
Peak VO2 with Weight	-0.329*
Peak VO2 with Cholesterol	-0.162*
Peak Vo2 with %Bodyfat	-0.321**
Peak VO2 with SBP	-0.187*
Peak VO2 with DBP	-0.291*
Cholesterol with %Bodyfat	0.220*
Cholesterol with Weight	0.153*
Cholesterol with SBP	0.062**
Cholesterol with DBP	0.121**
%Bodyfat with Weight	0.645*
%Bodyfat with SBP	0.130*
%Bodyfat with DBP	0.217*
Weight with SBP	0.235*
Weight with DBP	0.302*
SBP with DBP	0.590*

Table 5.5a : Partial Correlation Coefficients Between the Following Variables :- peak VO2 (ml/kg/min), weight (kg), %Bodyfat (%),cholesterol (mmols/l) systolic blood pressure (mmHg) and diastolic blood pressure (mmHg): Men

(* = $p<0.001$; ** $p<0.05$)

Correlation Variables	Partial Correlation Coefficient
Peak $\dot{V}O2$ with Weight	-0.283*
Peak $\dot{V}O2$ with Cholesterol	-0.131*
Peak $\dot{V}O2$ with %Bodyfat	-0.347*
Peak $\dot{V}O2$ with SBP	-0.118**
Peak $\dot{V}O2$ with DBP	-0.290*
Cholesterol with %Bodyfat	0.173*
Cholesterol with Weight	0.184*
Cholesterol with SBP	0.070**
Cholesterol with DBP	0.080**
%Bodyfat with Weight	0.666*
%Bodyfat with SBP	0.204*
%Bodyfat with DBP	0.201*
Weight with SBP	0.203*
Weight with DBP	0.291*
SBP with DBP	0.588*

Table 5.5b : Partial Correlation Coefficients Between the Following Variables :- peak $\dot{V}O2$ (ml/kg/min), weight (kg), %Bodyfat (%), cholesterol (mmols/l), systolic blood pressure (mmHg) and diastolic blood pressure (mmHg) : Women.

(* = p<0.001; ** = p<0.05)

Examination of Tables 5.5a and 5.5b shows that in all relationships examined the association is positive except for all those involving peak $\dot{V}O2$ where the relationships are negative. It should be noted that peak $\dot{V}O2$ is already expressed in relation to weight therefore it seems reasonable to state that some of the variation in peak V̇O2 can be attributed to its relationship with weight.

To examine the strength of the relationship between two variables, controlling for the effects of another, the partial correlation coefficient between the two variables is squared and then multiplied by 100 in order to calculate the percentage of variation in one of the variables which can be attributed to the linear relationship with the other. In other words, this calculation gives the proportion of the variance of one variable which can be explained by linear dependence on the other (and vice versa). For example, the partial correlation coefficient between peak V̇O2 and cholesterol, controlling for the effects of age,is -0.162. The percentage of variation in cholesterol which can be attributed to its relationship with peak V̇O2 (or vice versa), controlling for the effects of age, is therefore 2.6%. This figure was calculated for all the relationships for both men and women and can be found in Table 5.6. The entity is sometimes referred to as the partial coefficient of determination.

Correlation Variables	Partial Correlation Coefficient Squared (%)	
	Men	Women
Peak $\dot{V}O2$ with Weight	10.82	8.01
Peak $\dot{V}O2$ with Cholesterol	2.62	1.71
Peak $\dot{V}O2$ with %Bodyfat	10.30	12.04
Peak $\dot{V}O2$ with SBP	3.50	1.39
Peak $\dot{V}O2$ with DBP	8.47	8.41
Cholesterol with %Bodyfat	4.84	2.99
Cholesterol with Weight	2.34	3.39
Cholesterol with SBP	0.38	0.49
Cholesterol with DBP	1.46	0.64
%Bodyfat with SBP	1.69	4.16
%Bodyfat with DBP	4.70	4.04
%Bodyfat with Weight	41.60	44.36
Weight with SBP	5.52	4.12
Weight with DBP	9.12	8.46
SBP with DBP	34.80	34.50

Table 5.6 : The Partial Coefficient of Determination of the Associations Between the Following Variables :- Peak $\dot{V}O2$ (ml/kg/min),Weight (kg),Cholesterol (mmols/l) and %Bodyfat (%) : Men and Women.

Examination of Table 5.6 shows that, on controlling for age, over 40% of the variation in weight, in both men and women, is explained by its dependence on percentage bodyfat, and vice versa. Another relatively high partial correlation coefficient, was also observed for the relationship between systolic and diastolic blood pressure with almost 35% of the variation being explained by the relationship.

On correction for age, less than 12% of the variance in peak $\dot{V}O2$ in both men and women may be explained by its relationship to percentage bodyfat. Less than 3% of the variation in peak $\dot{V}O2$ in men and women may be explained by its dependence on cholesterol when the effects of age are ommitted. A similiar finding was observed for the relationship between peak $\dot{V}O2$ and systolic blood pressure.Less than 9% of the variance in diastolic blood pressure can be explained by its relationship with peak $\dot{V}O2$ in both men and women.

When age is corrected for, only a small proportion of the variation in cholesterol, in both men and women, can be explained by its relationship with weight. This is also true of the relationship between cholesterol and percentage bodyfat; between cholesterol and SBP and between cholesterol and DBP.

Of the relationship between weight and systolic blood pressure, less than 6% of the variation in both men and women can be explained. Similiarly, less than 10% of the relationship between weight and diastolic blood pressure in both men and women can be explained.

5.6 Participation in Vigorous Physical Activity

Figures 5.2a and 5.2b show the percentage of the workforce, by age group and by sex, who regularly participated in two or more sessions of vigorous physical activity per week. (It should be noted that compliance to the questionnaire was 100%).

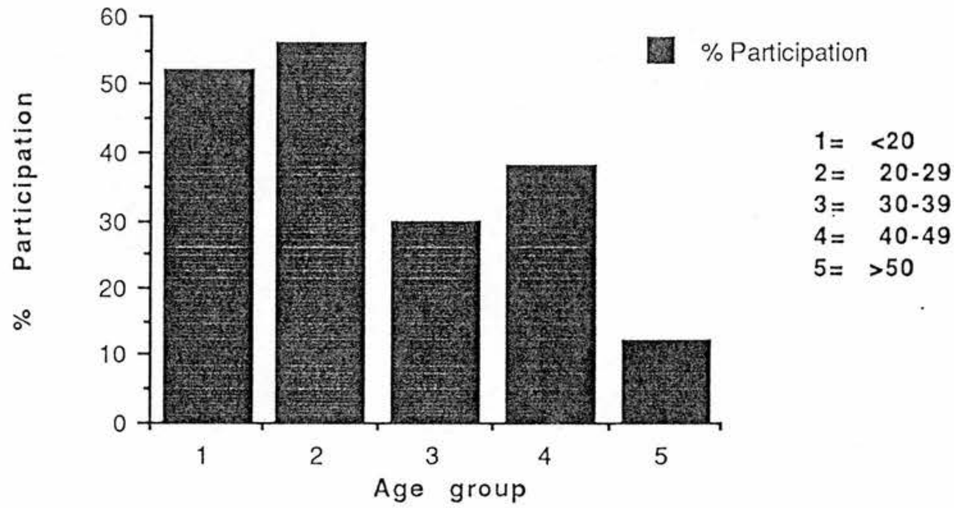

Fig 5.2a : Percentage of men, by age group, who regularly participated in two or more sessions of vigorous physical activity per week

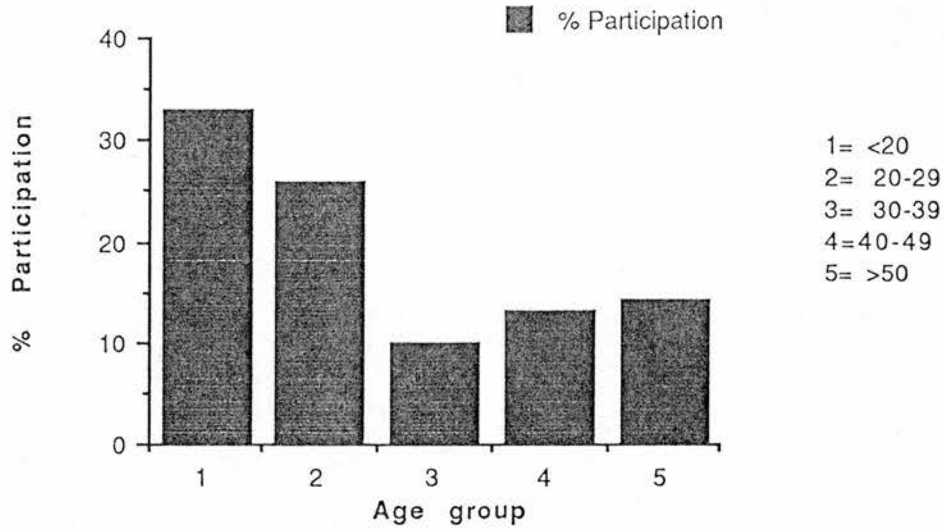

Fig 5.2b : Percentage of women, by age group, who regularly participated in two or more sessions of vigorous physical activity per week

Examination of Figure 5.2a shows that over 50% of men aged less than 30 years participated regularly in vigorous physical activity at least two times per week.Only 30% of men aged betwen 30 and 39 years participated in a similiar level of activity. The percentage of men aged between 40 and 49 who participated in a similiar level of activity was 38% whereas only 12% of men aged greater than 50 years participated in activity at such a level.

The figures for women were somewhat lower. Less than 30% of women aged less than 30 years participated in a suitable level and frequency of physical activity. This decreased to only 10% of women aged between 30 and 39 years and then rose to 12%

and 13% for women aged between 40 and 49 years and greater than 50 years respectively.

5.7 Threshold for Protection From Coronary Artery Disease

Figure 5.3 shows the percentage of men, grouped in 10 year age intervals, who had a peak V̇02 of equal to or above 33 ml/kg/min. (The criteria for the threshold will be discussed in Chapter Six).

Women were not included in this part of the study as the data on the threshold for protection from the disease is suspect. This will also be discussed in Chapter Six.

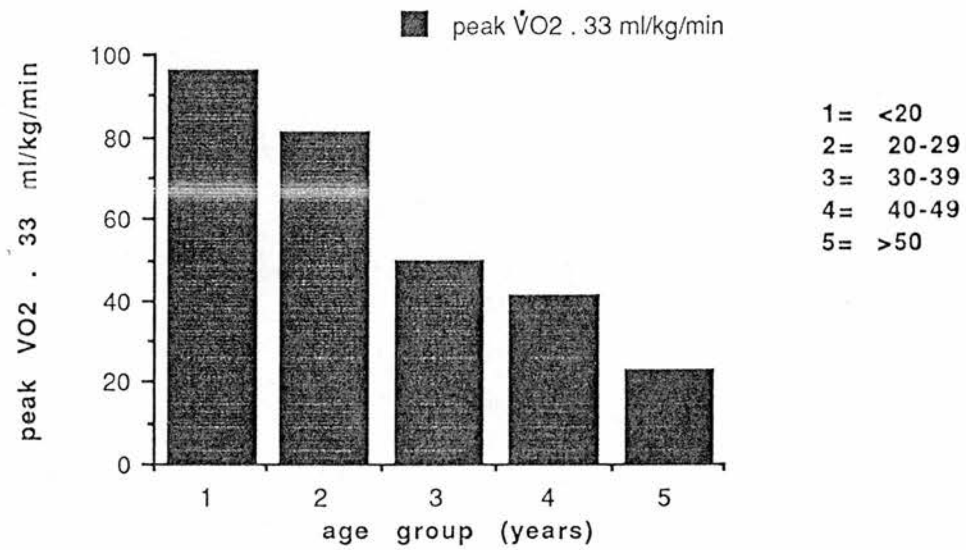

Fig 5.3: % of men,grouped in 10 year intervals,who had a peak V̇o2 greater than or equal to 33 ml/kg/min.

On examining Fig 5.3 it can be seen that 98% of men aged less than 20 years had a peak $\dot{V}O_2$ level equal to or above the threshold for protection from coronary artery disease. Almost 80% of men aged between 20 and 29 years had a similiar level of peak VO_2. After the age of 30 years the percentage of men who have a level of cardiorespiratory fitness above the threshold level necessary to provide protection from coronary artery disease decreased substantially. Only 48% of men in the 30 to 39 age group and 44% of men in the 40-49 age group possessed a level of aerobic fitness to optimise protection from coronary artery disease. Similarly only 16% of men aged greater than 50 years had an adequate level.

CHAPTER SIX : DISCUSSION

6.1 Representative Nature of the Sample.

The level of participation in the programme was 87% of the total factory population. This level was high when compared to other studies. The Cadbury-Schweppes study (Tuxworth et al,1986) had a participation level of 70%, with a large proportion of its population aged 50 years or over whilst the Canadian Life Assurance Study had a participation level of 61% (Cox et al,1981). It should be highlighted that the compliance by the subjects to the whole assessment programme was higher in the Cadbury-Schweppes study when compared to this study. The Canadian Fitness study (Bailley,1982) was concerned that its sample was biased towards the more physically active section of the population with a large proportion of its sample aged below 40 years. This was not the intention of the study but an unwelcome outcome.

The high level of participation may have been due to the pro-active efforts of the Project staff. These have been fully explained in Chapter 4. Key areas were the effective communication with management and employees, the flexibility of the appointment system, the targetting of individual work settings and the range of health promotion activities which were run in conjunction with the programme.

The pilot study was also invaluable in enhancing the participation level. The Management of the factory were convinced of the worth of the initiative and co-operated fully with its implementation. The study highlighted potential problems with the assessment of cardiorespiratory fitness and of body composition and enabled measures to be taken in order to improve compliance.

Non-participants were investigated to examine their effect on the representative nature of the sample. The Vale Project did not have the resources to fully investigate the reasons for non-participation. The problem was addressed subjectively by consulting the Appointments Administrator, the Screening Nurse and other Vale Project staff. It appeared that there were several main reasons for non-participation :-

i) the employee had already left the company

ii) the employee refused to participate

iii) the employee was too busy with work commitments to attend.

It seems that the two main reasons for non-participation were either the employee had ceased working for the company or the employee had refused to participate.

Those who had terminated employment with the company were mainly temporary workers whose contract had ceased. These people were employed to meet seasonal demands of production and were usually aged 30 years or less. It seems reasonable to state that the majority of these people would have participated in the programme , given the opportunity, and would probably have health characteristics similiar to their peers. Thus it seems reasonable to state that these people would have minimal effect on the representative nature of the sample. Records were not kept regarding the numbers who left the company. This was a shortcoming of this study.

There seemed to be several reasons for people refusing to participate. For example, fear of finding out about a major health problem, ill health or apathy . It seems that no one single factor stood out on its own. If health status was a factor then it would bias the sample. However it seems reasonable to assume that the bias would be slight because the numbers were small when compared to the overall participation level.

It should be noted that although 87% of the factory population took part in the overall programme, not all participants completed all aspects of the programme. For example, 30% of women declined to participate in the assessment of cardiorespiratory fitness and it may be that the data obtained from this test was biased towards the fitter women in the factory population. The compliance rates for the tests are listed in Table 6.1. It can be seen that the level of compliance was high for each test. It was particularly noticeable that the compliance to the assessment of cardiorepiratory fitness was much higher for both men and women than the level of compliance in the pilot project. It would seem that a female tester had a beneficial effect on both sexes.

	Level of Compliance	
Variable measured	Women %	men %
weight	100	100
height	100	100
SBP	100	100
DBP	100	100
cholesterol	98	98
%Bodyfat	88	95
peak $\dot{V}o2$	70	92

Table 6.1: Compliance rate for each test : men and women

With the evidence available, it seems reasonable to state that for all variables, except for peak VO2 for women, the sample was representative of the factory population and that this study may provide some quality information on the health and fitness characteristics of a factory population.

Research has shown that there are links between unemployment and health (Smith,1985; Kelvin,1985; Moser,1987,1984). Unemployment in Strathclyde Region, in which the Vale of Leven is situated, was 18% at the time when the study was conducted (Government Statistical Office,1988). It seems reasonable to conclude that the health of the unemployed would not be as good as that of the factory population due to social and economic factors and that the information obtained from this study is not applicable to the general population of adult working age.

6.2 Comparison of Summary Statistics With Other Populations.

Similiar studies on factory workers in Britain have been limited to the Cadbury-Schweppes study (Tuxworth et al,1986). This study investigated men aged between 35 and 60 years and the data derived from this will be used for comparative purposes. In addition, data which exists on similiar international populations, namely Canadian (Bailey et al,1982;Jette et al, 1978) and Scandanavian. (Astrand,1968) will also be used. The Canadian data will be used extensively whereas the Scandanavian data will only be used in the discussion of cardiorespiratory fitness. It must be highlighted that the data for the the Canadian and Scandanavian studies was collected in the 1970s and 1960s respectively. It is possible that these study populations may have changed since the period when the studies were completed. Normative fitness data does not exist for the Scottish population. A national fitness survey was recently completed in England (Sports Council & Health Education Authority, 1992) however the survey presented its data in age groupings which differ from all the other studies previously mentioned. This does not allow direct comparison to be made with this and the other studies. Interpolation does allow for some comparison however the reader should be reminded that measures of cardiorespiratory fitness are higher when measured by treadmill protocols than by cycle ergometer protocols.

Not all the variables examined in the factory study have been examined in the afore-mentioned studies. Other studies, namely the Scottish Heart Health Study (Tunstall-Pedoe et al1989;

Smith et al,1987,1989) and the Good Hearted Glasgow Study (Greater Glasgow Health Board-unpublished), will be utilised when discussing these variables.

The reader should also be reminded of the caveat in Chapter 5 which stressed that, because the study was cross sectional in nature, the differences between age groups could not be attributed to the ageing process. The study would had to have been longitudinal before the effects of time on variables could be examined.

Anthropometric Measures

Table 6.2 compares the mean value of weight for age decades for men and women in this study with corresonding mean values of men and women in the Canadian Employee Fitness Survey (Jette,1978) and with the age range of men studied in the Cadbury-Schweppes study (Tuxworth et al,1986).For mean weight of men, all three populations were close at all age groups. There was, however, a difference of 4.3 kg between those aged less than 20 years in the Canadian and those of a similiar age factory study. In women, the mean values of weight in the Canadian and this factory study were comparable for those aged less than 30 years. There were differences between these studies of between 2kg and 3kg for those in the age groups above 30 years of age.

For mean values of height (Table 6.3), the measures for each age group in all studies were close with the maximum difference at any age group being less than 2 centimetres. In terms of height and weight it seems reasonable to state that the factory population was similiar to the other populations discussed.

Variable	Age Group (years)	Study Population		
Weight		Canadian.	Cad-Schw.	This study
	MEN			
	<20	71.2	NA	66.9
	20-29	74.0	NA	72.6
	30-39	77.1	*77.5	78.5
	40-49	77.6	76.7	77.8
	>50	76.5	75.2	75.6
	WOMEN			
	<20	56.0	NA	56.9
	20-29	56.8	NA	57.3
	30-39	58.2	NA	61.3
	40-49	63.3	NA	60.3
	>50	61.6	NA	63.6

Table 6.2 : Comparison of the mean value of weight (kg) between the Canadian Employee Fitness Survey,the Cadbury Schweppes Study and this study by age group and by sex. (NA = Not applicable)

(* age group =35-39 years)

Variable Height	Age Group (years)	Study Population		
		Canadian.	Cad-Schw.	This study
	MEN			
	<20	176.8	NA	178.3
	20-29	176.3	NA	177.7
	30-39	176.3	*178.0	176.4
	40-49	175.5	176.7	175.7
	>50	174.2	175.0	173.3
	WOMEN			
	<20	162.3	NA	163.8
	20-29	162.6	NA	162.6
	30-39	162.1	NA	162.2
	40-49	162.3	NA	160.9
	>50	160.6	NA	161.9

Table 6.3 : Comparison of the mean value of height (cm) between the Canadian Employee Fitness Survey,the Cadbury Schweppes Study and this study by age group and by sex. (* age group =35-39 years) (NA = Not applicable)

On examining Table 6.4a,the mean values of percentage bodyfat of men in this study, in age groups less than 30 years, is lower than those of men in similiar age groups in the Canadian study. This relationship is reversed for men aged 30 years and older.For women, the mean values of %Bodyfat is higher for all age groups in the factory sample than in the Canadian study.

To examine whether these differences in the mean values were of statistical importance a 95% confidence interval (95% C.I.) for the difference in mean values between the two studies was constructed. The following formula was utilised:-

95% C.I. = xf -xs $\pm$ 1.96*e.s.e (xf-xs)

(xf=factory mean)

(xs=Scottish mean)

(e.s.e.(xf-xs)=estimated standard error of the difference in the means.)

The confidence intervals can be found in Table 6.4b. On examination of this table, it can be seen that the confidence intervals for the differences of the means between the two studies for those men aged less than 20 years and for those aged between 20 to 29 year do not contain zero. On the basis of this evidence, it is possible to state with confidence that for the two afore-mentioned age groups the mean value of percentage bodyfat in men was lower in the factory study than in the Canadian study. Using the same criteria, it is not possible to state with confidence that there were differences in %Bodyfat between the two studies for those men aged between 30 to 39 years, but for those aged between 40 and 49 years and aged 50 years or over it is possible to state with confidence that the mean value of percentage bodyfat in the Canadian study is lower than in this study.

For women in all age groups it is possible to state with confidence that the mean value of percentage bodyfat in women was lower in the Canadian study than in this study for all age groups.

There are many possible reasons for these differences. For example, different protocols were used to assess body composition and this may have resulted in the difference of results. (The problems associated with non-invasive estimation of body composition have been discussed in Chapter 4). The fact that the differences did not consistently favour one population casts doubt over this theory. It may be that Canadian men,aged 30 years and over, and Canadian women of all ages consumed a healthier diet and were more active or it may be that a genetic factor was responsible for the variation between the two groups. These hypotheses could equally apply to men in the factory sample aged less than 30 years. Data was not available to investigate these theories therefore it seems reasonable to conclude that further research is required to investigate this finding .

Further examination of Table 6.4a shows that, for the relevant age range surveyed, the mean values of percentage bodyfat are consistently lower in the Cadbury-Schweppes study than in the factory study. Unfortunately data was not available to establish confidence intervals for the differences in these mean values to examine whether or not these differences were of statistical significance.

Variable %Bodyfat	Age Group (years)	Study Population		
		Canadian.	Cad-Schw.	This study
		MEN		
	<20	17.7	NA	15.0
	20-29	20.2	NA	17.2
	30-39	21.9	*20.4	22.0
	40-49	22.8	23.3	24.6
	>50	23.6	24.8	26.3
		WOMEN		
	<20	21.6	NA	25.8
	20-29	21.5	NA	26.9
	30-39	22.0	NA	30.3
	40-49	23.2	NA	33.7
	>50	24.6	NA	36.2

Table 6.4a : Comparison of the mean values of %Bodyfat (%) between the Canadian Employee Fitness Survey,the Cadbury Schweppes Study and this study by age group and by sex. (* age group =35-39 years) (NA = Not applicable)

AGE GROUP (years)	95% CONFIDENCE INTERVAL	
	men	women
<20	-0.05 to -3.95	2.40 to 6.00
20-29	-2.08 to -4.92	4.55 to 6.25
30-39	-0.68 to 0.88	7.2 to 9.4
40-49	0.94 to 2.60	9.7 to 11.3
>50	1.62 to 3.78	9.9 to 13.3

Table 6.4b : 95% confidence intervals for the difference in the mean %Bodyfat of this study and the Canadian Employee Fitness Survey by age group and by sex.

Cardiorespiratory Fitness

The mean values of peak $\dot{V}O2$ for the factory, the Cadbury-Schweppes, Canadian Employee Fitness and Scandanavian studies by age group and by sex can be found in Table 6.5a. The Scandanavian study reported peak $\dot{V}O2$ in terms of litres per minute and did not present adequate data to convert their values in terms of oxygen uptake per kilogram of bodyweight. Tuxworth et al (1986) did however convert the data for men and these figures will be utilised.

On examination of Table 6.5a, it can be seen that the mean values for the men in this study were higher at all appropriate age groups than those of the Canadian and of the Cadbury-Schweppes studies and lower,in all age groups,when compared to those of the Scandanavian study.For women the mean values of the factory sample were higher at all age groups when compared to the Canadian data.

In all cases apart from the Canadian study, data was not available to establish confidence intervals. As a result, only the relationship between the Canadian and this study will be further examined. Confidence intervals for this relationship can be found inTable 6.5b.

Variable Peak $\dot{V}O2$	Age Group (years)	Study Population			
		**Can.	Scan.	Cad	This study
	MEN				
	<20	41.2	NA	NA	46.2
	20-29	37.9	47.5	NA	43.7
	30-39	33.3	43.5	*33.8	36.1
	40-49	30.0	39.5	31.9	34.3
	>50	26.1	34.0	27.1	30.5
	WOMEN				
	<20	30.0	NA	NA	36.7
	20-29	28.2	NA	NA	33.8
	30-39	26.2	NA	NA	31.7
	40-49	23.1	NA	NA	29.3
	>50	19.4	NA	NA	27.2

Table 6.5a : Comparison of the mean values of peak $\dot{V}O2$ (ml/kg/min) between the Canadian Employee Fitness Survey (Can),Cadbury Schweppes Study (Cad.) Scandanavian data (Scan.)and this study by age group and by sex. (*age group=35-39 years) **(Values modified)

AGE GROUP (years)	95% CONFIDENCE INTERVAL	
	men	women
<20	-8.2 to -1.8	-9.5 to -3.9
20-29	-7.3 to -4.3	-6.9 to -4.3
30-39	-4.6 to -1.0	-6.7 to -4.3
40-49	-5.6 to -3.0	-7.5 to - 4.9
>50	-6.2 to -2.6	-10.4 to -5.2

Table 6.5b : 95% confidence intervals for the differences in the mean values of peak $\dot{V}O2$ between this study and the Canadian Fitness Survey by age group and by sex.

Examination of Table 6.5b shows that in all cases the confidence interval does not contain zero. It is possible to state with confidence that the cardiorespiratory fitness levels of the factory sample were higher than those for the corresponding age and gender groups of the Canadian Employee Fitness survey.

This finding should be treated with caution. The Canadian utilised a step test to collect their data. This was modified by reducing the value of peak $\dot{V}O2$ by 21% so as to conform with predictions from a standard cycle ergometer protocol (Bailley et al,1982; Jette, 1978). It is highly possible that this modification may not be accurate and that the Canadian values may be higher. The data collected in this study, however, was rigorously collected. A heart rate was elicited from each subject which was within 10 beats of the target range of 85% of predicted maximum heart rate. The findings from both studies are worthy of further discussion.

The cardiorespiratory fitness levels of the factory sample may have been higher than those of their Canadian counterparts due to the increased opportunity for exercise within the factory and due to the increased awareness of the benefits of exercise which were promoted by the Vale Project. As stated earlier, the Project facilitated participation in exercise by providing a variety of exercise classes, organising an exercise break during working hours, promoting national fitness campaigns and by organising a major road race and fun run. This was an intensive effort which was ongoing and which had begun before the initiation of the coronary artery disease risk factor identification programme was initiated. Not enough information exists to directly compare these initiatives to those in Canada. It could be argued that the sample in the factory , particularly of women, was biased towards the fitter members of the population whereas the Canadian sample was not. This argument is however doubtful as the Canadian authors acknowledged that, because of the voluntary nature of the study, the sample was possibly biased towards the fitter members of their population.

Other factors may also have contributed to the differences between the studies. For example, the factory may have operated a more stringent recruitment policy which resulted in a healthier and fitter workforce or it may have been that there were cultural factors which were the cause of the difference.

Cholesterol and Blood Pressure

The Scottish Heart Health Study (Tunstall-Pedoe et al 1989;Smith et al, 1987, 1989) investigated cholesterol in the Scottish population and therefore provided comparable data for men and women aged 40 to 60 years. Unpublished comparable data for both sexes and a similiar age range was also obtained from the Good Hearted Glasgow programme (Greater Glasgow Health Board- unpublished). This initiative was aimed at a variety of workplaces including manufacturing,service and public industries throughout the Greater Glasgow Health Board area.

Table 6.6a presents the comparison of mean levels of cholesterol for the factory sample and for the two afore-mentioned studies. It can be seen that the mean values of cholesterol for this study, for both men and women, were consistently lower than for the Scottish population and were consistently higher than for those in the Glasgow study than in the factory study.

Table 6.6b shows the confidence intervals which were calculated for the differences in means between the Scottish study and this factory study. It can be stated with confidence that the mean cholesterol level was lower in the factory sample than in the Scottish population for men aged between 40 and 49 years and for women aged greater than 50 years.

Table 6.6c shows the confidence intervals which were calculated for the differences in means between the Glasgow study and this study. The mean value of cholesterol in all age groups, except for men aged less than 20 years, was lower in the Glasgow study than in the factory study.

The differences between the Scottish sample and the factory sample were not unexpected. Diet plays a major role in cholesterol production and the factory employees had access to a subsidised canteen which operated a menu system in accordance with the national nutritional guidelines (National Advisory Committee on Nutrition Education,1983). It would seem reasonable to state that this may have contributed to the differences in cholesterol. In addition, socio-economic factors may also have contributed to differences between the two studies (this has been discussed earlier).

Further investigation of the data found that 33% of men and

31% of women aged greater than 40 years had a cholesterol level above 6.5mmol/l. For the Scottish population, the figures were 42% and 49% for men and women respectively. At present it is advocated that General Practitioners treat all patients who have cholesterol levels above 6.5mmol/l. If health promotion activities within the factory have affected the cholesterol levels of employees, it seems reasonable to state that this type of initiative may be a more cost effective method of controlling cholesterol.

The differences between the factory results and those of Good Hearted Glasgow are somewhat surprising. The Vale of Leven is geographically close to the city of Glasgow and although the Glasgow study involved a variety of workplaces, there was no indication that these workplaces operated policies which would have caused a difference in health status.

No data was available from the Glasgow study to show how representative their samples were of the various workplaces involved in their study. Participation in this study was voluntary and it is possible that the samples were biased towards those interested in health. This may be a cause of the differences between the two populations. It is hoped that

Greater Glasgow Health Board will publish their findings from the Good Hearted Glasgow programme .

Variable Chol.	Age Group (years)	Study Population		
		Scottish	GGHB	This study
		MEN		
	<20	NA	3.90	4.07
	20-29	NA	4.47	4.89
	30-39	NA	5.15	5.82
	40-49	6.35	5.60	6.05
	>50	6.40	5.73	6.19
		WOMEN		
	<20	NA	4.19	4.97
	20-29	NA	4.62	5.18
	30-39	NA	4.82	5.28
	40-49	6.09	5.21	5.97
	>50	7.05	5.86	6.47

Table 6.6a : Comparison of the mean values of cholesterol between the Scottish Heart Health Study, Good Hearted Glasgow Study and this study by age group and by sex. (NA = Not applicable)

***(age group=35-39 years)**

AGE GROUP (years)	95% CONFIDENCE INTERVAL	
	men	women
40-49	-0.47 to -0.13	-0.27 to 0.03
>50	-0.40 to 0.02	-0.58 to -0.30

Table 6.6b : 95% confidence intervals for the difference in the mean cholesterol levels of this study and the Scottish population by age group.

AGE GROUP (years)	95% CONFIDENCE INTERVAL	
	men	women
<20	-0.21 to 0.19	0.37 to 1.19
20-29	0.13 to 0.61	0.41 to 0.71
30-39	0.44 to 0.90	0.34 to 0.58
40-49	0.27 to 0.63	0.61 to 0.91
>50	0.27 to 0.63	0.31 to 0.91

Table 6.6c : 95% confidence intervals for the difference in the mean cholesterol levels of this study and the Good Hearted Glasgow studies by age group. (NA = Not applicable) *(age group=35-39 years)

Tables 6.7 and 6.8 show the mean values of systolic and diastolic blood pressure respectively by age group and by sex for the Scottish Heart Health, the Good Hearted Glasgow, the Cadbury-Schweppes and for the factory studies. On examining the tables it can be seen that the mean values of both systolic and diastolic pressure for all age groups for both the Good Hearted Glasgow and this factory study are similiar. The systolic blood pressure values for both the Scottish and Cadbury-Schweppes study are higher than for this factory study. It was decided not to further investigate this finding as the difference in blood pressures is relatively small and unlikely to affect health.

Variable	Age Group	Study Population			
SBP	(years)	Scottish	GGHB	Cad	This study
		MEN			
	<20	NA	119.5	NA	116.2
	20-29	NA	122.6	NA	118.9
	30-39	NA	124.2	*130.0	122.6
	40-49	130.6	127.0	130.0	124.3
	>50	137.4	132.6	136.6	131.0
		WOMEN			
	<20	NA	113.1	NA	114.9
	20-29	NA	115.0	NA	112.3
	30-39	NA	116.4	NA	113.8
	40-49	125.4	122.0	NA	122.0
	>50	136.4	130.3	NA	125.5

Table 6.7 : Comparison of the mean values of systolic blood pressure (mmHg) between the Scottish Heart Health Study,Good Hearted Glasgow Study,Cadbury Schweppes Study (Cad.) and this study by age group and by sex. (NA = Not applicable) *(age group=35-39 years)

Variable	Age Group (years)	Study Population			
		Scottish	GGHB	Cad	This study
		MEN			
DBP	<20	NA	70.9	NA	69.6
	20-29	NA	74.5	NA	71.9
	30-39	NA	77.8	*80.0	78.1
	40-49	83.5	81.3	81.0	80.0
	>50	85.0	83.4	82.5	81.0
		WOMEN			
	<20	NA	69.4	NA	68.4
	20-29	NA	70.9	NA	69.5
	30-39	NA	73.4	NA	73.1
	40-49	79.4	76.3	NA	78.7
	>50	83.0	80.7	NA	77.9

Table 6.8 : Comparison of the mean values of diastolic blood pressure (mmHg) between the Scottish Heart Health Study,Good Hearted Glasgow Study,Cadbury Schweppes Study (Cad.) and this study by age group and by sex. (NA = Not applicable) *(age group=35-39 years)

6.3 Participation in Vigorous Physical Activity

Only data on leisure time physical activity was collected. Although physical activity at work has been shown to be a determinant in the prevention of coronary artery disease (Paffenbarger, 1975; Morris,1953;1958,1966; Kanel,1986) data on activity at work was not included in the analysis as it was felt that the work within the factory did not require physical exertion. It would seem reasonable to state work activity would have had limited effect on cardiorespiratory fitness.

Efforts were made by the tester to ensure that the information given by the individual was as accurate as possible. Time was spent to ensure that the subject fully understood the questions asked about physical activity and the tester emphasised the importance of only listing those activities which met with the criteria previously discussed.

Figures 5.2a and 5.2b show the percentage of the workforce, by age group and by sex, who regularly participated in two or more sessions of vigorous physical activity per week. These results show that the majority of the workforce did not regularly participate in an adequate level of vigorous physical activity in order to maintain protection from coronary artery disease (American College of Sports Medicine, 1978). These findings concur with those from the Cadbury- Schweppes study (Tuxworth et al,1986) although it must be highlighted that different criteria were used.

Although the percentage of the workforce who participated in an adequate level of vigorous physical activity was disappointing, the results compared favourably to the general population. The British Heart Foundation (Hardman) estimated that only between 15 and 20% of the population participated in regular vigorous physical activity. Similarly, the National Fitness Study found that less than 30% of men and less than 20% of women participated in physical activity to benefit health. These findings should be treated with caution as the National Fitness Study utilised different criteria for determining an adequate level of participation in physical activity.

6.4 Thresholds for Protection From Coronary Artery Disease

The relationship between physical fitness levels with mortality is somewhat controversial (Laporte,1985, Bouchard, in press). A study by Blair et al (1989) has has shown that those who have low levels of cardiovascular fitness had almost a four fold risk of all-cause mortality compared with those of a similiar age with a high level of cardiorespiratory fitness. The risk of mortality from coronary artery disease was even greater with almost an eight fold risk factor increase. These relationships were shown to be independent of other risk factors. It seems reasonable to state that cardiorespiratory fitness, as well as participation in regular physical activity, can play a major role in the prevention of coronary artery disease. Section 6.3 showed that the number of men who participated regularly in an adequate level of vigorous physical activity to maintain protection from coronary artery disease was somewhat low. This section of the discussion will investigate the proportion of male employees who possessed an adequate level of cardiorespiratory fitness to optimise protection from coronary artery disease.

Although links have been shown between cardiovascular fitness levels and the reduction of coronary artery disease, few studies have attempted to quantify the level of fitness required for such an effect. Norms exist on Scandanavian (Astrand,1968) and Canadian (Jette,1978) populations. Although these studies classified levels of fitness,they did not relate the levels to mortality nor morbidity. For example,the categories of 'average' and 'minimum' suggest levels which provide adequate protection from disease yet both these studies did not have any evidence to support these claims. Tuxworth et al (1986) deduced from Morris' data (1973) that a peak V02 level in men of 33ml/kg/min and above provided protection from coronary artery disease. Similiarly Blair et al (1989) calculated that a peak $\dot{V}02$ of at least 35 ml/kg/min provided protection from all-cause mortality (Data was not provided for a threshold level for protection from coronary artery disease). Both these authors recognised the limitations of their recommendations . Blair's study was carried out on a population consisting mainly of an upper socio-economic group of white people and excluding those with pre-existing disease. Tuxworth acknowledged that there were approximations in his deduction of optimal levels. Further research is needed in this area. However, with the limitations of both studies acknowledged, it was decided to use the threshold level identified by Tuxworth et al for men so as to enable further analysis of this data. This was chosen because the research used was carried out on British men.

Figures 5.3 show the percentage of men , grouped in 10 year age intervals, who had a peak $\dot{V}02$ of equal to or above 33 ml/kg/min.

On examining Fig 5.3a it can be seen that between 80 and 98% of men aged less than 30 years had a level of cardiorespiratory fitness to optimise protection from coronary artery disease. After this age, the percentage of men who have a level of cardiorespiratory fitness above the threshold level necessary to provide protection from the disease decreased substantially.

Only 48% of men in the 30 to 39 age group and 44% of men in the 40-49 age group possessed a level of cardiorespiratory fitness to optimise protection from coronary artery disease. Similarly only 16% of men aged greater than 50 years had an adequate level.

Women were not included in this part of the investigation due to the lack of information on an appropriate threshold for protection from coronary artery disease. Only Blair et al (!989) have attempted to identify a threshold level. In this study the authors identified a peak $\dot{V}O2$ level of 32.5 ml/kg/min as the threshold for protection from all-cause mortality. (They did not produce a figure for protection from coronary artery disease). It is difficult to reconcile this finding with other information presented in the same paper. The authors found that women who were in the upper three quintiles of cardiorespiratory fitness had lower relative risk of all-cause mortality compared with those in the lower two quintiles. Yet, the mean values of cardiorespiratory fitness in older women in the upper three quintiles were lower than 32.5 ml/kg/min. These findings were in contradiction to one another and therefore it was decided not to include women in this part of the analysis.

6.5 Relationships Between Variables Controlling for the Effects of Age

One of the objectives of this study was to investigate relationships between variables and to compare the findings to those of other studies. The variables which have been examined in this study may be subject to the influence of more than one other variable. For example, blood pressure can be affected by weight,diet,exercise,age and medication (Kannel & Gordon, 1980). Controlling for the effects of all modifying variables would produce relatively meaningless results. However, only by controlling for the major effect of age can the influence of other variables be identified.

It was decided to restrict the discussion to only those relationships which may be of practical interest and which have been studied elsewhere. The relationship between cholesterol and blood pressure will not be discussed as no evidence exists to suggest that either has an effect on the other. Neither will the relationship between systolic and diastolic blood pressure be discussed as these variables are undoubtedly related. Similarly the relationship between percentage bodyfat and weight will not be discussed as this relationship has been shown elsewhere (Kanel & Gordon, 1980; Keys et al, 1953).

Many of the investigations into coronary artery disease risk factors have concentrated on their relationship with participation in exercise. Only a relatively small amount of studies have examined the relationship of cardiorespiratory fitness to the disease and its risk factors. In this study the discussion will concentrate on the latter relationships.

Examination of Tables 5.5a and 5.5b show that just over 10% in men and12% in women of the variance in percentage bodyfat can be explained by its dependence on peak VO2 and vice versa. This finding is worthy of further discussion. Most of the studies in this area have concentrated on the relationship between participation in vigorous physical activity and percentage bodyfat (Hagan,1988). Wood et al (1983), in a case controlled randomised study, found that percentage bodyfat decreased as cardiorespiratory fitness increased. Cooper et al (1976) demonstrated that bodyfat was strongly inversely related to peak VO2 levels. Both these studies assessed bodyfat using data obtained by underwater weighing. Wood et al assessed peak VO2 in terms of weight whereas Cooper et al did not. Poole (1984) also found that bodyfat was significantly inversely related to cardiorespiratory fitness, when the effects of age were controlled.

The finding from this factory study did not concur with the previously mentioned studies. It may have been that the sample in this factory study was more like the general population than the other studies whose samples were drawn from fitness orientated populations. For example, the sample used by Poole was self-selected and each subject had to pay to participate in the study. It is possible that these people had a lifestyle which was significantly different from the factory sample. It may have been that relationship between percentage bodyfat and peak VO2 varied within sub-groups of the factory population. For example, a stronger relationship may have existed within groups who were more like the samples in the other studies. Unfortunately, time was not available to investigate this further. It would seem reasonable to conclude that further, more detailed investigation into the relationship between cardiorespiratory fitness and body composition is required.

A low partial correlation coefficient of determination (less than 5%) was found to exist between percentage bodyfat and both systolic and diastolic blood pressure when age were controlled. This statement is applicable to both men and women. Tuxworth et al (1986) investigated the relationship between percentage bodyfat and both systolic and diastolic blood pressure and found there to be little correlation between the variables. Links between obesity and hypertension and ultimately, coronary artery disease, have been well documented (Kannel & Gordon, 1980,Shaper et al,1985). Obesity in such studies was determined by either weight or body mass index. %Bodyfat was not used as an indicator of obesity. The result in this study and that by Tuxworth et al is quite surprising. It seems reasonable to state that because of the evidence linking obesity to hypertension, one would have expected a stronger relationship to be shown between percentage bodyfat and blood pressure when the effect of age was controlled. It may be that other variables such as diet, sodium intake, exercise and stress play a more significant role in determining blood pressure than body composition or it may be that the method used to estimate body composition is inaccurate and does not give a true representation of bodyfat content (the deficiences of the technique used have been discussed in Chapter 4). It seems reasonable to state that a more detailed investigation into the relationship between these two variables is required.Ideally the effects of diet, sodium intake and exercise should be controlled as well as those of age.

The partial correlation coefficient of determination of the relationship between percentage bodyfat and cholesterol controlling for the effects of age,was less than 5% for both men and women.

Superko (1988) in a review paper discusses the association between bodyfat and blood lipids.This author acknowledges that bodyfat may be linked to lipoprotein production but does not discuss its relationship with cholesterol.Superko acknowledges that further investigation is required in this area. On the basis of the evidence presented in the factory study it seems reasonable to state there seems to be little association between percentage bodyfat and cholesterol levels when the effects of age are controlled.

Less than 2% of the variation in cholesterol, for both men and women can be explained by its dependence on cardiorespiratory fitness levels, when the effects of age are controlled. The association between cholesterol production and levels of cardiorespiratory fitness is not clear. Cooper (1976) found cholesterol levels to be significantly reduced amongst those with excellent levels of cardiorespiratory fitness when compared to those with low levels of fitness. Other studies have failed to show a consistent correlation between peak VO2 and cholesterol when the effects of age were controlled (McDonough et al,1970;Montoye et al 1978). These latter findings concur with those of the factory study.

It must be highlighted that the study could have been enhanced if the analysis of lipoproteins had been included. High density lipoprotein (HDL) is thought to be a risk factor in coronary artery disease. However its relationship to cardiorespiratory fitness is not clear. Schnabel and Kinderman (1982) found a correlation between HDL concentration and cardiorespiratory fitness although other studies have found no such relationship (Haskell et al,1988;Montoye,1978). This study could have contributed to the level of knowledge in this area if lipoprotein levels had been examined.

Only 8% of the variation in diastolic blood pressure,in both men and women,can be explained by its dependence on cardiorespiratory fitness. Similarly less than 3% of the variation in systolic blood pressure can be explained by dependence on peak VO2. These results concur with other studies which found no relationship (Tuxworth et al,1986;Gilders et al,1989). Other studies have found that cardiorespiratory fitness can affect blood pressure. For example Blair et al (1984) found that the relative risk of hypertension developing in those with low fitness over a four year period was 1.52 times of those with high fitness. Hagberg

(1990) in a meta-analysis of longitudinal studies found that participation in exercise resulted in a decrease in blood pressure. Massie (1992) in a review of the relationship of exercise and fitness to blood pressure found that blood pressure reduction was more likely when the subject had high blood pressure, low fitness and low levels of exercise. The results from the factory study are not surprising since blood pressure was normally distributed and the sample did not consist solely of people who had high levels of blood pressure or had low levels of fitness.

On reviewing this section, it seems apparent that because the sample in this study is more like the general population than the samples in other studies, the investigation into the relationships between variables has become 'clouded'. It may be that there were significant relationships between variables within sub-groups of this sample but the relationship has been diluted due to the effects of other subgroups. For example there may have been a significant relationship between peak VO2 and %Bodyfat within groups of people who had a high level of cardiorespiratory fitness yet this relationship may not have become evident due to the number of people with low levels of cardiorespiratory fitness. It seems reasonable to conclude that future studies into the relationship between variables within workplace populations should, providing resources are available, involve investigation of sub-groups within the factory.

CHAPTER SEVEN : CONCLUSIONS & RECOMMENDATIONS

This study has provided information which should be of value to those working in the field of health and fitness in the workplace environment. The level of participation in the coronary artery disease risk factor programme was high when compared to other similiar studies. Within the programme the compliance to each assessment, with the exception of cardiorespiratory fitness in older women, was also high. It seems reasonable to state that because of the high level of participation and of compliance, the sample in this study is one of the most representative samples utilised in any workplace health and fitness investigation.

Care was taken in the selection of assessment procedures, which were appropriate to the field situation, in order to enhance the validity of measures. Experiences learnt from the pilot study, the training of personnel and the quality control measures enhanced the accuracy of the collection of data.

In Chapter one, a null hypothesis was offered which stated that there were no differences between selected health and fitness characteristics of the Vale of Leven factory population and those of other populations. Having established that the sample was representative of the factory population, the results from this study have shown that selected health and fitness characteristics of the factory population were different and it is therefore necessary to reject the null hypothesis.

The mean values of percentage bodyfat were lower in this study when compared to other similar factory populations. Similarly, mean values of peak VO2 were higher. It is not possible to conclude why these differences existed. It may have been that the factory in this study operated a stringent recruitment policy which favoured healthier people and/or it may have been that the overall health promotion programme within the factory was responsible for some of these differences. The study could have been enhanced if it had attempted to monitor what intervention each subject had been exposed to and how long the person had been exposed.

The results showed that 33% of men and 31% of women aged greater than 40 years possessed a level of cholesterol greater than 6.5mmol/l. These findings compared favourably with those of the Scottish Heart Health study (Smith et al, 1989). At present, it is advocated that individuals with cholesterol levels above 6.5mmol/l be treated by their general practitioner. If the activities of the Vale Project were responsible, or partly responsible, for the lower cholesterol levels then it seems reasonable to state that the initiative may be a more cost effective method of controlling cholesterol than the traditional methods used by general practitioners. This is an interesting finding which needs to be researched further.

The findings from this study when compared to those of the Cadbury-Schweppes (Tuxworth et al,1986) study are worthy of further comment. Although the results could not be statistically compared the results in terms of %Bodyfat and cardiorespiratory fitness favoured the workforce in this study. Again, it seems reasonable to suggest that the Vale Project may have had a beneficial effect on the health of the workforce of the Vale of Leven factory.

In Chapter One a null hypothesis was offered which stated that employees of the factory did not participate in adequate vigorous physical activity to optimise protection from coronary artery disease. The results found that over 35% of men and over 16% of women participated in adequate vigorous physical activity to optimise protection from the disease. On the basis of these findings it is therefore possible to only reject the null hypothesis for these cases.

Although the percentage of the workforce who participated in adequate vigorous physical activity to benefit health was disappointing, the results compared well with the general population. It would seem that the workplace can be utilised to promote participation in vigorous physical activity. Although it was not possible to assess the effect of the activities of the Vale Project on participation in exercise, it seems reasonable to state that the provision of exercise opportunities may enhance participation. At the Vale of Leven factory there were recreational facilities which were utilised by the Vale Project. Classes, led by suitably qualified individuals, were offered and events such as fun runs and 'walkabouts' were actively promoted by the Project. These were intense efforts but it would seem that they may have been successful in encouraging the uptake of physical activity. It seems reasonable to conclude that future studies of this nature should try to assess the effect of their activities.

In Chapter one a null hypothesis was offered which stated that male employees of the factory did not possess adequate cardiorespiratory fitness to optimise protection from coronary artery disease. In relation to the threshold identified by Tuxworth et al (1985) it was found that 48% of men possessed possessed adequate cardiorespiratory fitness to optimise protection from the disease. It is therefore possible to reject the null hypothesis for these subjects.

In Chapter One a null hypothesis was offered which stated that the relationship between selected health and fitness characteristics of this population were no different to those of other populations. Several relationships were investigated however the null hypothesis could only be rejected for the relationship between percentage bodyfat and peak VO2. Only 10% in men and 12% in women of the variance in percentage bodyfat could be explained by its dependence on peak VO2, indicating that there was little relationship between the variables. This finding was in contrast to those of other investigations into this relationship. The difference may be explained by the fact that some of the other studies were carried out on fitness orientated populations whereas the population of the factory was more like a cross-section of the general population. Whereas in a fitness orientated population high percentage bodyfat may be seen as a handicap, in the general population there are obese individuals with good cardiorespiratory fitness and non-obese individuals with poor cardiorespiratory fitness. Further investigation into this area is of worth.

This study has shown that the workplace can be utilised to promote health. Employees were willing to participate in the coronary artery disease risk factor identification programme. The asessment selection and methodologies utilised by the Vale Project resulted in a high level of compliance and it seems reasonable to advocate this methodology for future studies in this area. Only the compliance of women to the assessment of peak VO2 was disappointing. In future, women should be targetted more intensively in order to enhance this level of compliance.

It was not possible to evaluate the effect of the activities of the Vale Project on the health and fitness characteristics of the factory population. The coronary artery disease programme was not a baseline study as many health promotion activities were run either in conjunction with or previous to the initiative. Subjects were not exposed to a similar amount of intervention as those who were assessed towards the end of the coronary artery disease risk factor identification programme were exposed to more intervention than those who were assessed at the beginning of the initiative. There was also no control population which could be utilised for comparative purposes. It seems reasonable to state that future workplace health promotion initiatives should be fully evaluated. Utilising the procedures described in this study, both baseline and summative measures should be obtained and these measures should be repeated in a control workplace and the findings compared.

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Manufacturing Factory

The manufacturing factory at the Vale of Leven is a subsidiary of an American Corporation. It is a major centre for the production of cameras and film and is also the Corporation's world centre for the production of sunglass lens. The company is committed to caring for its workforce and for the local community in which it is based. At the Vale of Leven the company assists local sports clubs, schools and small businesses. It sponsors many sporting events and clubs such as the Peoples 10K Road Race, Loch Lomond Rowing Club and Dumbarton F.C.. It organises several school events and hosts the Schools Business Enterprise initiative. The company's commitment to health and sport has increased as a result of the Vale Project's work.

The company pays wages and salaries which are well above the local average for similar types of work. It provides its employees with a fully equipped occupational health department,subsidised canteen,sports and social facilities and operates a profit sharing scheme.It is a sought after employer in the area.

APPENDIX : TWO

Vale of Leven Health Promotion Project

The Vale of Leven Health Promotion Project (Vale Project) was established in 1986 as a charitable trust.It was a multi-disciplinary, longitudinal initiative towards promoting health, especially the reduction of coronary artery disease risk factors amongst the population of the Vale of Leven.It aimed to achieve this by targetting lifestyle change within the whole community and by identifying individuals at high risk to the disease and encouraging these people to alter their lifestyle.

The initiative to establish the Project arose from the efforts of the factory medical officer and three other professionals in the health and fitness fields.The medical officer was concerned with the prevention of disease amongst the employees of the factory. Contact was made with the three other health professionals and as a result a health week was held in the factory in 1983. Activities included fitness testing, exercise groups, diet education and smoking cessation groups. In addition the canteen focussed on food dishes which were regarded as being beneficial to health.The event was considered, by both employees and management, to be a major success in raising the profile of health in the factory.

Due to the success of the event the four health and fitness professionals developed a proposal for a health initiative which would attempt to promote health within the factory and within the community at large.Applications were made for funding and the Vale Project was formally established in 1986. Funding was obtained from Strathclyde Regional Council,through Urban Aid, the Scottish Health Education Group and private industry. The Project was financed for a total of seven years.

It was a two phase project with the initial two year phase centring on the health needs of the employees. Intervention was initiated in March,1986 and was completed in 1988. The second phase was aimed at the health needs of the local community, especially those living in areas of priority treatment.

The Vale Project had a management committee of four who had backgrounds respectively in physical education, epidemiology, health education and medicine. They provided their services to the Vale Project without receiving any renumeration. Only the Medical Officer was based at the Vale Project and as a result most of the day to day management of specific initiatives was allocated to one of the staff members.

Four staff were employed by the Vale Project :- an evaluation officer, a health promotion officer,a secretary and a physical educationalist. The author was employed in the latter position in November,1985. He was the first member of staff to be employed and his duties included the planning and co-ordination of exercise initiatives, quality control within the coronary artery disease risk factor identification programme and the supervision of the training of personnel involved in the afore-mentioned initiative.

The Vale Project's policy of intervention was decided upon by the management and staff,with the former group having overall responsibility.The experiences of other projects and the recommendations of national bodies and expert groups were utilised in planning.In addition, two of the managers were awarded fellowships to visit similiar programmes in the U.S.A. and the information which they obtained was also used.

APPENDIX : 3

Pilot Project Results

Age Group	PEAK VO2 (ml/kg/min)			
	Men		Women	
	n	$\bar{x} \pm$ S.D.	n	$\bar{x} \pm$ S.D.
<30	7	45.9 ± 6.7	8	40.4 ± 10.7
30-39	10	43.2 ± 6.0	9	33.0 ± 6.5
40-49	15	40.8 ± 6.8	16	27.0 ± 4.6
>50	4	35.5 ± 4.7	5	27.1 ± 2.6

Peak Vo2 : Mean ($\bar{x}$) and standard deviation (S.D.) for men and women by age group (ml/kg/min).

Age Group	%BODYFAT (%)			
	Men		Women	
	n	$\bar{x} \pm$ S.D.	n	$\bar{x} \pm$ S.D.
<30	9	16.8 ± 4.7	8	26.7 ± 4.9
30-39	10	22.0 ± 4.3	11	30.3 ± 4.6
40-59	15	24.6 ± 5.3	20	33.7 ± 4.7
>50	4	26.3 ± 5.5	6	36.2 ± 5.5

%Bodyfat: Mean($\bar{x}$) and Standard Deviation (S.D.) for Men and Women by Age Group.

Age Group	WEIGHT (Kg)			
	Men		Women	
	n	$\bar{x} \pm$ S.D.	n	$\bar{X} \pm$ S.D.
<30	9	71.7 ± 10.1	8	57.2 ± 8.7
30-39	12	78.5 ± 12.5	14	61.3 ± 9.3
40-49	19	77.8 ± 11.3	24	63.3 ± 10.9
>50	4	75.6 ± 9.9	10	63.6 ± 10.2

Weight : Mean ($\bar{X}$) and Standard Deviation (S.D.) for Men and Women by Age Group. (Kg).

Age Group	HEIGHT (cm)			
	Men		Women	
	n	$\bar{X} \pm$ S.D.	n	$\bar{X} \pm$ S.D.
<30	9	177.3 ± 6.2	8	163.0 ± 5.9
30-39	12	176.4 ± 6.3	14	162.2 ± 5.7
40-49	19	175.7 ± 6.5	4	160.9 ± 6.4
>50	4	173.3 ± 6.1	10	161.9 ± 6.1

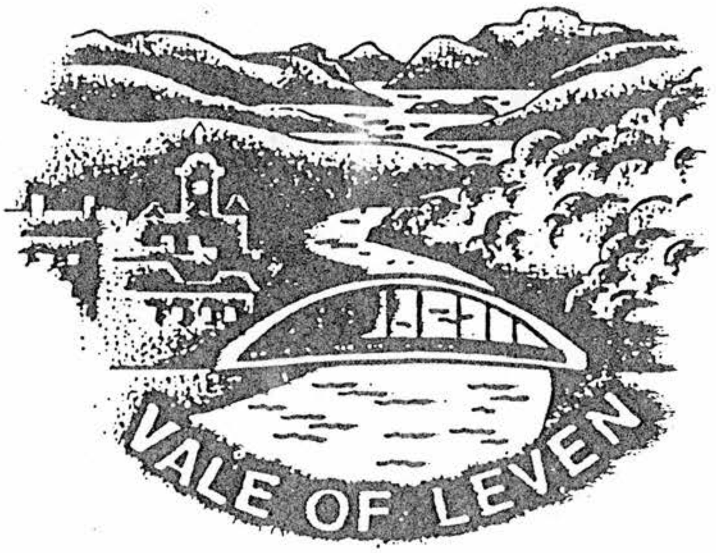
Height : Mean ($\bar{X}$) and Standard Deviation (S.D.) for Men and Women by Age Group.(cm)

APPENDIX : FOUR

Recording booklet / Questionnaire

Heart Health

Screening Record



HEALTH PROMOTION PROJECT

Date: ______

Screener: ______

Ext. No: ______

B I O G R A P H Y

I'd like to start off by asking you a few questions about yourself, firstly..

1. What is your.

Surname: ______
First Name: ______

2. What is your Home Address?

Street ______
Town ______
Postcode ______

(collect district e.g. Bonhill if given)

3. Sex: tick one box

Male ☐

Female ☐

4. When were you born?

______ Day ______ Month ______ Year

5. What Division Do you Work In?

_______________________________ [Write in names of division i.e. Film, Camera, G & A, or IBM]

6. What is your Employee No?

_______________________________ [Write in Employee number]

7. Do you work shifts?

YES ☐

NO ☐

[Tick one box only]

8. Which of the statements on the card best describe your own current marital status? (HAND OVER CARD 1)

SINGLE	
MARRIED	
SEPARATED	
DIVORCED	
WIDOWED	

[Tick one Box only)

(TAKE BACK CARD 1)

9. And can you tell me who your G.P. is?

Dr. _______________________

Now just a few questions about your medical history.

10. Do you have any history of.....

HIGH BLOOD PRESSURE	
ANGINA	
PREVIOUS HEART ATTACK	
HIGH CHOLESTEROL	
DIABETES	
STROKE	

[Enter for each symptom]

0 if None

1 if diagnosis before assessment

2 if diagnosis after assessment

3 uncertainty

11. Is there any history of Coronary Heart Disease in your immediate family? By that I mean either your mother or father or any brothers or sisters had any heart trouble before 55 years of age?

____

[Count up and write in the numbers of close relatives who have had heart trouble before the age of 55. Write in 9 for don't know]

12. And what about diabetes? Is there any history of diabetes in your immediate family? By that I mean have your mother or father or brothers or sisters had any diabetes?

____

[Count up and write in the numbers of close relatives with diabetes: Write in 9 for don't know].

13. TAKE BLOOD PRESSURE AND ENTER RESULT IN BOX

Blood Pressure	____ Systolic Diastolic	BP1 ____ BP2 ____ BP3 ____

14. TAKE HEIGHT AND WEIGHT AND ENTER RESULTS IN BOX IN CMS AND KGS.

Height ______________ cms

Weight ______________ kgs

15. Can you tell me, do you take any of the following drugs regularly?

	YES =1	NO =0
Lipid lowering agents		
Betablockers		
Hypoglycaemic agents		
Duiretics		
Thyroid Hormones		
Steroids		
Contraceptive Pill		

[For each drug enter 1 for yes 0 for no]

EXERCISE

NOW GO TO EXERCISE STATION - State: as I said at the beginning exercise protects against Heart Disease, so we need to know a bit more about the activities you are involved in. So first of all let me ask ....

16. Do you currently take part in any activity or exercise which leaves you short of breath and perspiring at the end of 20 minutes.

IF YES ASK: Which activities? (take first 3 only and wite in activity, then for each activity ask: how often, and how many minutes each time? How long have you been doing this?

IF NO ASK: Are you sure what about walking or at home

ACTIVITY	FREQUENCY How Often Per Week			DURATION How Many Minutes Per Session			Since When Have You Done This	
	3+	1-2	Less Than	Less Than 20	20 40	40+	Less Than 6 Months	More Than 6 Months
1.	3	2	1	A	B	C	X	Y
2.	3	2	1	A	B	C	X	Y
3.	3	2	1	A	B	C	X	Y

Count up the duration and frequency of exercise in the grid and put in ....

0 = 2-3 times a week

1 = Once a week

2 = Less than once a a week or more

17. Take skinfold measures and enter results.

i) Skinfolds - Biceps ____________

Triceps ____________

Subscapula ____________

Suprailliac ____________

Percentage Body Fat ______

ii) **DO BIKE TEST AND ENTER RESULTS**

Bicycle egometer __________ PWC2 85%

RUN BBC PROGRAMME

iii) MVO2 __________ MM/S/LITRE

Fitness Rating __________

GO TO SMOKING STATION

Do you know, smoking among other things, increases your chances of developing Heart Disease. So I would like to ask you a few questions about smoking. Can you tell me first of all .....

18. Do you smoke at all these days?

[RING ONE CHOICE AND FOLLOW INSTRUCTIONS]

YES - if yes go to question 19

NO - if no, go to question 26

19. How much do you smoke each day?

2 = Cigar; Pipe any amount
3 = 1-10 cigarettes
4 = 11-20 cigarettes
5 = 21-40 cigarettes
6 = 40+ cigarettes
9 = Not stated

[Ring one choice to enter in programme]

20. And how old were you when your started to smoke regularly?

______________Years

[Enter age in years for programme]

21. What brand do you usually smoke ?

__________________________ [write in brand name]

22. Have you ever tried to give up smoking altogether?

YES ☐

NO ☐

[TICK ONE BOX]

23. How many times have you given up smoking for more than three days? Is it ....

READ SLOWLY

ONCE ☐

TWICE ☐

THREE+ ☐

NEVER ☐

[TICK ONE BOX)

24. Why did you go back to smoking cigarettes?

PUT ON WEIGHT	[ ]	[Listen and tick as as many as appropriate]
AFFECTED RELATIONSHIPS	[ ]	
STRESS	[ ]	
SOME OTHER REASON	[ ]	Please specify ....

25. How important is it to you to stop smoking now?

PASS CARD 5

Would you say it was very important, important, not all that important or not important at all?

VERY IMPORTANT	[ ]	[Tick one box only and go to question number 30]
IMPORTANT	[ ]	
NOT ALL THAT IMPORTANT	[ ]	
NOT IMPORTANT AT ALL	[ ]	

TAKE BACK CARD 5

26. i) Have you ever smoked cigarettes regularly?

YES	[ ]	[IF YES ASK 26ii]
NO	[ ]	[ENTER 0 IN PROGRAMME GO TO QUESTION 30]

ii) How long ago did you quit?

Is it......

READ SLOWLY ......

TICK ONE BOX ONLY		
LESS THAN 6 MONTHS AGO		[Enter 2 in programme]
6 MONTHS - 1 YEAR AGO		
ONE - TWO YEARS AGO		[Enter 1 in programme]
TWO - FIVE YEARS AGO		
MORE THAN FIVE YEARS AGO		

27. How old were you when you started to smoke regularly?

_______ YRS [ENTER AGE IN YEARS]

28. How many did you smoke a day when you smoked regularly?

_______ [Write in number smoked per day]

29. What were your most important reasons for giving up?

[WRITE IN FIRST THREE]

1. ....
2. ....
3. ....

30. **DO ECOLYSER & ENTER RESULT**

_______ Coppm

TAKE BLOOD SAMPLE AND ENTER INTO REFLOTRON - NOW GO TO DIET STATION

D I E T

31. Everyone has their own tastes and preferences in food and we need to have some idea of what yours are, so that we have some idea of what might be affecting your Cholesterol level.

I am going to read out a list of foods and I want you to think about each one and tell me how often you eat it. (PASS OVER CARD 2). You can see from the card that the choices for each food are: Every day, at least 3 times a week, a few a month, less than once a month or never. The first food is.....

RING ONE CHOICE PER FOOD

	EVERY DAY	AT LEAST 3 TIMES A WEEK	ONCE OR TWICE A WEEK	A FEW TIMES A MONTH	LESS THAN ONCE A MONTH OR NEVER
WHITE BREAD	5	4	3	2	1
WHOLEMEAL BREAD	5	4	3	2	1
HIGH FIBRE CERIALS LIKE, BRAN, MUESLI, WEETABIX, SHREDDED WHEAT.	5	4	3	2	1
ORDINARY WHOLE MILK	5	4	3	2	1
SEMI-SKIMMED OR SKIMMED MILK	5	4	3	2	1
CHIPS	5	4	3	2	1
WHITE MEAT OR FISH	5	4	3	2	1
RED MEAT, INCL. MINCE, SAUSAGES, PIES ETC.	5	4	3	2	1
A VARIETY OF FRESH VEGETABLES	5	4	3	2	1
FRESH FRUIT	5	4	3	2	1
BUTTER	5	4	3	2	1
MARGARINE, LOW IN SATURATED FAT	5	4	3	2	1
FIZZY DRINKS	5	4	3	2	1
EGGS	5	4	3	2	1

TAKE BACK CARD

32. Here are some statements people might make about food.

Tell me how they apply to you, by answering yes or no to each food.

[TICK ONE CHOICE PER FOOD]

	YES	NO
I usually grill foods not fry	☐	☐
I usually read food labels	☐	☐
I have a sweet tooth	☐	☐
I usually add salt to my food at the table	☐	☐
I eat sugary snacks between meals	☐	☐

33. Are you worried at all about your present wieght?

YES TOO HIGH ☐ [TICK ONE BOX]

NO ☐

YES TOO LOW ☐

34. Have you made any change in your eating habits in the past year? - [TICK ONE BOX]

YES ☐ If yes go to question 35

NO ☐ If no go to question 36

35. If YES: Why have you changed

[Listen to answers and tick as many boxes as appropriate]

- To Lose Weight ☐
- To Gain Weight ☐
- Health ☐
- More Fibre ☐
- Less Fat ☐
- Other Reason ☐ Please specify ....

....

....

36. In a week, how many of the following do you drink?

Pints of Beer/Lager/Cider ____
Single Measures of Spirit ____
Glasses of Wine ____

[Enter numbers of each drink and convert to standard unit of alcohol]

______ Standard units of alcohol

[Write in number of standard units consummed]

37. Write in Cholesterol measure from reflotron

____

38. Finally, have you ever had pains in your chest?

[Listen and enter appropriate number]

No Chest Pain	(0)
When going uphill in a hurry	(1)
When going uphill in a hurry and on the level	(2)
Uphill in hurry on the level	
And sometimes when stationery	(3)
Don't know	(9)

NOW GO TO THE COMPUTER. GO BACK THROUGH HISTORY AND ENTER INFORMATION IN HEAVY OUTLINED BOXES INTO PROGRAMME.

USE RUNNING ORDER HELP SHEET AS A GUIDE

---***O***---

APPENDIX : FIVE

Distribution of each variable by gender

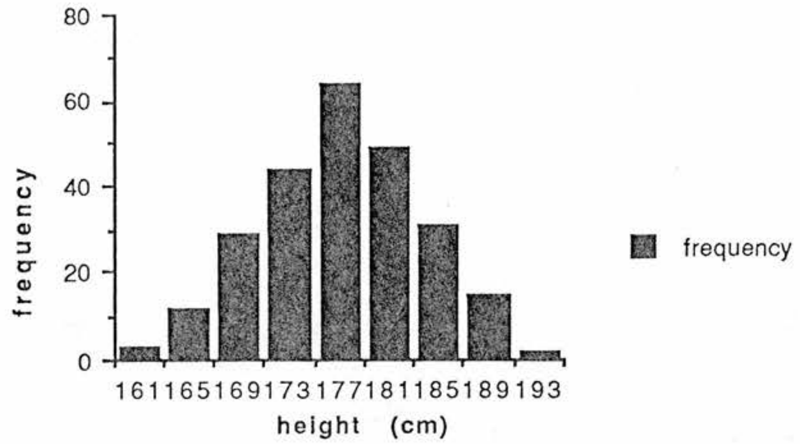


Fig 5.1a : Frequency distribution of height : men

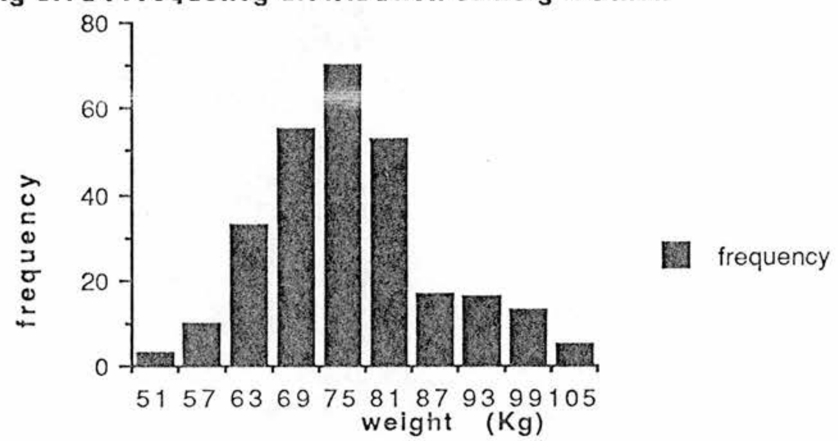


Fig 5.1b : Frequency distribution of weight : men

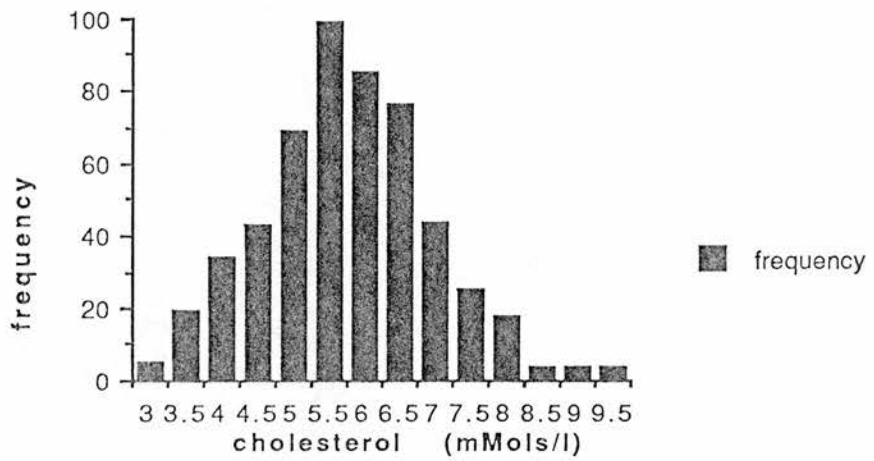


Fig 5.1c : Frequency distribution of cholesterol : men

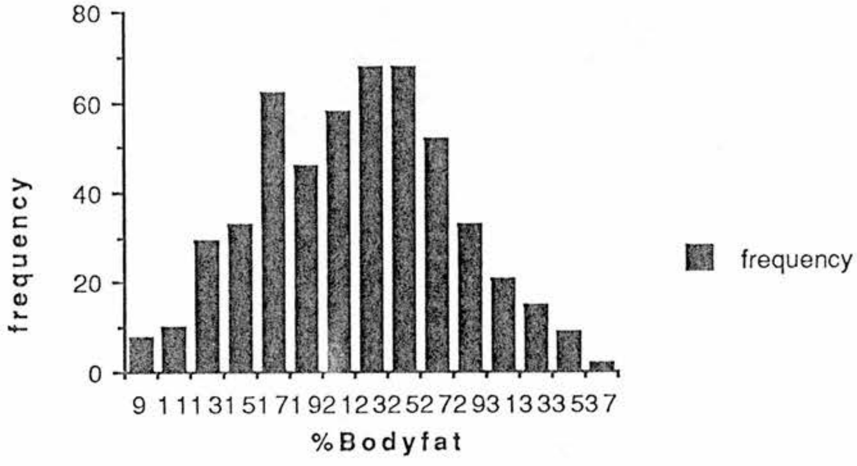


Fig 5.1d : Frequency distribution of %Bodyfat : men

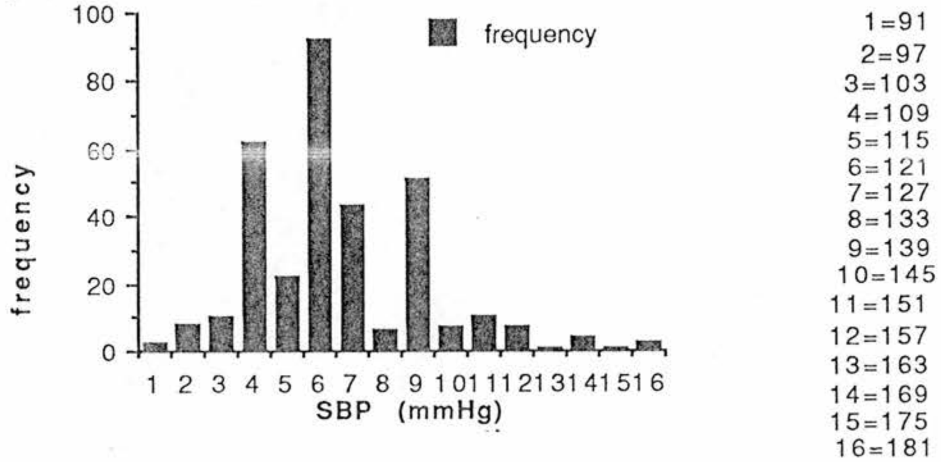


Figure 5.1e : Frequency distribution of SBP : Men

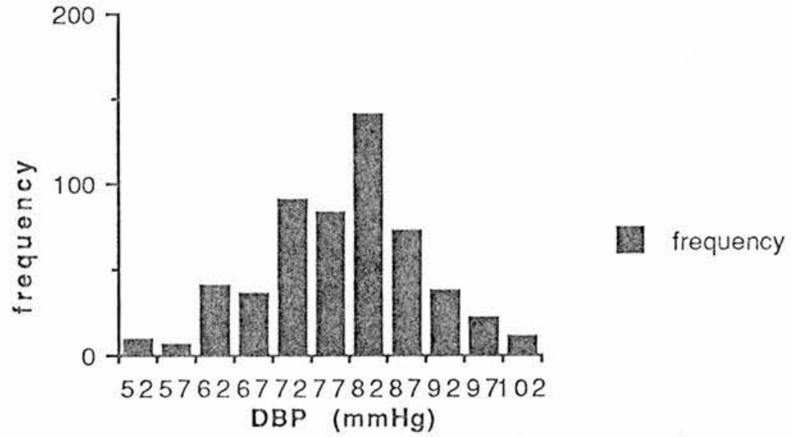


Fig 5.1f : Frequency distribution of DBP : men

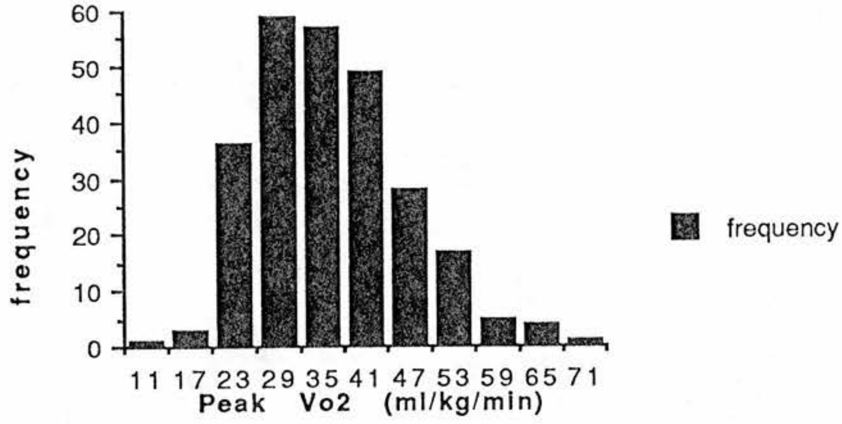


Fig 5.1g : Frequency distribution of peak $\dot{V}O2$: men

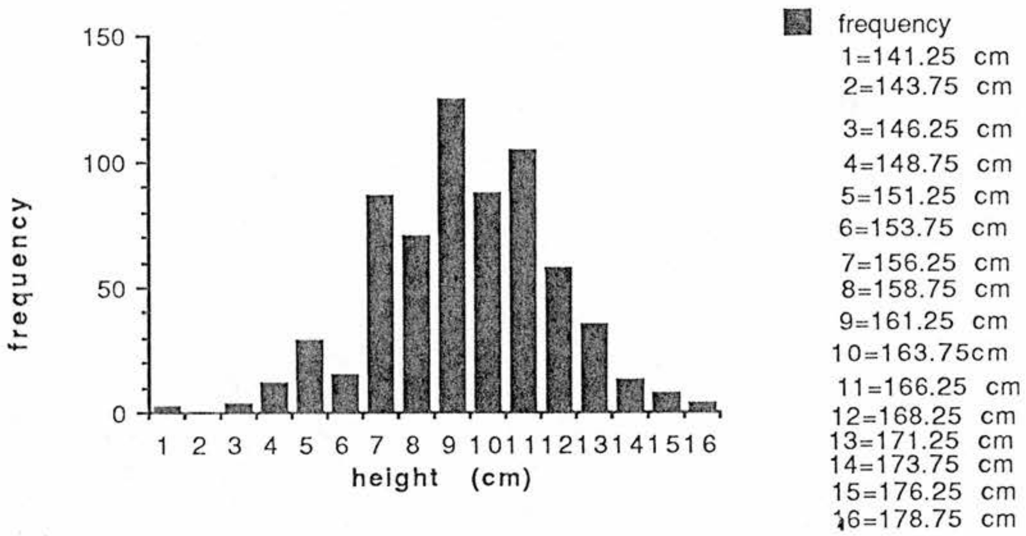


Fig 5.1h : Frequency distribution of height : women

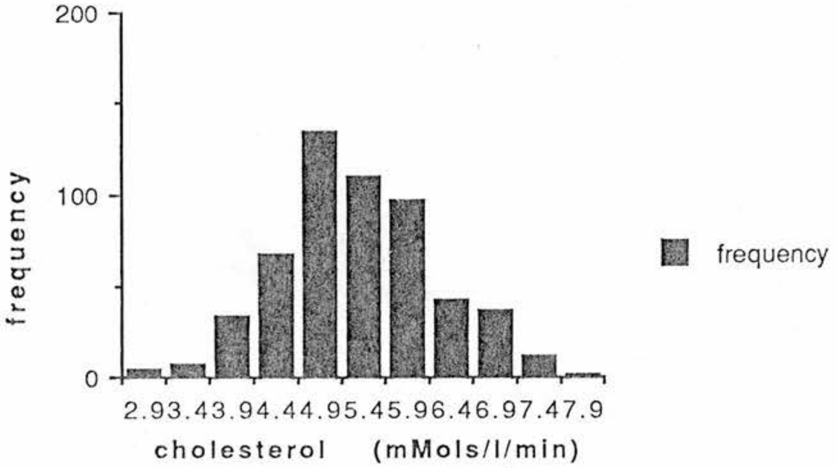


Fig 5.1i : Frequency distribution of cholesterol : women

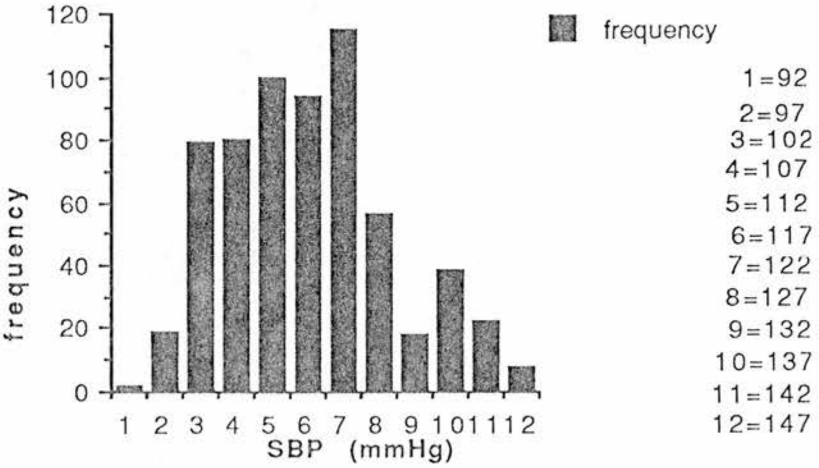


Fig 5.1j : Frequency distribution of SBP : women

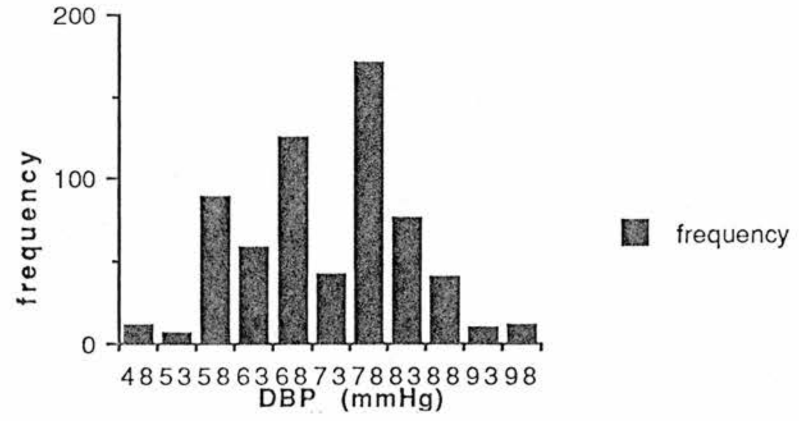


Fig 5.1k : Frequency distribution ofDBP : women

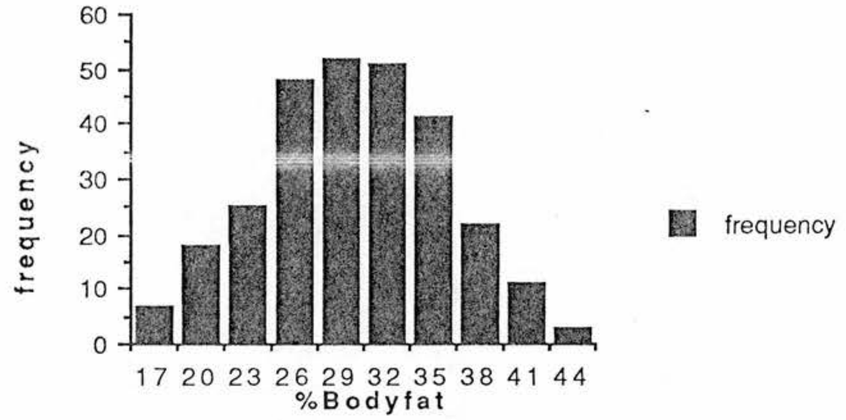


Fig 5.1l ~~m~~: Frequency distribution of %Bodyfat : women

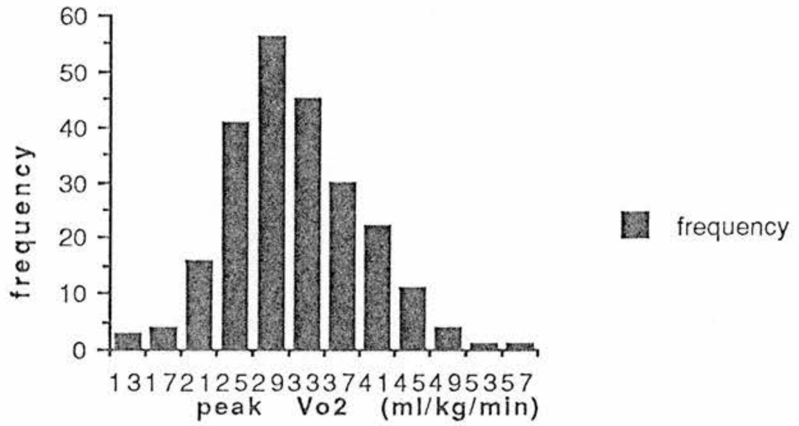


Fig 5.1m: Frequency distribution of peak $\dot{V}O2$: women

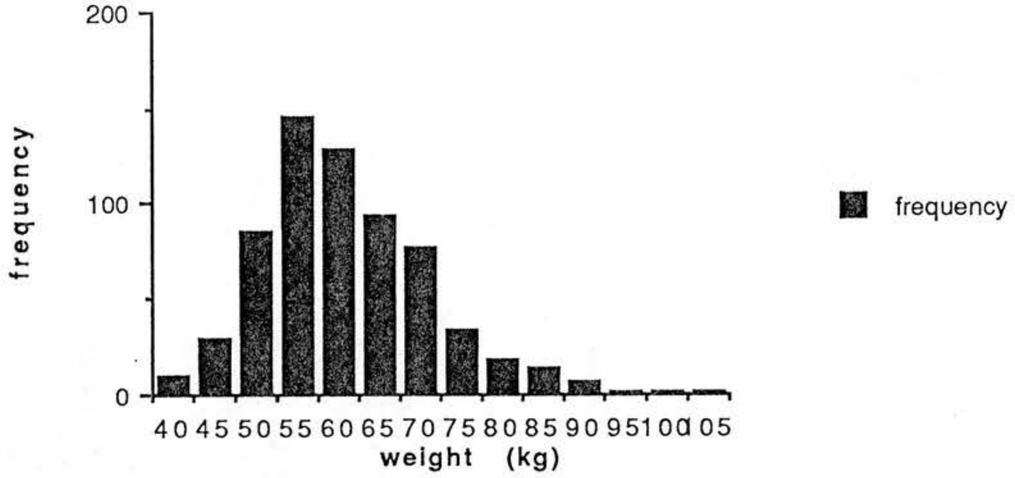
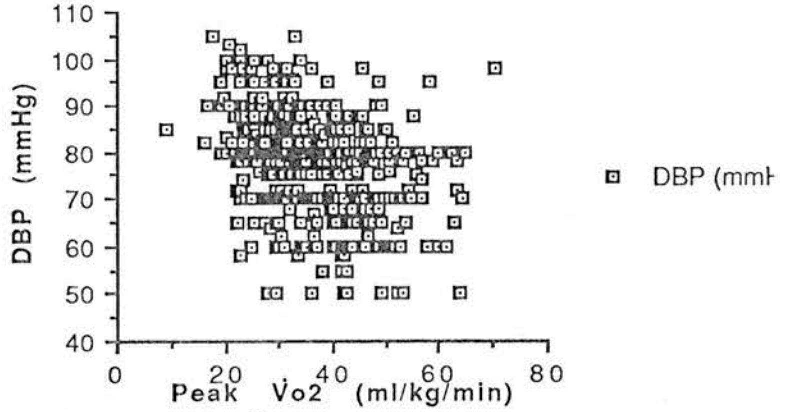
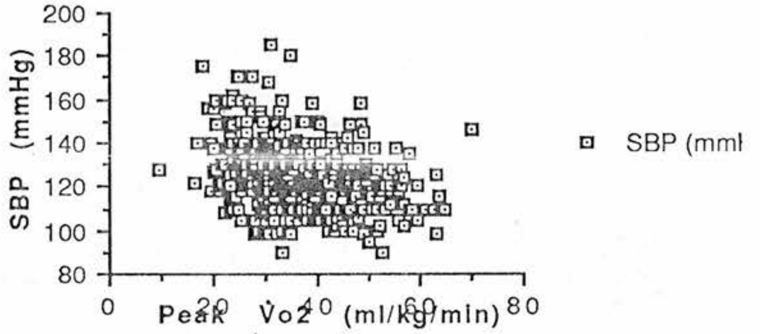


Fig 5.1n : Frequency distribution of weight : women

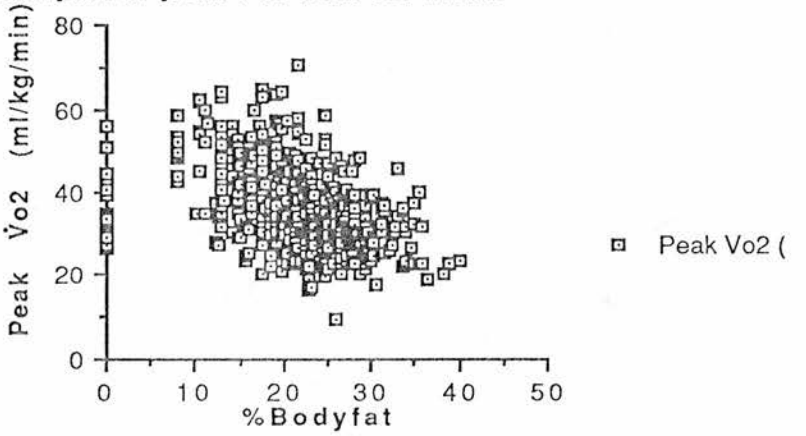
APPENDIX SIX : SCATTERPLOTS



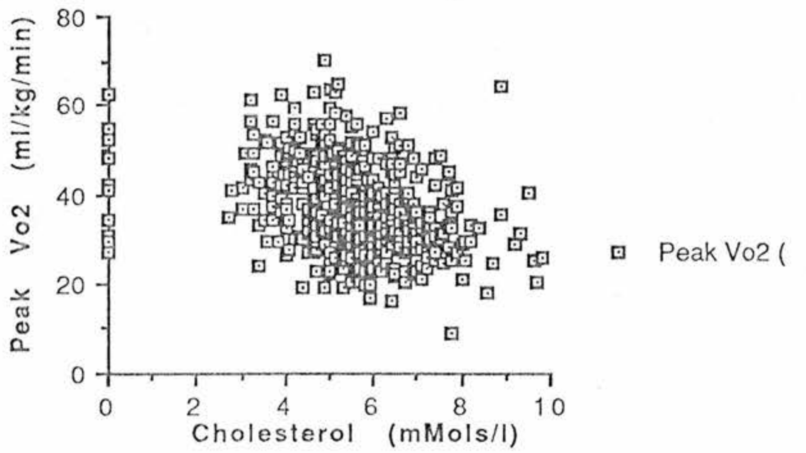
Scatterplot of peak V̇O2 with DBP : men



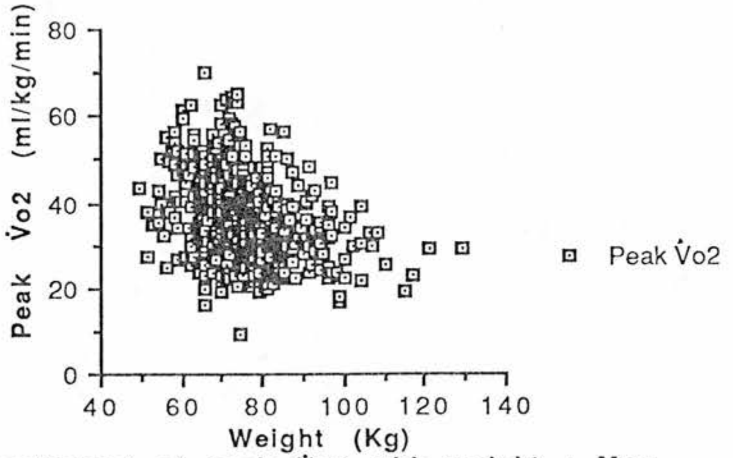
Scatterplot of peak V̇O2 with SBP : men



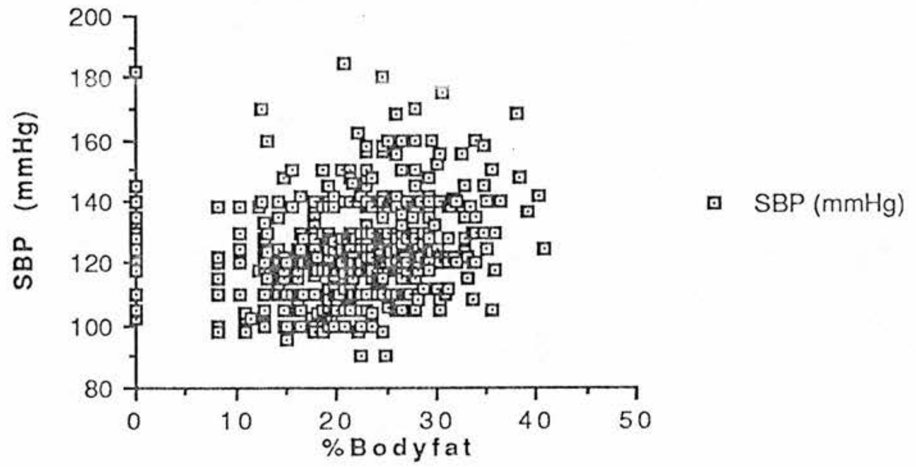
Scatterplot of peak V̇O2 with %Bodyfat : men



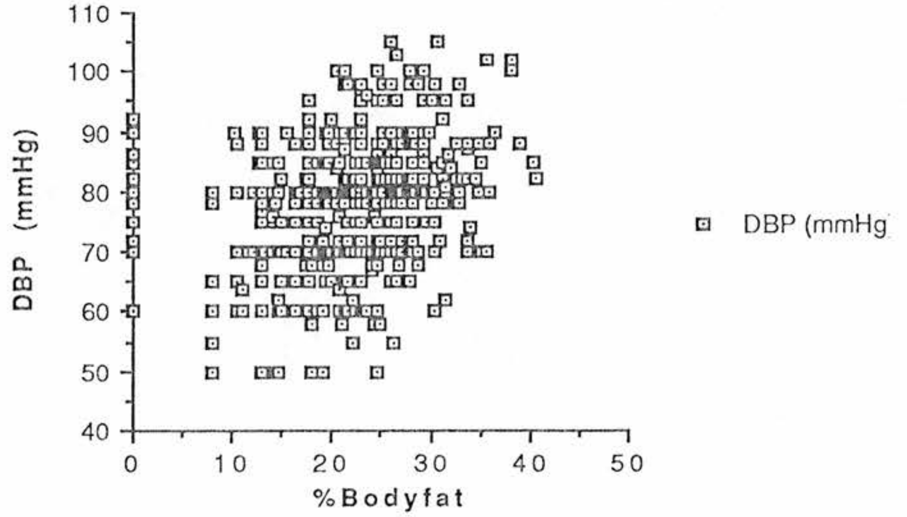
Scatterplot of peak V̇O2 with cholesterol : men



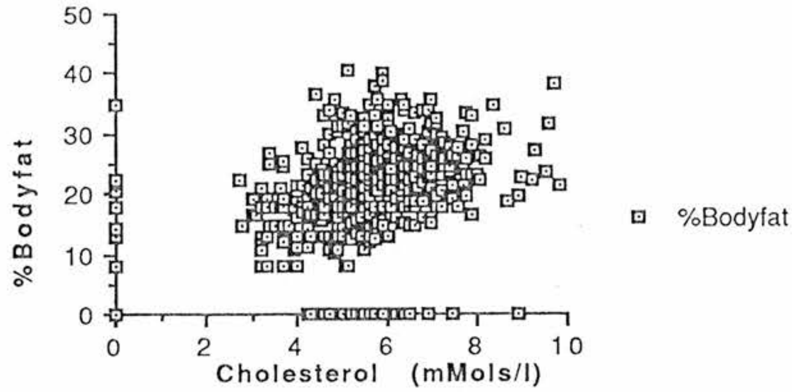
Scatterplot of peak V̇o2 with weight : Men



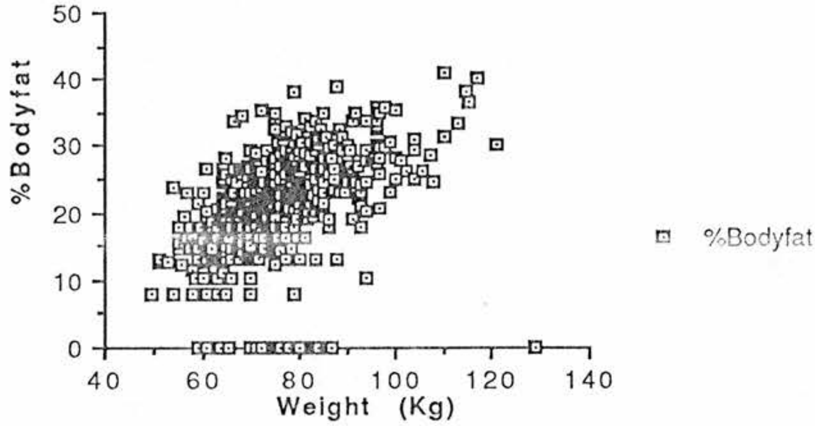
Scatterplot of %Bodyfat with SBP : Men



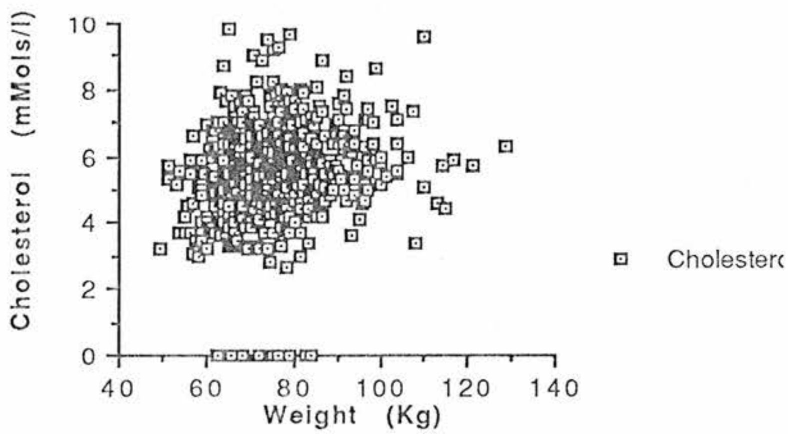
Scatterplot of %Bodyfat with DBP : Men



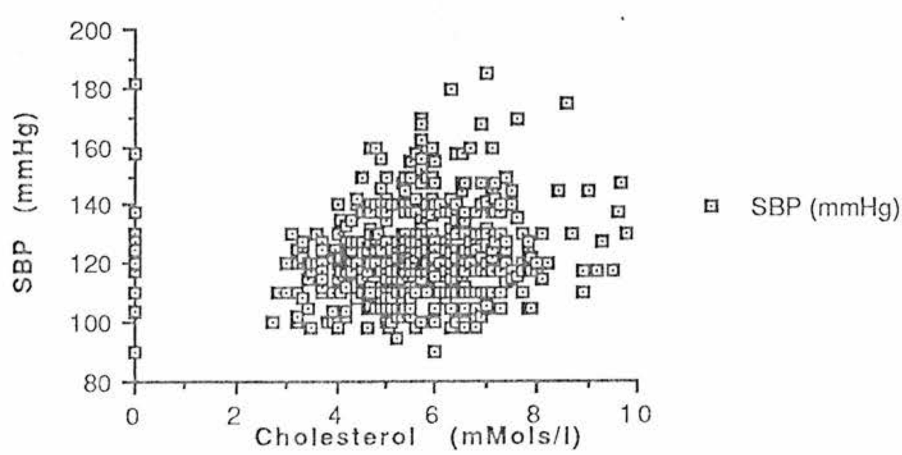
Scatterplot of %Bodyfat with cholesterol : men



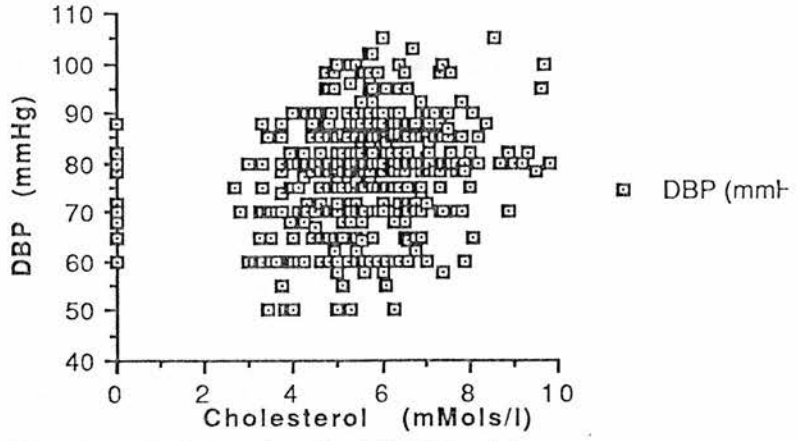
Scatterplot of %Bodyfat with weight : men



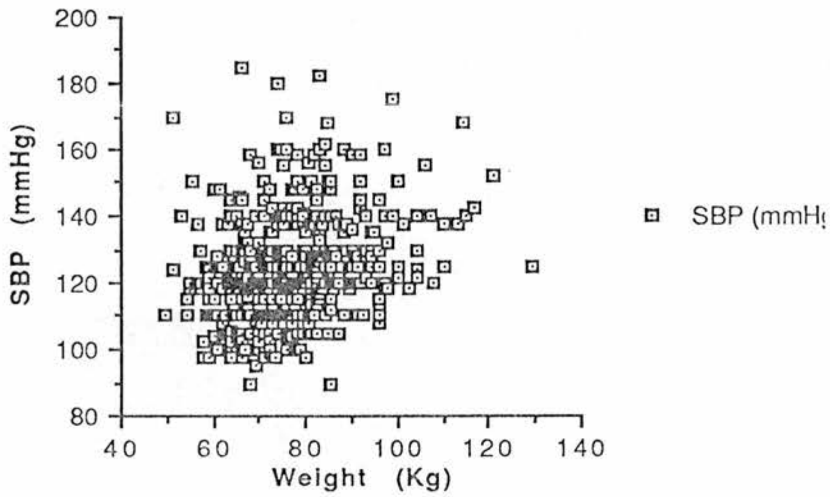
Scatterplot of cholesterol with weight : men



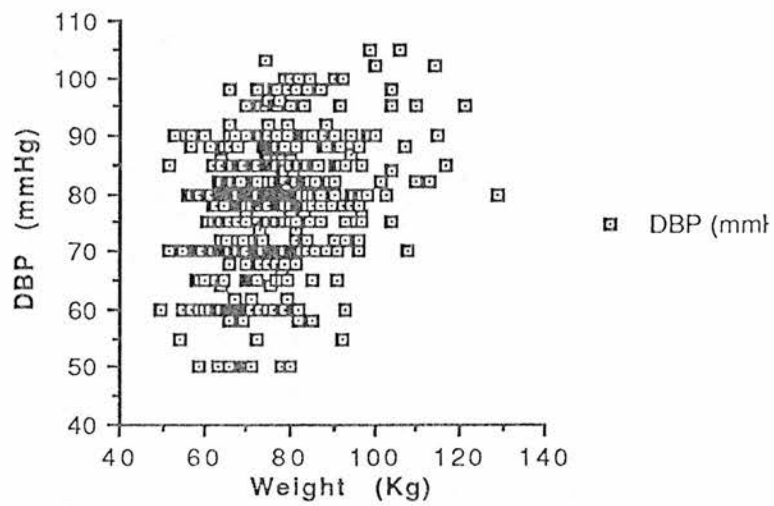
Scatterplot of cholesterol with SBP : Men



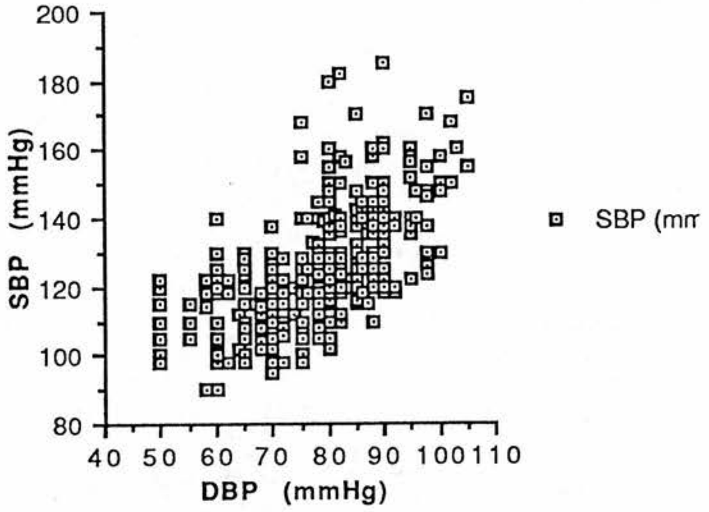
Scatterplot of cholesterol with DBP : Men



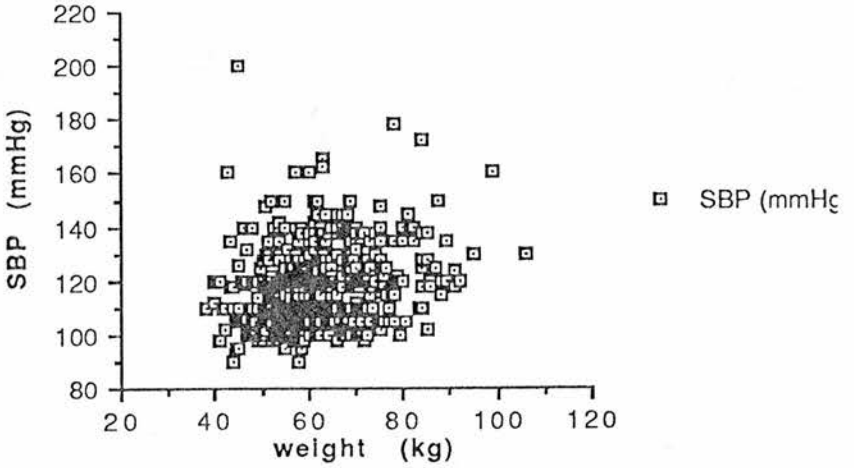
Scatterplot of weight with SBP : Men



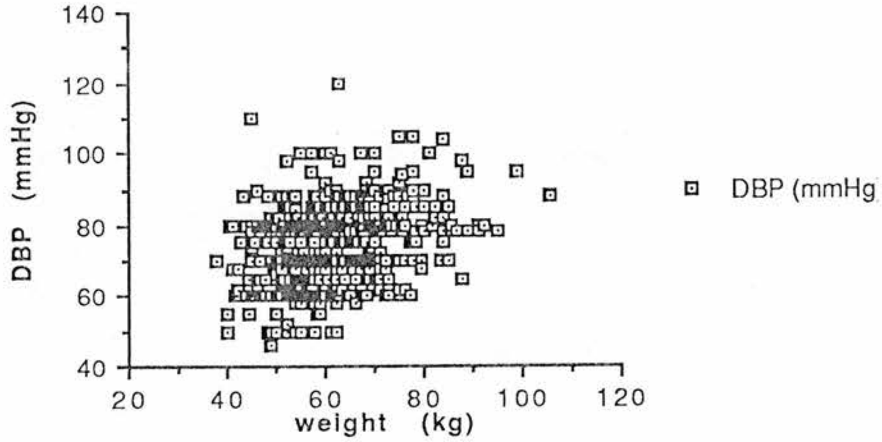
Scatterplot of weight with DBP : Men



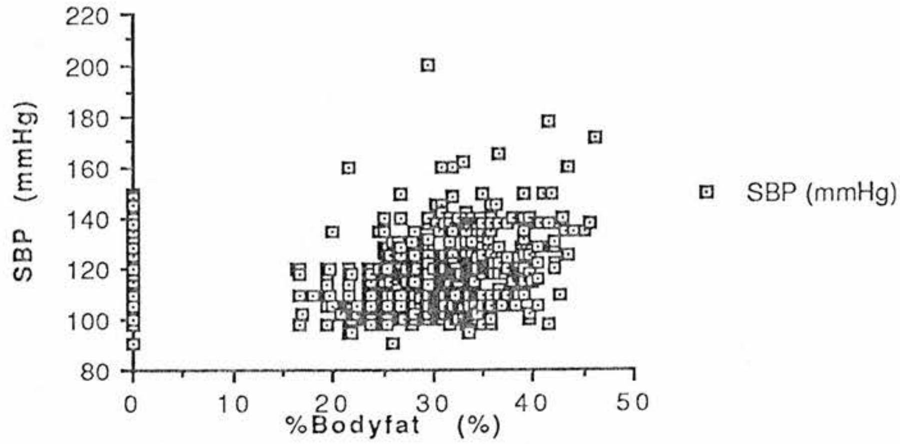
Scatterplot of SBP with DBP : Men



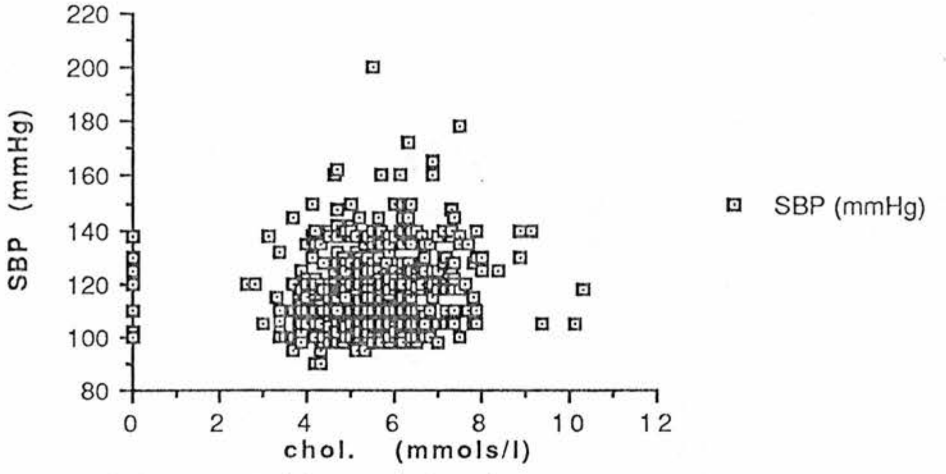
Scatterplot of weight with systolic blood pressure : women



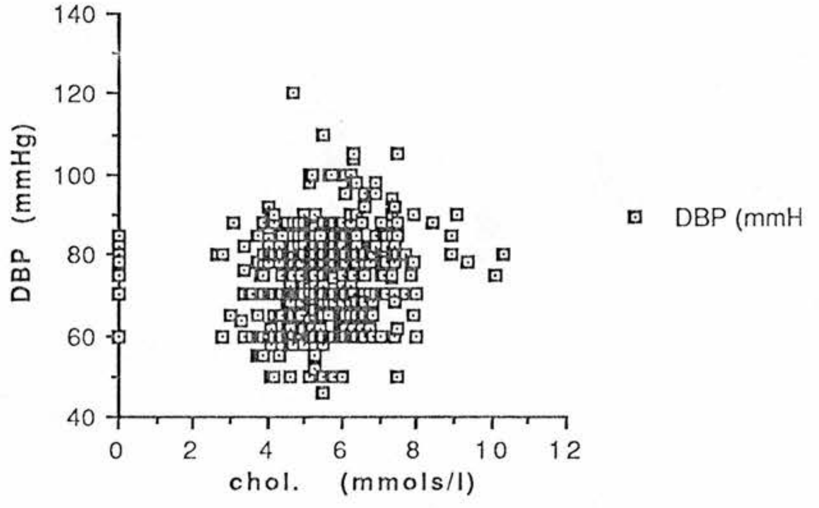
Scatterplot of weight with diastolic blood pressure : women



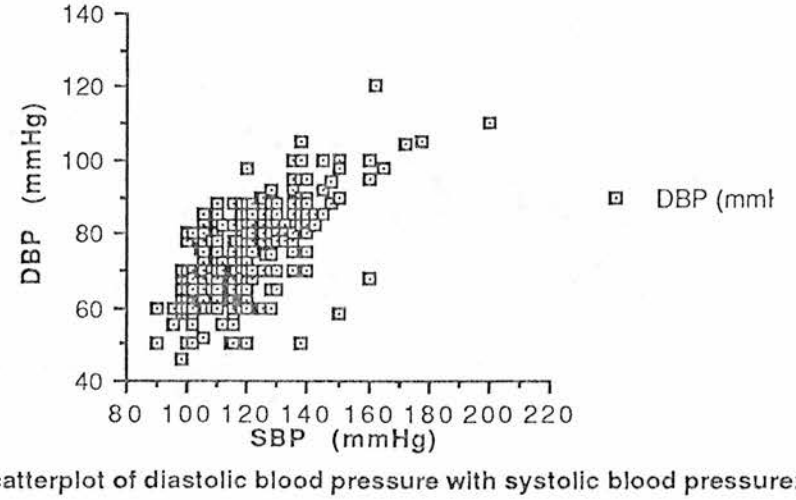
Scatterplot of %Bodyfat with systolic blood pressure : women



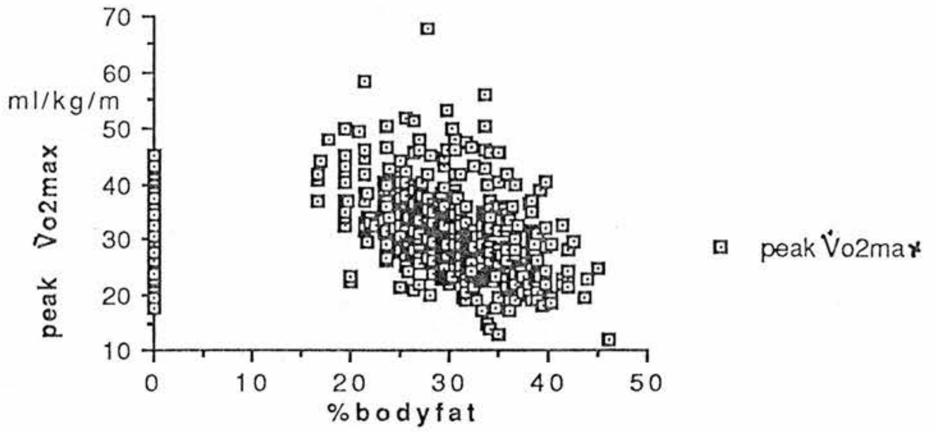
Scatterplot of cholesterol with systolic blood pressure : women



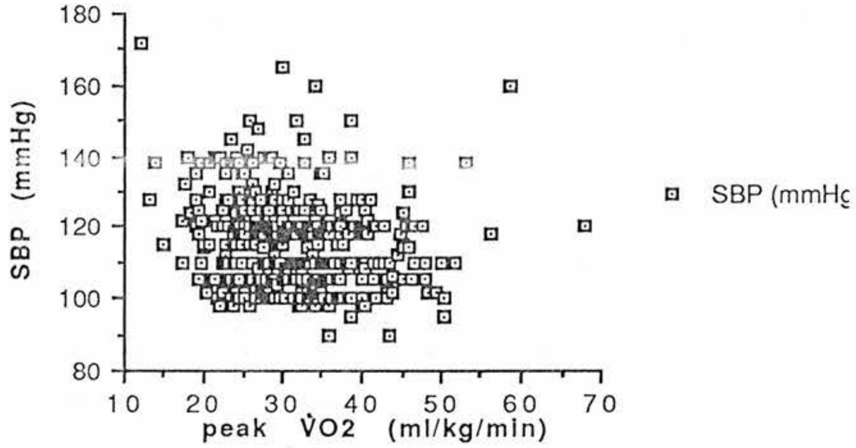
Scatterplot of cholesterol with diastolic blood pressure : women



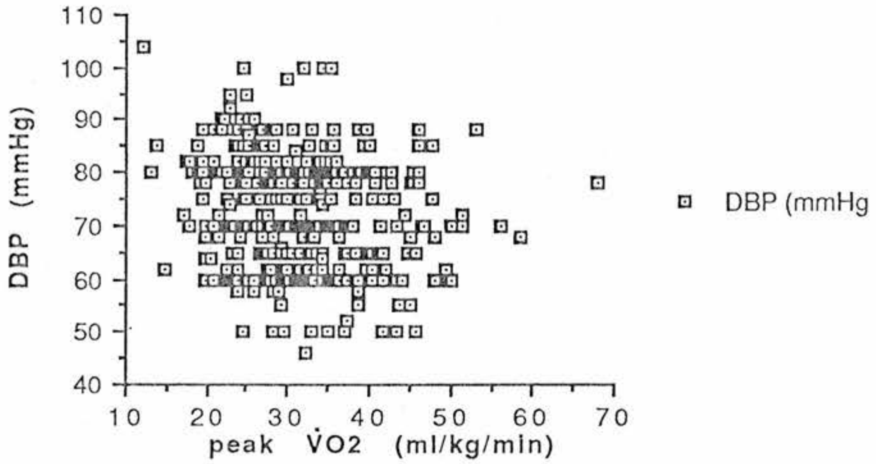
Scatterplot of diastolic blood pressure with systolic blood pressure:women



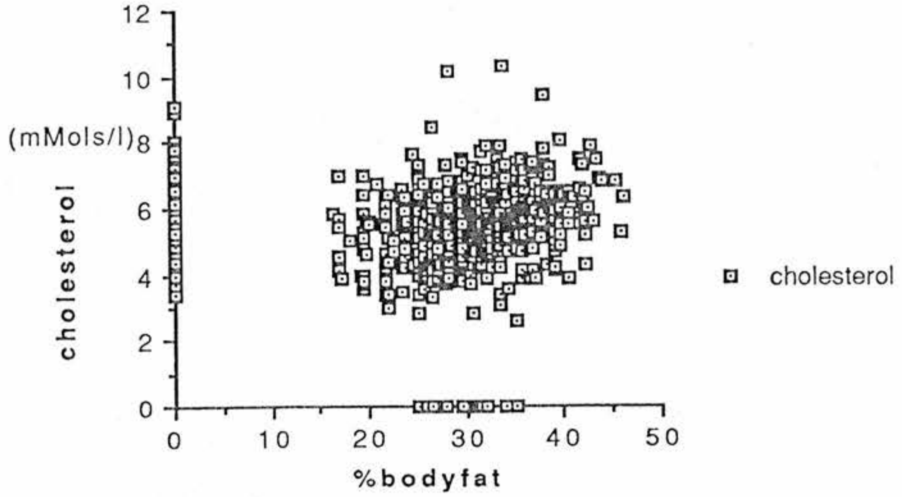
Scatterplot of peak V̇O2 with %BF : women



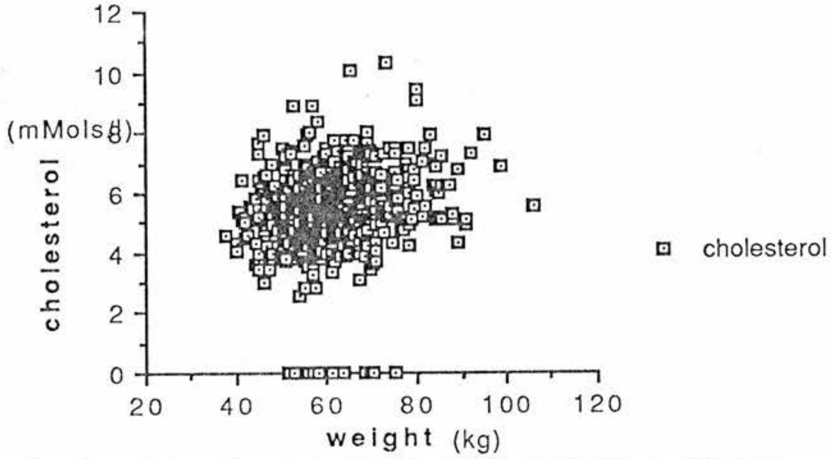
Scatterplot of peak V̇O2 with systolic blood pressure : women



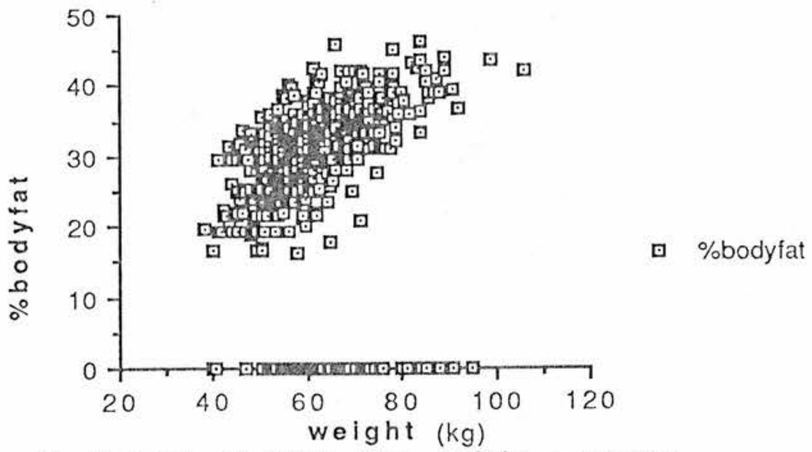
Scatterplot of peak V̇O2 with diastolic blood pressure : women



Scatterplot of chol with %BF : women



Scatterplot of cholesterol with weight : women



Scatterplot of %BF with weight : women