EXERCISE COMPLIANCE AND HEALTH OUTCOME IN A CHRONIC DISEASE MANAGEMENT PROGRAMME

by

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CONTENTS

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SYNOPSIS

TITLE	Exercise compliance and health outcome in a chronic disease management programme
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In the latter part of the 20th century chronic diseases, especially cardio vascular-related diseases (CVDs) and Type 2 diabetes mellitus (DM) seemed to have emerged as substantial problems. This can be seen in the prevalence and the cost of CVDs in South Africa and worldwide. It was predicted that by the year 2030 more people would be dying from CVDs than from Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/Aids). The reasons for the occurrence of CVDs are linked to biological (i.e. hypertension, hyperlipidemia, obesity, insulin resistance, etc), psychological (i.e. emotional stress), and behavioural or lifestyle risk factors. It is known that physical exercise can aid in the treatment of CVDs. Institutions such as the American College of Sports Medicine (ACSM) recommended an exercise frequency of three times per week for 20 minutes. According to literature, a third of patients in exercise studies do not comply with their exercise protocol, and after three to six months, 50 percent will drop out of organised training groups. Less than a third of South Africans complied with exercising 30 minutes a day on most days of the week. Thus, there has been much interest among health-care providers to manage exercise compliance. Exercise compliance is a complex construct, and thus in the present study the role that behavioural patterns play was also investigated *via* psychological behavioural models.

The major objectives of the study were the following:

- Firstly, to determine if exercise compliance or non-compliance had an influence on shifts measured in the clinical parameters (i.e. blood pressure, blood lipid levels, blood glucose levels, body mass index, body fat percentage and cardiac risk percentage) over time.
- Secondly, to determine whether there were any correlation between the psychological behavioural models and the exercise compliance of the members over the course of the Best Med/Access Health-Disease Management Programme (BM/AH-DM Programme).

In the present study, a retrospective data analysis was done on data collected from Best Med Medical Aid members (n = 400) who participated in a chronic disease management programme for three and a half years. The inclusion criteria for participation on the programme were the presence of one or more of the following CVDs namely: hypercholesterolemia, hypertension and DM. The members' clinical parameters (height, body weight, body fat percentage, blood pressure, finger-prick non-fasting (random) blood cholesterol level, finger-prick non-fasting (random) blood glucose, sub-maximal VO_2 fitness test) were measured every three months. After a baseline assessment was done, an exercise programme was given to each member and a norm of exercising twice a week was prescribed. If members adhered to the norm they were considered compliant and if they did not adhere to the norm, they were considered as being non-compliant. Their exercise compliance, and relevant clinical parameters were measured over 30 months, although data analysis was only a reflection of the first 12 months' data. At the beginning of the BM/AH-DM Programme the members' Level of Readiness (LOR) to make a lifestyle change was measured via a questionnaire and by the end of the programme they completed an Implicit Theory Scale (ITS) questionnaire. Descriptive statistics (means, standard deviation) were used to determine the entire groups' compliance, and to divide the group into compliant and non-compliant groups. The T-test or the Mann-Whitney Test (an equivalent non-parametric technique) was applied to determine significant differences between groups. Thus did the clinical parameters measured over time (baseline to 3 months, baseline to 6 months and baseline to 12 months), change more in the compliant than in the non-compliant group? And were there correlations between psychological questionnaires answers and the two exercise groups?

The results indicated that the group's exercise compliance trend decreased drastically over time. Statistical significant decreases were demonstrated in systolic (p = 0.007) and diastolic (p = 0.012) blood pressure, BMI (p = 0.072 and p = 0.0003), cardiac risk percentage (p = 0.003), and body weight (p = 0.003 and p = 0.0000). All of these decreases were seen in the exercise compliant group. There were no statistical correlations between the psychological questionnaires and the exercise groups. Limitations were the quality of the clinical data, the exercise compliance data that deteriorated over time, and the LOR and ITS questionnaires was neither valid nor reliable tools in making predictions regarding exercise behaviour/compliance. For future research it is recommended that measurements of blood pressure and cholesterol be done more thoroughly, and dietary fat intake must be monitored. A valid and reliable cardiac risk tool, LOR and ITS questionnaires must be designed.

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SAMEVATTING

TITEL	Exercise compliance and health outcome in a chronic disease management programme
KANDIDAAT	Riana du Plessis
PROMOTOR	Me. F. Rossouw
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Die voorkoms en kosteïmplikasies van kroniese siektetoestande in Suid–Afrika en wêreldwyd, het in die laaste gedeelte van die 20ste eeu 'n wesenlike probleem geword. Kardiovaskulêre (KVS) siektes en tipe 2 diabetes mellitus (DM) is veral voorbeelde van sulke siektetoestande. Daar is voorspel dat in die jaar 2030, meer mense wêreldwyd aan KVS sal doodgaan, as aan Menslike Immuniteitsgebrekvirus/Verworwe Immuniteitsgebreksindroom (MIV/Vigs). Die risikofaktore wat met die oorsake van KVS geassosieer word, is die volgende:

- Biologiese (met inbegrip van hipertensie, insulienweerstandigheid, hoë bloedcholesteroltellings, ens)
- Sielkundige (bv emosionele spanning)
- Risikofaktore wat verband hou met lewenstyl.

Literatuur bevestig dat fisiese oefening help om KVS en diabetes mellitus te behandel. Die *American College of Sports Medicine (ACSM)* het 'n oefenriglyn van drie maal per week vir 20 minute lank as 'n minimumfrekwensie daargestel. Volgens literatuur oefen 'n derde van pasiënte wat deelneem aan oefeningnavorsingsstudies nie volgens die riglyne wat gestel word nie en binne die eerste drie tot ses maande sal 50% van die pasiënte ophou oefen. Navorsing wat op die Suid-Afrikaanse bevolking gedoen is, toon dat minder as 'n derde 30 minute lank op meeste dae van die week oefen. Dus is die belangstelling van gesondheidsterapeute rakende die bestuur van gereelde oefeningdeelname geprikkel. Gereelde oefeningdeelname sluit ook die rol van gedragspatrone in en dus is sielkundige gedragsmodelle gebruik om dit ook in die huidige studie te ondersoek.

Die hoofdoelwitte van die studie was die volgende:

- Het gereelde of ongereelde oefeningdeelname 'n uitwerking gehad op die veranderinge in kliniese parameters (bloeddruk, bloedlipiedprofiele, bloedglukosevlakke, liggaamsmassaindeks, liggaamsvetpersentasie, en kardiovaskulêre risikoprofiele) wat oor 'n tydperk gemeet is?
- Was daar 'n korrelasie tussen die sielkundige gedragsmodelle en gereelde of ongereelde oefeningsdeelname met die verloop van die Best Med/Access Health (BM/AH) kroniese siektebestuursprogram?

'n Retrospektiewe data-analise is gedoen van data wat tydens die BM/AH kroniese siektebestuursprogram ingesamel is. Vierhonderd lede van die Best Med mediese fonds het oor 'n periode van drie jaar en ses maande deelgeneem aan dié program. Insluitingskriteria vir deelname aan die program was een of meer van die volgende siektetoestande: Hipertensie, diabetes mellitus en hoë bloedcholesteroltellings. Die lede se kliniese parameters (lengte, gewig, liggaamsvetpersentasie, bloeddruk, (lukrake nie-vastende) bloedlipiedprofiele, (lukrake nie-vastende) bloedglukosevlakke, en submaksimale VO_2 fiksheidstoets) is elke drie maande gemeet. Nadat 'n aanvangsevaluering (basisevaluering) gedoen is, het lede 'n oefenprogram ontvang en is 'n norm vir oefening twee maal per week daargestel. Lede wat voldoen het aan die norm is as gereelde oefendeelnemers geag en lede wat nie voldoen het daaraan nie is as ongereelde oefendeelnemers geag. Die oefendeelname en toepaslike kliniese parameter is oor 30 maande gemeet, alhoewel die data-analise slegs 'n refleksie van die eerste 12 maande was. Tydens die aanvang van die BM/AH-siektebestuursprogram is 'n vraelys uitgedeel om die gereedheidsvlak te meet van die lede om 'n gedragsverandering te maak, ("Level of Readiness questionnaire"). Aan die einde van die program is die "Implicit Theory Scale (ITS) questionnaire" uitgedeel.

Beskrywende statistiek (gemiddelde en standaardafwyking) is gebruik om oefeningdeelname van die groep as geheel te bepaal, asook om die lede in die twee oefengroepe (gereeld en ongereeld) op te deel. Die T-toets of die "Mann-Whitney" toets ('n ekwivalente non-parametriese tegniek) is toegepas om die beduidende verskille tussen die twee oefengroepe te bepaal. Dus, het die kliniese parameters wat oor tyd gemeet is (basisevaluering tot 3 maande, basisevaluering tot 6 maande

en basisevaluering tot 12 maande) meer veranderinge getoon in die gereelde oefeningdeelnamegroep as die ongereelde oefeningdeelnamegroep? En was daar korrelasies tussen die sielkundige vraelyste en die twee oefengroepe?

Die resultate het getoon dat die oefeningdeelname van die groep as geheel drasties afgeneem het oor tyd. Statiese beduidende afnames is gemeet in die volgende kliniese parameters: Sistoliese ($p = 0.007$) en diastoliese ($p = 0.012$) bloeddruk, liggaamsmassaindeks ($p = 0.072$ en $p = 0.0003$), kardiale risikopersentasie ($p = 0.003$), en liggaamsgewig ($p = 0.003$ en $p = 0.0000$). Al die afnames in kliniese parameters is in die gereelde oefeningdeelnamegroep waargeneem. Daar was geen statistiese korrelasie tussen die twee LOR- en ITS- vraelyste, en die twee oefeningdeelnamegroepe nie. Beperkinge van die studie was die kwaliteit van die kliniese data, die oefeningdeelname wat drasties afgeneem het oor tyd, en die ongeldige en onbetroubare LOR- en ITS-vraelyste. Voorstelle vir toekomstige navorsingstudies is die volgende: Die deeglike meting van bloeddruk en bloedlipiedprofiele, die monitering van vetinname in die dieet van 'n pasiënt, en die ontwerp van 'n betroubare en geldige kardiovaskulêre risikomeetinstrument, asook LOR- en ITS-vraelyste.

Sleutelterme:

kroniese siektetoestande
kardiovaskulêre siektes
gereelde oefeningdeelname
kroniese siektebestuursprogram
hoë cholesterol
hipertensie
diabetes mellitus
liggamsmassaindeks
bloeddruk
gereedheid vir gedragsverandering

ABBREVIATIONS

ATP-   Adenosine Tripshosphate

ACSM-   American College of Sports Medicine

AHA-   American Heart Association

β-   Beta

BIA-   Bioelectrical Impedance Analysis

BM/AH-DM Programme-   Best Med/Access Health Chronic Disease & Lifestyle
                            Management Programme

BMI-   Body Mass Index

BP-   Blood Pressure

CAD-   Coronary Artery Disease

CADs-   Coronary Artery Diseases

CD-   Chronic Disease

CDs-   Chronic Diseases

CETP-   Cholesterol Ester Transfer Protein

CHD-   Coronary Heart Disease

CHO-   Carbohydrates

CHOL-   Indicates serum cholesterol value

CRISK-   Indicates cardiac risk percentage

CVD-	Cardiovascular-related Diseases
CVDs-	Cardiovascular-related Diseases
DM-	Diabetes Mellitus
DBP-	Diastolic Blood Pressure
DSE-	Diabetes Support and Education
FAT-	Indicates body-fat percentage
FFA-	Free Fatty Acids
GLUC-	Indicates serum glucose value
H_a-	Alternative Hypothesis
HBM-	Health Belief Model
HR-	Heart Rate
HRR-	Heart Rate Reserve
HR_{max} –	Maximum Heart Rate
HDL-	High-Density Lipoprotein
HPC-	High Performance Centre
HSL-	Hormone Sensitive Lipase
HIV/Aids-	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
ITS-	Implicit Theory Scale

ITSQ-	Implicit Theory Scale Questionnaire
LOR-	Level of Readiness
ILI-	Intensive Lifestyle Intervention Group
kcal-	Kilocalorie
kg-	Kilogram
kg/m^2-	Kilogram divided by metres square
LDL-	Low-Density Lipoprotein
LPL-	Lipoprotein Lipase
MI-	Myocardial Infarction
min-	Minute
mg/d ℓ-	Milligram per decilitre
mmHg-	Millimetres of mercury
mmol/ ℓ-	Millimoles per litre
NCEP-	National Cholesterol Education Program
p-value-	Is a measure of how much evidence you have against the null hypothesis
R-	South African Rand
RPE-	Rating of Perceived Exertion
REF-	Risk Equalisation Fund

SA-	South Africa
SNS-	Sympathetic Nervous System
SBP-	Systolic Blood Pressure
TTM-	Trans Theoretical Model
USA $-	United States of America Dollars
USA-	United States of America
VLDL-	Very Low-Density Lipoprotein
VO_{2max}-	The maximum ability of the cardiovascular system to deliver oxygen to all working muscles and the ability of the muscles to utilise this oxygen
VO_2R-	Oxygen uptake reserve
WHO-	World Health Organization
WT-	Indicates body weight
%HRR-	Percent Heart Rate Reserve
α-	Alpha
<	Less than
>	More than

LIST OF TABLES

LIST OF FIGURES

Figure	Page No.

LIST OF FIGURES

CHAPTER 1

SCOPE AND INTENT

1.1 INTRODUCTION

The question whether an epidemic of modern chronic diseases began to emerge in the latter part of the 20th century may rightly be posed as an opening to this dissertation.

According to Steyn and Fourie (2006), a chronic disease (CD) will develop as a result of combining risk factors such as high blood pressure, tobacco smoking, obesity, stress, and high blood cholesterol. Continuous exposure to these risk factors over a long period will eventually progress to a CD (Steyn & Fourie, 2006). Examples of CD are cardiovascular-related diseases (CVDs), eg atherosclerosis, heart failure, hypertension, stroke and hyperlipideamia, Type 2 diabetes mellitus (DM), some cancers and osteoporosis. All the above may be classified as CDs (Booth *et al.*, 2000).

The prevalence of CDs worldwide, as well as in South Africa, could be viewed as being of grave concern. The World Health Organization's statistical report for 2008 predicted that globally by the year 2030 there will be more deaths from CVD than from Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/Aids) (*World Health Statistics 2008.* Retrieved August 19, 2009, from http://www.who.int/whosis/whostat/EN_WHS08_Full.pdf). In South Africa in 2002, 18 percent of all deaths were caused by CD, and 20 percent of these deaths occurred in the age group 34 to 64 (Steyn & Fourie, 2006). In this country in 2004, the prevalence of chronic diseases of lifestyle measured at approximately 12,3 percent (REF Contribution Table, 2005).

Not only is the prevalence of CVD another major concern, but so also are the costs involved in cases of CVD. It was indicated that by the year 2000, the national health-care costs of CVD in the United States of America amounted to almost one trillion dollars (Booth *et al.*, 2000; Morrow *et al.*, 2004). In South Africa by the year 2005, the total costs of CVD was approximately one billion rand per year. (Council for Medical Schemes, Annual Report 2004-5 p. 54; REF Contribution Table, 2005). In a study by Abegunde *et al.* (2007) it was stated that if nothing were to be done about the prevalence of CVD in low- and middle-income countries such as South

Africa, the total loss of economic production for these countries would amount to US $ 84 billion for the time period 2006 to 2015 (Abegunde *et al.,* 2007).

It would be absolutely foolish to ignore the prevalence of CVD and its financial implications in the private medical sector worldwide and in South Africa.

As mentioned above, the causes of CVD are linked to risk factors such as elevated blood cholesterol, hypertension, smoking, age and DM (Steyn & Fourie, 2006; *A Better way to predict cardiovascular risk.* Retrieved August 19, 2009, from https://www.health.harvard.edu/fhg/updates/a-better-way-to-predict-cardiovascular-risk.shtml). According to Booth *et. al.* (2000), physical inactivity, or the lack of doing exercise, potentiates at least 17 unhealthy conditions, and all of these unhealthy conditions are CDs or are risk factors for CDs. For an individual to benefit from exercising, compliance with an exercise routine is crucial (Covera-Tindel *et al.,* 2004). According to the American College of Sports Medicine (ACSM) exercise training should be conducted at a moderate to vigorous intensity for a minimum of three times a week for 20 minutes at a time. (Franklin *et al.,* 1998).

Most health-care providers are aware that compliance with an exercise regimen is critical for the patient's recovery or improvement of clinical parameters (Seckin *et al.,* 2000). According to Covera-Tindel *et al.* (2004) a third of patients in exercise-training studies are non-compliant with the exercise protocol. For most organised exercise programmes, such as the present study, 50 percent of patients will stop doing exercises within the first three to six months (Dishman, 1988). Thus, Frederich *et al.* (1998) stated that health-care providers must be taught to manage a patient's compliance with exercise programmes.

Thus, the focus of this study will be on exercise as intervention in a chronic disease population. The emphasis will be on compliance with exercise as an indicator of the anticipated improvement of physical clinical parameters of people registered on a chronic disease management programme. Exercise compliance is a multifaceted construct and, according to Steyn and Fourie (2006) may be seen as a behavioural pattern. Thus investigating the role that attitude, behavioural patterns and social skills play in adopting and maintaining regular exercise is warranted (Dishman, 1994).

In order to explain exercise compliance as health behaviour, certain theoretical models that are associated with health behaviour will be explained in Chapter 2. Examples of these models are the Health Belief Model and Prochaska's Transtheoretical Model or Stages of Change Model (Kemper *et al.,* 2002). The theoretical models to be discussed in Chapter 2 are based on the following premises:

- Based on an individual's perception that a disease is a threat to him or her, and that the behaviour adopted will reduce this threat, the individual will adopt a certain behaviour to prevent or control that disease.
- Individuals will make changes, such as exercise patterns, in their lifestyle behaviour if they have a psychological readiness to make those changes, despite the fact that they may know that if changes are not made, it may be detrimental to their health (Dishman, 1994)
- Individuals will be compliant with an exercise routine if they believe that through effort they could become physically fitter, and thereby change their fitness status (Lochbaum *et al.,* 2006).

In the current study the researcher analysed data collected from 400 participants of the Best Med/Access Health Chronic Disease & Lifestyle Management Programme (BM/AH-DM Programme). Thus, a retrospective data analysis was done and a non-equivalent group design was chosen as the research design.

1.2.   STUDY OBJECTIVES

1.2.1 Major objectives

Considering the literature overview and the nature of the study, the following research questions arose:

- Did exercise compliance or non-compliance have an influence on shifts measured in the clinical parameters (ie blood pressure, blood lipid levels, blood glucose levels, body mass index, body fat percentage and cardiac risk percentage)?

- Over the course of the BM/AH-DM Programme was there any correlation between the psychological behavioural models and the exercise compliance of the members?

1.2.2. Secondary objectives

- Determining how many individual records corresponded with the present study's definition of exercise compliance, and thereby determining the number of compliant and non-compliant records
- Establishing the baseline of each clinical parameter of every individual record
- Establishing the shifts measured in each selective clinical parameter, as mentioned above, by comparing each clinical parameter's baseline value to its values recorded over time
- Determining whether there was a difference in the shifts measured in the clinical parameters when comparing it to the exercise-compliance status of the group
- Determining whether there was a difference in the level of readiness to change when comparing it to the exercise-compliance status of the group
- Determining the differences in the answers from the questionnaire on the Implicit Theory Scale, and comparing the answers to the exercise-compliance status of the group.

CHAPTER 2

LITERATURE OVERVIEW

2.1. CHRONIC DISEASES

2.1.1. Definition and prevalence of chronic diseases

According to Booth *et al.* (2000), a chronic disease can be classified as "a disease that is slow in its progress and long in its continuance". Booth *et al.* (2000) explain further that an individual crosses a threshold called a "clinical horizon" to manifest (and be diagnosed with) a multi-factorial chronic disease generally years after the original causes of the disease have taken effect. That implies that the physiological mechanisms underlying some chronic diseases have usually been active long before a person shows signs and symptoms of the particular condition. Examples of chronic diseases (CDs) are cardiovascular-related diseases (CVDs), eg atherosclerosis, heart failure, hypertension, stroke and hyperlipideamia. Type 2 diabetes mellitus, some cancers and osteoporosis are also classified as CDs (Booth *et al.*, 2000).

In 2002 the prevalence of worldwide deaths caused by CVDs amounted to 17 million, while diabetes mellitus was responsible for almost one million deaths (20 June 2004, p.2616). According to Yach *et al.* (2005), about three million deaths occurred annually in India and China. The above authors also stated that one million tobacco-related deaths occurred annually in China and 700 000 in India. Yach *et al.* (2005) also reported that one in five children in the world were smoking, and one in ten was classified as being overweight or obese. This understandably led the authors to conclude that the future prospects regarding CVD and Type 2 DM were rather grim (Yach *et al.,* 2005). According to the World Health Organisation's (WHO) global report in 2005, 35 million of the 58 million human deaths were attributed to CVD causes (WHO 2006, p1107). Chronic diseases may therefore be identified as a global concern (20 June 2004, p.2616).

The WHO statistical report for 2008 predicted that globally by the year 2030 there would be 23.4 million deaths caused by CVD. It was also predicted that deaths from Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome

(HIV/Aids) would increase from 2.2 million in 2008 to a maximum of 2.4 million in 2012, and then decline to 1.2 million in 2030.

Thus, in the year 2030 there would be more deaths globally from CVD than from HIV/Aid (*World Health Statistics 2008.* Retrieved August 19, 2009, from http://www.who.int/whosis/whostat/EN_WHS08_Full.pdf).

Closer to home, in South Africa for the year 2000, human deaths totalled 500 000. Of these, 37 percent were caused by chronic diseases of lifestyle, 30 percent by HIV/Aids, 12 percent by injuries, and 21 percent by infectious diseases. In the same year, in the age group of 45, cardiovascular and lifestyle-related cancers were the leading causes of death (Steyn & Fourie, 2006). Two years later, owing to the increase in HIV/Aids, 18 percent of deaths were caused by chronic diseases of lifestyle and 20 percent of these were for the age group 35 to 64 (Steyn & Fourie, 2006). Thus, one cannot ignore the prevalence of CVD and its financial implications in the private medical sector worldwide as well as in South Africa.

In the United States of America (USA) statistics indicated that by the year 2000, 950 000 Americans had died annually from CVD, with national health-care expenses totalling almost one trillion dollars per year for CDs (Booth *et al.*, 2000; Morrow *et al.*, 2004). The WHO determined that of the 35 million deaths that occurred in 2005 owing to CVD, 80 percent were in low- or middle-income countries (WHO, 2006 p 1107). According to Abegunde *et al.* (2007) 23 countries, including South Africa, had been identified as low- or middle-income countries. The above authors predicted that if nothing was going to be done to decrease the incidence of CVD in these countries, the loss of economic production between the years 2006 and 2015 would amount to US $ 84 billion (Abegunde *et al.,* 2007).

In South Africa, the financial implications of chronic diseases in the private medical sector can also not be ignored. Among the South African population (for the private medical sector) the prevalence of chronic diseases in 2004 amounted to approximately 12.3 percent (REF Contribution Table, 2005). According to the Council for Medical Schemes Annual Report 2004-5, there were approximately 6.9 million beneficiaries in the medical scheme environment (Council for Medical Schemes, Annual Report 2004-5 p 54). At a cost of R104.00 per beneficiary per month (REF Contribution Table, 2005), the total cost for the private medical sector

for chronic diseases in South Africa then would amount to about one billion rand a year.

Thus, apart from the costs of CDs for the private medical sector, it should be noted that the age group mostly affected by these diseases, namely
35 to 64, forms part of the economically productive sector of the country (Steyn & Fourie, 2006).

2.1.2. Risk factors associated with CVD

The causes of chronic diseases can be linked to the prevalence of risk factors in the individual. Within this context, risk factors that may be defined as contributing to CVD are listed as age, elevated blood cholesterol, hypertension, smoking and DM (*A Better way to predict cardiovascular risk*. Retrieved August 19, 2009, from https://www.health.harvard.edu/fhg/updates/a-better-way-to-predict-cardiovascular-risk.shtml).

During the second half of the 20th century there was a shift from infectious diseases to CD as leading causes of deaths globally (Schneiderman, 2004). Researchers thus began to investigate the probable causes of CD. Unable to identify a single cause for CVD, scientists began to investigate the following possible risk factors associated with it:

- Biological
- Psychosocial
- Behavioural or lifestyle risk factors (Schneiderman, 2004)

The classification of biological and behavioural risk factors were accepted in the classification in the Consensus Statement for the Prevention of Vascular Disease (2004). More recently Kolbe-Alexander *et al.* (2008) identified and measured the following CVD risk factors:

- Servings of fruit and vegetables a day, smoking habits, activity levels, body mass index (BMI) (all being behavioural risk factors)
- Age, blood pressure, cholesterol levels (all being biological risk factors)
- Level of readiness to change.

However, it should be remembered that although strong correlations may exist between the above-mentioned risk factors and CD, these correlations are not by implication causal in every situation. Thus, an attempt to manage 1 or 2 risk factors may not reduce the risk of CVD. It should rather be attempted to simultaneously manage a number of these risk factors throughout the lifespan of an individual (McArdle *et al.*, 2001).

2.1.2.1. Biological risk factors

Wallace and Schluter (2008) assessed blood pressure, hyperlipedemia, blood-glucose levels, smoking status, exercise status (the norm being 150 minutes a week) and positive family history as risk factors for CVD. Molenaar *et al.* (2008), also tested all of the above-mentioned as risk factors for CVD, but did not measure smoking and exercise status. Thus, for the purpose of the present study the following biological risk factors for CVD will be discussed:

- Hypertension
- Insulin resistance
- Hypercholesterolemia
- Obesity
- Family history

Each of these risk factors will be tested and measured over time. However, reports will only be written on blood pressure (hypertension), blood-glucose levels (insulin resistance), cholesterol levels (hypercholesterolemia) and BMI (obesity). Family history will be used, together with other variables to predict cardiac risk percentage.

2.1.2.1.1. Hypertension

During contraction of the left ventricle, the maximum force exerted by the blood against the arterial walls is called systolic blood pressure. During the cardiac relaxation phase, the pressure in the arteries decreases, and the ease with which the blood flows from the arterioles into the capillaries

is referred to as diastolic pressure. The normal values for blood pressure are 120 mmHg systolic, and 80 mmHg diastolic (McArdle *et al.*, 2001).

Hypertension can be defined as a resting systolic blood pressure higher than 140 mmHg and a diastolic blood pressure higher than 90 mmHg during rest (Steyn & Fourie, 2006; Molenaar *et al.*, 2008; Wallace & Schluter, 2008). Blood pressure at rest will rise if hardened fatty material is deposited within the arterial walls, or if the connective tissue within this has thickened (McArdle *et al.*, 2001). Blood pressure can also rise because of neural hyperactivity. When emotional stress is experienced, the sympathetic nerves will stimulate the heart to beat faster and more forcefully (Bukworth & Dishman, 2002). If blood pressure remains high, endothelial damage to the inner lining of the arterial wall is eminent. The resulting inflammation will assist the process of depositing low-density lipoprotein (LDL) within the arterial walls (ACSM, 2001).

Hypertension is considered to be a primary risk factor for CVD such as stroke, congestive heart failure, angina, renal failure and myocardial infarction (ACSM, 2001) for all ages and genders. A resting blood pressure of 140/90mmHg or higher is also a risk factor for Type 2 DM (McArdle *et al.*, 2001). Researchers Steyn and Fourie (2006) commented that hypertension usually co-exists with other forms of CDs of lifestyle such as DM and obesity. The prevalence of hypertension in South Africa in 1998 was 23.9 percent (Steyn & Fourie, 2006). Briganti *et al.* (2003) reported that if hypertension were managed, the risk for CVDs would be reduced. In the same study, the researchers found that individuals with untreated hypertension had a high prevalence of modifiable lifestyle risk factors (smoking, inactivity and excessive alcohol use) associated with CVD (Briganti *et al.,* 2003). According to Goldberg and Elliot (2000) the modifiable risk factors for hypertension are the following:

- Smoking
- Consuming excessive amounts of alcohol
- Eating too much salt
- Having to much body fat
- Exercising too little

According to Goldberg and Elliot (2000) and Briganti *et al.* (2003) drug treatment is warranted for the management of hypertension. However, for the purpose of this study the focus will be on exercise as treatment for hypertension and indirectly for CVD risk.

2.1.2.1.2. Hypercholesterolemia

Hypercholesterolemia can be defined as abnormally high blood cholesterol levels. Cholesterol that circulates in the plasma consists of three sizes of lipoprotein particles, namely: very low-density lipoprotein (VLDL), low-density lipoprotein (LDL) and high-density lipoprotein (HDL) (ACSM, 2001). The following are normative values for these serum lipoproteins:

- Total cholesterol of less than 5,2 mmol/ℓ
  (Kolbe-Alexander *et al.,* 2008)
- LDL of less than 25 mmol/ℓ
- HDL of more than 1 mmol/ℓ

(National Vascular Disease Prevention Alliance, 2004, p 234).

In the present study, only total blood cholesterol levels were measured, and no distinction was made between the types of serum lipoproteins. However, to explain the changes that occurred in this parameter (total blood cholesterol) over the course of the study, a deeper understanding of triglyceride and lipoprotein metabolism is needed.

A triglyceride (also termed triacylglycerol) is a simple or "neutral" fat. It is a molecule that contains three fatty acid esters that are chemically bonded to a glycerol molecule. Fatty acids are made up of three clusters of carbon-chained atoms, usually even in the number of carbon atoms. Triglycerides are nature's most abundant lipid. It accounts for 98 percent of fats in food and more than 90 percent of fats in the adipose tissue (McArdle *et al.,* 2001). The synthesis of triglycerides is also referred to as esterification, and this process is facilitated or increased after a meal.

Triglyceride catabolism is termed lypolysis. In this 3-step process, which is regulated by hormone-sensitive lipase (HSL), energy-rich fatty acids and glycerol are mobilised from the adipose tissue usually during exercise, a low-calorie diet or fasting, and cold stress. Lypolysis occurs in the adipocytes and also in the small intestine where triglycerides are catalysed by pancreatic lipase and lipoprotein lipase. Fatty acids that are released can either taken up by the adipose tissue and muscle cells for resynthesis into triglycerides, or for energy production (McArdle *et al.*, 2001).

To describe the dynamics of cholesterol and its transport amongst the small intestine, liver and peripheral tissue, it is important to firstly describe the four types of lipoproteins. Chylomicrons are formed when lipid droplets (long-chain triglycerides, phospholipids and free fatty acids) leave the small intestine and enter the lymphatic vasculature. These chylomicrons then enter the bloodstream, and are transported to the liver. There the chylomicrons are deconstructed and then reconstructed to form lipoproteins. Cholesterol combines with triglycerides to form a very low-density lipoprotein (VLDL) (McArdle *et al.,* 2001), because triglycerides alone cannot circulate freely in the blood (Magkos, 2009). Between 50 percent to 90 percent of triglycerides are carried in the core of VLDLs (Magkos, 2009). Thus, VLDLs contain the highest percentage of lipids, and transport triglycerides to the muscle and adipose tissue. In the peripheral tissue (eg skeletal muscle and adipose tissue), lipoprotein lipase (LPL) hydrolyses the VLDL-triglycerides to produce fatty acids for intra-cellular triglyceride synthesis (fat storage) and/or for energy production (Magkos, 2009). When LPL acts on VLDL it will be converted into low-density lipoprotein (LDL). LDL carries between 60 percent and 80 percent of total serum cholesterol. When LDL levels are too high, atherosclerotic plaque development may result that will damage and narrow the arteries (McArdle *et al.*, 2001). Apart from the above process, triglycerides can also be removed from VLDL by an enzyme called cholesterol ester transfer protein (CETP) and convert it (VLDL) to high-density lipoprotein (HDL) (Magkos, 2009). HDL carries the least amount of lipids and cholesterol and the highest percentage of protein, giving HDL the ability to remove LDL cholesterol from the arterial walls (McArdle *et al.*, 2001). Thus, an increase in HDL and a concomitant decrease in LDL

will reduce both total serum cholesterol and the risk of coronary artery disease.

HDL makes up 20 percent to 30 percent of total cholesterol, and has an inverse correlation with risk for CVD. It seems that higher HDL values may even protect one against the development of atherosclerosis (NCEP, 2002, p 3143). Research has shown a strong correlation between elevated LDL and CVD (NCEP, 2002, p 3143). According to the authors of the Third Report of the National Cholesterol Education Program (NCEP, 2002, p 3143), clinical trails have demonstrated that cholesterol-lowering therapy has decreased the risk for CVD. McArdle *et al.* (2001), also stated that total serum cholesterol and LDL are powerful predictors for increased risk of CVD. This becomes an even higher risk if combined with other risk factors such as cigarette smoking, physical inactivity, obesity and hypertension (McArdle *et al.,* 2001; Tutor & Campbell, 2004; Molenaar *et al.,* 2008).

According to the third report of the National Cholesterol Education Program high blood triglyceride levels are also considered a risk factor for CVD. Steyn and Fourie (2006) reviewed on research done to reflect the prevalence of hypercholesterolemia in South Africa and indicated that, for South Africans older than 30 years, more than five million people are at risk of CD of lifestyle due to high triglycerides levels.

According to Goldberg and Elliot (2000) exercise, diet and drug therapy are valuable in treating hypercholesterolemia. It was reported that 66 studies were reviewed dating back to the 1970s investigating the effect of exercise on blood-cholesterol levels. It was concluded (Goldberg & Elliot*,* 2000) that exercise training lowered LDL and triglyceride levels, and increased HDL levels.

2.1.2.1.3. **Insulin resistance**

Prolonged high blood glucose levels during a fasting glucose test, or elevated fasting blood glucose levels lead to diagnoses of DM (Turcotte & Fischer, 2008). DM is associated with a high risk for other CVD-related

diseases such as hypertension, artherosclerosis, elevated cholesterol levels, high triglyceride levels and in the end myocardial infarction (MI) or stroke (Goldberg & Elliot*.,* 2000; NCEP, 2002, p 3143; Hafnet *et al.,* 1998).

When there is an increase in blood glucose levels after a meal, insulin is secreted from the β-cells in the islets of Langerhans in the pancreas (McArdle *et al.,* 2001). This happens so that the insulin can act as a mediator between blood glucose and the receptor molecules on the cell surface, and thus the glucose can be catabolised and used as fuel for energy.

Insulin resistance (the body's inability to react to insulin) will cause glucose levels to remain at the upper limit of the norm (McArdle *et al.,* 2001). The body's inability to respond to the insulin, and thus the inability of glucose to enter the muscle cells can cause the glucose being stored as fat. An enlargement in fat cells further decreases the body's ability to react to insulin, thus a chronically high output of insulin result. In the long run the above process can cause Type 2 DM (McArdle *et al.*, 2001). Thus control of blood-glucose levels is essential for the prevention and treatment of DM (Turcotte & Fischer, 2008).

An individual with DM may develop other complications over a long period of time. Some of these complications are due to restricted blood flow to the main organs such as the heart and kidneys. Thus, the individual will have a higher risk of developing hypertension, atherosclerosis, elevated blood cholesterol and triglyceride levels, and in the end MI or a stroke (Goldberg & Elliot, 2000). This statement is consistent with the Third Report of the National Cholesterol Education Programme (NCEP, 2002, p 3143), which declared that there was growing evidence that people with DM had the same risk for CHD as people who already had CVD. An example of such evidence is a study by Haffnet *et al.* (1998), which concluded that individuals with Type 2 DM, who never had a MI, in comparison with non-diabetics who did have a MI, presented with the same risk for MI.

2.1.2.1.4. Obesity

According to the guidelines of the association of the ACSM (Balady *et al.*, 2000) obesity can be classified as a BMI of 30.0 kg/m² and as the percentage of body fat at which CD risk increases (Balady *et al.*, 2000). A strong association exists between obesity and chronic diseases such as CVD, DM, depression and cancer, as well as between obesity, morbidity and mortality (Anderson *et al.*, 2005). The Behavioural Risk Factor Surveillance System was used to determine the association of obesity and smoking, respectively, with CVD. Results indicated that the incidence of self-reported DM, arthritis, lifetime elevated blood pressure, and high blood cholesterol were higher amongst obese adults than in non-obese adults (Tutor & Campbell, 2004). Research by Molenaar *et al.* (2008) also indicated a higher burden of CVD risk factors amongst obese individuals. In this study (Molenaar *et al.*, 2008) the treatment and control of CVD risk factors were sub-optimal amongst overweight and obese individuals. Records indicated that in obese participants (n = 1748) –

- only 1 in 4 achieved the recommended blood pressure;
- less than one third with elevated LDL cholesterol achieved optimal control; and
- only 1 in 6 participants with DM achieved fasting blood glucose levels of < 126 mg/dℓ (Molenaar *et al.,* 2008).

During exercise, the amount of fat that is being oxidised is dependent on the type of exercise, the energy expended during exercise, and the individual's fitness status (Hansen *et al.*, 2005). These characteristics will influence the preferred use of fuel (Hansen *et al.*, 2005). High-intensity exercise (aerobic or anaerobic) utilises CHO as fuel while low- to moderate-intensity exercise (< 65 percent of $VO_{2\ peak}$) rely primarily on fat oxidation. A study by Osei-Tutu and Campagna (2004) demonstrated that a prolonged bout of exercise (30 minutes a day) was more effective than a short bout of exercise (3 sessions of 10 minutes a day) in reducing body fat percentage. Fat is also oxidised after exercising (Hansen *et al.*, 2005). Higher intensities of exercise seem to elevate post-exercise fat oxidation the most (Hansen *et al.,* 2005).

2.1.2.1.5. Family history

According to Weir (2005) a family history of CD such as coronary artery disease, DM, arthritis, certain types of cancers and osteoporosis may independently predict the likelihood of future disease, and is an important risk factor for the development of CVD. The researcher (Weir, 2005) found that 14 percent of families in Utah (USA) with a family history of CVD accounts for 72 percent of all early coronary artery disease events. In the same study (Weir, 2005) it was demonstrated that 11 percent of families who had a history of strokes (hypertension-related), accounted for 86 percent of early strokes.

Thus, existing research demonstrates a strong correlation between biological risk factors and CVD. For the purpose of the present study it is important to note this correlation, because each risk factor may act either in a direct or indirect fashion as an independent variable for exercise compliance. The change that took place over time in each risk factor, due to the intervention (exercise), will be reported on.

2.1.2.2. Psycho-social risk factors associated with CVD

When physical stress is experienced, the body reacts by increasing the activation of the sympathetic nervous system (SNS) (Bukworth & Dishman, 2002). Sympathetic nerves innervate organs such as the heart, the adrenal glands, and arteries. Under physical or emotional stress the sympathetic nerves stimulate the –

• heart to contract faster and more forcefully;
• adrenal glands to secrete epinephrine and norepinephrine; and
• arteries that supply the heart and skeletal muscles to dilate to increase blood flow (Bukworth & Dishman, 2002).

During emotional stress the above processes happen to a lesser extent. The nervous, cardiovascular and endocrine systems respond to emotional threat by activating the fight-or-flight response. This elevated sympathetic response to a perceived threat, which is not always real, is common in people with anxiety or depression. Thus a constant elevation of the stress hormones as a result of prolonged emotional strain make the tissue in the

brain, heart and blood vessels more vulnerable to injury or death (Bukworth & Dishman, 2002).

In a systematic review article Bunker *et al.* (2003) searched MEDLINE, Embase, and Psych-info data bases for articles relating stress as a psycho-social risk factor with CVD. Studies involving at least 100 subjects, publications in peer-reviewed journals after 1979, the inclusion of healthy populations or those with known CVD, and CVD outcomes including MI were selected. The reviewed literature ranged from 1960 to 2006. Evidence was graded according to the 1995 National Health and Medical Research Council. It was concluded (Bunker *et al.,* 2003) that strong evidence existed indicating depression as an independent risk factor for clinical CVD. The strength of the above association was rated the same as that of smoking and hypercholestrolemia for CVD (Bunker *et al.,* 2003).

In an investigation into the ability of psychosocial interventions to improve clinical outcomes in organic diseases, epidemiological studies were reviewed (Williams & Schneiderman, 2002). All the epidemiological studies documented the impact of psychosocial risk factors on incidence or prognosis of diseases. Samples included the analysis utilised in 1 000 or more patients. It was concluded (Williams & Schneiderman, 2002) that depression was associated with an increase in the rate of deaths of patients with CDs such as CVD, cancer and HIV/Aids. Schneiderman (2004) reported that one reason for depressed individuals to have CVD, were poor lifestyle habits such as smoking and the excessive use of alcohol. An increased production of, or an increased tendency for blood to clot, was presented as alternative reasons for the higher incidence of CVD in depressed individuals (Schneiderman, 2004).

There is also evidence that stress may hasten the onset of DM (ACSM*,* 2001). During stress, rising cortisol levels facilitate the use of blood glucose for energy by elevating blood insulin concentrations, and keep the immune system in check by inhibiting inflammation (Bukworth & Dishman, 2002). However, too much cortisol will overly suppress the immune system causing infection and chronically elevated insulin levels (Bukworth & Dishman, 2002). Stress thus compromises the secretory ability of the pancreas (ACSM*,* 2001).

In a study reporting on more than 12 000 individuals in the age groups 18 to 30, work stress was associated with high levels of blood cholesterol, systolic blood pressure and smoking behaviour (ACSM, 2001).

Although psychological risk factors were not measured in this study, the researcher acknowledges the above relationship that exist between psychological risk factors and CVD.

2.1.2.3. Behavioural or lifestyle factors associated with CVD

Behavioural or lifestyle factors include excess intake of saturated fat or a faulty diet, as well as excess intake of alcohol. Cigarette smoking, lack of exercise or inactivity and high-risk sex are also risk factors that contribute to CD (Kemper *et al.,* 2002). According to Kemper *et al.* (2002) physical inactivity and unhealthy dietary patterns, which include excess caloric intake, are second after tobacco in contributing to mortality. Booth *et al.* (2000) confirmed this statement, reporting that low fitness together with obesity may raise the risk of death two- to threefold. In their study quantitative estimates showed that physical inactivity was responsible for about one third of deaths due to it contributing significantly to the development of CVD, colon cancer, and Type 2 DM (Booth *et al.*, 2000).

Over the past century, the average amount of daily physical exercise has declined (Booth *et al.,* 2000). All of the most prevalent chronic diseases have an association with physical inactivity (Booth *et al.,* 2000). Thus, it may be concluded that important associations between lifestyle factors (diet and exercise) and CD exist (Schneiderman, 2004). Also, lifestyle and psycho-social factors are associated with CD outcomes. These factors influence the disease processes, and may play an important role in the prevention and the management of chronic diseases (Schneiderman, 2004).

2.1.3. Prevention and treatment of CD

In South Africa infectious diseases account for 28 percent of years of lives lost, while chronic diseases account for 25 percent (20 June 2004, p 2616). The Medical Letter on the CDC & FDA (20 June 2004, p2616) also reported that health services were being strained by this double burden, and that decision-makers had to be fully informed by up-to-date evidence on the burden and impact of CD on the country. In this effect, the timely diagnosis and prevention of CD was deemed very important. The following recommendations were made:

- Health systems had to be realigned.
- Policy leaders had to encourage trans-national corporations to improve the health of the employees
- Coordinated and focused emphasis had to be placed on tobacco use, unhealthy diets and physical inactivity (20 June 2004, p 2616).

Thus, it is clear that CD has been a burden for most countries, and is predicted to still be so in future (Booth *et al.*, 2000; 20 June 2004, p2616; WHO 2006, p 1107; Fourie & Steyn, 2006; Abegunde *et al.,* 2007). A two-fold action to "cure" CD is implied, namely: firstly the prevention of CD, and secondly the treatment of individuals who have already been diagnosed with CD.

2.1.3.1. Prevention of CD

In order to prevent CD, and more specifically CVD and Type 2 DM, it is necessary to implement strategies and/or programmes to control the risk factors associated with CD.

Results from a researched article (Pi-Sunyer *et al.,* Look *AHEAD* Research group, 2007) showed that weight loss in individuals with Type 2 DM leads to better glucose control and reduction in CVD risk factors. It described changes in CVD risk factors that took place after one year of intensive lifestyle changes, which included diet, exercise therapy and DM education (Pi-Sunyer *et al.,* Look *AHEAD* Research group, 2007). The results of the

intensive lifestyle intervention group (ILI) were then compared to individuals assigned to a usual-care intervention (DSE group) that included diabetes support and education (Pi-Sunyer *et al.,* Look *AHEAD* Research group, 2007). The specialists who were included in the intervention team were a dietician, exercise specialist, and behavioural psychologist. Participants also received DM education prior to being randomly assigned to the ILI or DSE groups. Significant improvements in the ILI group (*vs* the DSE group) in systolic and diastolic blood pressure, blood triglyceride levels, and HDL cholesterol were demonstrated. The ILI group also experienced a reduction in DM, hypertension and cholesterol-lowering medication (Pi-Sunyer *et al.,* Look *AHEAD* Research group, 2007).

Yusuf *et al.* (2004) indicated that risk factors associated with myocardial MI (in order of the most influential to the least influential on MI) were the following:

- Smoking
- DM
- Hypertension
- Psycho-social risk factors
- BMI

Approaches towards the prevention of coronary artery disease (CAD) should thus be based on the fact that a strong correlation exists between the above-mentioned risk factors and MI. Therefore, lifestyle modifications, such as giving up smoking, dietary modifications and exercise could be the cornerstones of the prevention of CVD in all populations worldwide (Yusuf *et al.,* 2004).

For the purpose of this literature review the researcher will focus on exercise as treatment for CD, specifically CVD and Type 2 DM.

2.1.3.1.1. CD prevention and exercise

According to Paffenbarger *et al.* (1984) many epidemiological studies have shown a strong inverse relationship between physical exercise and CVD

risk. Studies conducted on British transport workers and civil servants, as well as American stevedores and college alumni, have provided evidence that contemporary vigorous activity is accompanied by a lower risk of fatal and non-fatal CVD (Paffenbarger *et al.*, 1984).

According to Booth *et al.* (2000), the most prevalent CDs are associated with physical inactivity. It is known that physical exercise will benefit the human body in a multifactor manner. The authors (Booth *et al.,* 2000) thus stated that: "Indeed, with the possible exception of diet modification, we know of no single intervention with greater promise than physical exercise to reduce the risk of virtually all chronic diseases simultaneously*."*

Evidence linking exercise and physical activity to the prevention of the seven most common and costly CDs, namely: Type 2 DM, hypertension, coronary heart disease, stroke, cancer, osteoporosis and depression were reviewed (Ross & Rodriguez*,* 2000). In each of these, CD prevention was directly linked to exercise. The only exception was for cancer, where an indirect link was indicated. It was concluded (Ross & Rodriguez, 2000) that exercise could aid in the prevention for CVD. In a study by Forrest *et al.* (2000), the lack of physical activity was positively associated with adverse risk profiles for CVD in developing populations. Research by Gaillard *et al.* (2007), also indicated that modest aerobic fitness had a significant impact on reducing the overall risk for CVD.

Earlier research has shown that exercise may positively influence blood pressure, blood lipid levels, body composition, insulin sensitivity, and glucose tolerance (Dishman, 1994; Arakawa, 1996). It was therefore suggested that exercise could theoretically prevent CVD, or even death owing to cardiovascular reasons. A lack of activity may have the opposite results, which, in the long run may contribute to the development of CDs. In an editorial published by Koplan & Dietz (1999) the need for physical activity was stressed by the following statement: "... far too many people appear to have accepted the determinants of the problems of overweight and inactivity, and rely on 'treatments' in the forms of a myriad ineffective diet remedies and nostrums. As with many health issues, it is essential to emphasize prevention as the only effective and cost-effective approach''.

2.1.3.2. Treatment of CD

2.1.3.2.1. Medical solutions

In searching for a cure for CD the tendency is to turn to physicians and biomedical scientists. In the last 75 years, definite progress has been made concerning the understanding of the mechanisms underlying the treatment of CD (Booth *et al.,* 2000). According to the Third Report of the National Cholesterol Education Programme (NCEP, 2002, p 3143), evidence exists that cholesterol-lowering drug treatment should lower the risk of CVD. This is confirmed in a review article by Mason *et al.* (2009) that found statin drug therapy to reduce LDL cholesterol and indirectly decrease the risk for major vascular events. However, it emphasised that lifestyle modifications, together with drug therapy, were necessary to successfully treat elevated LDL cholesterol in patients with CVD (Mason *et al.,* 2009).

2.1.3.2.2. Exercise

To define the term "exercise", the definition of physical activity should be clarified. According to Dishman *et al.* (2004) physical activity is any bodily movement produced by skeletal muscle that results in energy expenditure and includes occupational work, chores, leisure activity, playing sports and exercise that is planned for fitness or health purposes. Thus exercise forms part of physical activities, and to become physically fit, regular exercise is required (Ross & Rodriguez*,* 2000).

In the present study the focus will be on exercise as a tool to combat the progression of CD. Specific emphasis will be placed on compliance with exercise programmes as an indicator of the anticipated improvements in clinical and physical parameters of medical-aid members registered on a chronic-disease management programme. The diseases reported on in this study will be cardiovascular-related conditions and Type 2 DM. According to the ACSM Resource Manual (ACSM*,* 2001), the physiological factors that contribute to the afore-mentioned chronic diseases are the following:

- Hypertension
- High blood lipid levels

- High blood glucose levels,
- High insulin levels
- Unfavourable body composition

The association between these factors, CVD and Type 2 DM is confirmed by the following research:

- Forrest *et al.* (2000): The purpose of this study was to investigate the role of physical activity in the development of CVDs in a large population (N = 799) of civil servants from Benin City, Nigeria. Physical activity was measured as the average amount of hours per week spent on occupational and leisure activities over the time period of a year. This included time spent walking or biking to work. Clinical and physical measurements recorded BMI, waist-to-hip ratio, blood pressure, plasma insulin level, serum lipid profiles and diet. In the men significant inverse correlations between physical activity and CVD risk factors (weight, BMI, waist-to-hip ratio, blood pressure, serum insulin, total cholesterol, LDL, HDL, and triglycerides) were reported. The correlations were inconsistent in the women. In this trial the male participants were more active than the female participants. It was concluded that a lack of physical activity was associated with adverse risk profiles for CVD.
- Kolbe-Alexander *et al.* (2008): Partly, the aim of this study was to determine the health and CVD risk profile of South African employees (n = 1954) reporting for health-risk assessments. Clinical measures included total blood cholesterol (finger-prick) test, blood pressure, and BMI. The participants' health-related age was calculated by using an algorithm incorporating relative risk for all-case mortality associated with smoking, physical activity, fruit and vegetable intake, BMI, and total blood cholesterol. Physical activity was measured against a norm of 150 minutes per week of moderate to vigorous intensity. Results indicated that participants who did not comply with the afore-mentioned norm of physical activity also had insufficient fruit and vegetable intake, smoked, were overweight or obese, had increased total blood cholesterol concentrations, and elevated blood pressure. It was

concluded that an increase in habitual physical activity may lower the overall risk profile of South African employees.

- Wallace *et al.* (2008): This study reported on the prevalence of CVD risk factors amongst supported adults with intellectual disability attending a clinic for the elderly (n = 155). Results indicated that participants who exercised less than 150 minutes a week were hypertensive, had elevated total cholesterol levels, elevated LDL levels, elevated triglycerides and were overweight or obese.

In South Africa 40 percent of all adult deaths are due to chronic diseases of lifestyle. A survey (Steyn & Fourie, 2006) conducted between December 2002 and May 2003 as part of the World Health Survey, indicated that less than one third of South Africans complied with the ACSM's recommendation that one should participate in at least 30 minutes of moderate-intensity activity on most days of the week. According to Steyn & Fourie (2006) this recommendation indicates that the benefits of exercise are also influenced by the frequency, duration, and intensity of exercise.

When designing an exercise program, the type of exercise (aerobic or anaerobic) and the mode of exercise (intensity, frequency and duration) are important (Balady *et al.,* 2000; Baechle & Earle, 2009). In the present study the design of the individuals' exercise programmes will not be analysed in terms of validity. However, the researcher as a biokineticist acknowledges that the afore-mentioned is imperative and affected the results of the study as will be discussed in Chapter 5. To investigate exercise as treatment for CVD risk factors, research articles reporting on type and mode of exercise will be discussed.

2.1.3.2.2.1. Type of exercise

To define aerobic and anaerobic exercises, understanding the use of energy in the biological system is essential (Baechle & Earle, 2009). However, this literature review will only highlight the basics of energy metabolism since its focus is on CD.

Energy can be defined as the ability or capacity to perform work, and may be classified as mechanical, chemical, heat, nuclear, etc. Within the context of the biological systems, the conversion of chemical energy into mechanical energy is relevant to movement (Baechle & Earle, 2009).

Adenosine tripshosphate (ATP) allows for energy transfer from exergonic reactions (energy requiring reactions, that are catabolic) to endergonic reactions (requiring energy, including anabolic reactions). Thus, ATP provides energy for muscular contraction and in the end human movement (Baechle & Earle, 2009). There are three basic biological energy systems namely:

- The phosphagen system: An anaerobic process, which occurs in the relative absence of molecular oxygen. It provides ATP very rapidly and supports maximal-intensity activities.
- Fast and slow glycolysis: The anaerobic breakdown of CHO (either glycogen stored in the muscle or glucose delivered by the bloodstream) to rapidly replenish ATP during high-intensity activities.
- The oxidative system: An aerobic process which requires molecular oxygen. This is the primary source of ATP during rest and low-intensity activities.
  Each of these systems can be modified by specific training regimen (Baechle & Earle, 2009).

2.1.3.2.2.2 Mode of exercise programmes

The intensity of an exercise programme refers to the amount of effort expended. The duration of exercise is the period of time that an exercise session lasts, and the frequency is the number of times exercised per week (Goldberg & Elliot, 2000). The Intensity and duration of exercise are inversely related. The same results in cardiorespiratory fitness can be achieved by either low-intensity and longer duration or high-intensity and shorter duration (Balady *et al.,* 2000)

Table 2-1: Classification of physical activity intensity based on physical activity lasting up to 60 minutes (Balady *et al.,* 2000)

Intensity	Percentage HRR or VO$_2$ R	Percentage HR$_{max}$	Rating of perceived exertion (RPE)
Very light	Less than 20	Less than 35	Less than 10
Light	20 to 39	35 to 54	10 to 11
Moderate	40 to 59	55 to 69	12 to 13
Hard	60 to 84	70 to 89	14 to 16
Very hard	85 or more	90 or more	17 to 19
Maximal	100	100	20

- HRR or VO$_2$ R indicates the heart-rate reserve or oxygen-uptake reserve and is one of the methods to prescribe a target heart-rate range for exercise.
- Percentage of HR$_{max}$ is the percentage of maximum heart rate. This is also a method to set a target heart rate for exercise (Balady *et al.,* 2000).

A linear relationship exists between heart rate (HR) and percentage VO$_{2max}$ (the maximum ability of the cardiovascular system to deliver oxygen to all working muscles and the ability of the muscles to utilise this oxygen) (Balady *et al.,* 2000). Thus, it is necessary to monitor HR during an exercise session because an individual should exercise at a certain percentage of his or her HR$_{max}$ (intensity) to achieve certain exercise goals. Maximum HR decreases with age (Balady *et al.,* 2000).

Exercise duration is determined by the intensity of the exercise and depends on the exercise goals. Usually, the lower the intensity, the higher the duration and *vice versa* (Balady *et al.,* 2000). When exercising at 70 percent to 85 percent of HR$_{max}$ for 20 to 30 minutes (excluding warm-up and cool-down) health, fitness and weight-management goals can be met. The duration of an exercise session may also progress as an individual adapts to it.

According to the ACSM, frequency of exercise should be set at three to five days per week. The lower the intensity of exercise, the higher the frequency should be (Balady *et al.,* 2000)

2.1.3.2.2.3. Exercise modalities and CD management

Both aerobic and/or resistance training can be performed for the treatment of hypertension (Goldberg & Elliot, 2000). It is advised (Balady *et al.,* 2000; Goldbeg & Elliot, 2000) that the intensity be 65 percent to 75 percent of HR_{max} or a RPE Rate of between two and three (where zero is no effort and above10 is absolute maximum effort). The duration should be 20 to 30 minutes at a frequency of at least three times per week (Goldberg & Elliot, 2000). The ACSM guidelines for exercise testing and prescription (Balady *et al.,* 2000) also suggest aerobic and resistance exercise for the treatment of hypertension. Resistance training should be done at low resistance and high repetitions (Balady *et al.,* 2000). Intensity is recommended to be at 40 percent to 70 percent of VO_{2max} (%HRR) for the duration of 30 to 60 minutes three to seven days per week (Balady *et al.,* 2000).

Arakawa (1996) carried out nine controlled comparative studies over 10 years. At an intensity of 50 percent of VO_{2max}, training three times per week for 60 minutes per session, results indicated a mean decrease of 11 mmHg in resting systolic pressure and 6 mmHg in resting diastolic blood pressure. Improvements in blood lipid levels, blood glucose levels, and insulin sensitivity were reported (Arakawa, 1996).

According to ACSM's guidelines for exercise testing and prescription (Balady *et al.,* 2000) exercise therapy for hyperlipidemia or for decreasing blood lipid levels should be three to seven days per week training at an intensity of 40 percent to 70 percent of VO_{2max}. The duration must be 20 to 40 minutes per session. Goldberg and Elliot (2000) suggested aerobic or resistance training to lower blood lipid levels. An intensity of 75 percent to 85 percent of HR_{max}, training for at least 20 minutes was suggested. The exercise frequency that was suggested was a minimum of four days for aerobic training and three days for resistance training (Goldberg & Elliot, 2000).

A five-year study (Aadahl *et al.,* 2009) was done on 4 039 men and women from Denmark (ages 30 to 60 years) with the aim of evaluating the association between self-reported physical activity (obtained *via* a

questionnaire, by the end of the five-year period) and changes in serum lipids and other CVD risk factors (waist circumferences, blood pressure and body weight). A total physical activity variable was calculated by summing responses to physical activity questions and converting it into hours per week exercised. The hours per week (5-day week) spent exercising were calculated and physical activity status grouped into four categories, namely < 2 hours/week (low intensity), 2 to 3,9 hours/week (moderate intensity), 4 to 6.9 hours/week (high intensity), and > 7 hours / week (very high-intensity). Results (Aadahl *et al.,* 2009) indicated that those individuals who changed their physical activity level from a low-intensity level and from a moderate-intensity level, respectively, to a higher-intensity level, demonstrated decreased blood total cholesterol, LDL and triglyceride levels. In another study, 128 healthy 40 to 65 year old men were classified as either being physically active (exercising at least 30 minutes at moderate intensity on most days of the week) or sedentary (Perkins, 2009). Results indicated no significant differences in total cholesterol or triglyceride levels in the men who were physically active, although it is reported that intervention studies were needed to clarify these preliminary findings (Perkins, 2009).

Insulin is a hormone produced by the pancreas. It controls the entry of glucose in the blood stream into the body's cells. The release of insulin is stimulated by a rise in blood glucose levels due to the ingestion of carbohydrate-rich foods and drinks. Blood glucose levels should remain constant, as either too high or too low levels are detrimental to the body (Goldberg & Elliot, 2000). Type 1 DM usually occurs among young children and adults. It results from the destruction of the insulin-producing cells in the pancreas. Type 2 DM usually results from poor lifestyle habits such as the over-consumption of refined sugars. In Type 2 diabetics, insulin is still being produced, but the body cells are resistant to its blood glucose lowering effects (Golberg & Elliot, 2000). Any changes in insulin action will affect blood glucose levels.

The role of physical activity in 11 children with insulin-dependent DM was assessed by Defrin *et al.* (2004). The intervention entailed that individuals exercised for 20 minutes on either a bicycle ergometer or by means of free exercise. Blood glucose levels were measured both before

and after exercise. Results indicated that only cycling caused a decrease in blood glucose levels (Defrin *et al.,* 2004).

Data from prospective cohort studies and controlled intervention trails regarding exercise and its efficiency in preventing Type 2 DM were reviewed by Gill and Cooper (2008). The authors searched MEDLINE for topic-related articles from 1966 to September 2007. The cohort studies that were selected, reported on the incidence of DM with the effect of physical activity being the primary purpose of the study. Diabetes mellitus prevention studies were only included for analyses if the intervention period lasted a minimum of 12 months. Physical activity had to be a component of these studies and the development of DM the end point. Twenty longitudinal cohort studies consistently indicated that a high level of physical activity was associated with a reduced risk of Type 2 DM (Gill & Cooper, 2008). Moderate (2 to 4 metabolic equivalents per hour) to vigorous (5.5 to > 10 metabolic equivalents per hour) intensity activities, as well as regular low-intensity (2 metabolic equivalents per hour) activities indicated protection against the onset of DM (Gill & Cooper, 2008).

Table 2-2: Exercise modalities for treatment of diabetes mellitus

TYPE OF DIABETES MELLITUS	DAYS	MINUTES	INTENSITY
(Goldberg & Elliot, 2000) Type 1	Minimum 3	25 minutes	70 percent of HR_{max}
Type 2 (normal weight)	4 to 7days	30 min	70 to 85 percent of HR_{max}
Type 2 (over-weight)	4 to 7days	30 min	60 to 70 percent of HR_{max}
ACSM (Balady *et al.* 2000) Type 1 and 2	4 to 6 days	30 min	50 to 85 percent of VO_2max
Type of exercise suggested is aerobic exercise combined with resistance training. (Exercise and Sport in Diabetes, 2005).			

The following research studies reported on the efficacy of exercise as treatment for obesity as risk factor for CVD:

- Nicklas *et al.* (2009) assigned 112 women presenting with abdominal obesity, and under equal caloric restriction, to either moderate or

vigorous intensity aerobic exercise groups. Both groups participated in three days per week treadmill walking, at a moderate intensity of 45 to 50 percent of HR_{max} or at a vigorous intensity of 70 to 75 percent of HR_{max}. Both groups showed a similar loss in abdominal fat.

- Kvaaik *et al.* (2009), in a prospective cohort study, utilised data that was collected from 1 016 individuals between 1979 and 2006. The mean age of the participants was 40 years in 2006. The aim was to evaluate the influence of physical activity during childhood and later in life on CVD risk factors (including obesity). Measurements were taken in 1979, 1981, 1991, 1999 and 2006. In 1979 (mean age 13 years), 1981 (mean age 15 years) and 1999 (mean age 33 years), an inverse relationship was demonstrated between physical fitness and obesity (and blood pressure). It was concluded that there seemed to be an inverse relationship between physical fitness and CVD risk factors during childhood. However, this benefit/relationship diminished into middle age.

- Farpour-Lambert *et al.* (2007) evaluated the effect of a three-month exercise programme on CVD risk factors and ambulatory blood pressure in obese children. Participants were divided into an exercise and non-exercise group. There were no dietary interventions. The exercise programme consisted of aerobic exercises (games, swimming and walking), performed at a moderate intensity (55 to 65 percent of VO_{2max}) and for 180 minutes per week for 12 weeks. Results indicated a significant improvement in ambulatory blood pressure, body fatness and cardiorespiratory fitness. It was concluded that obese children should participate in moderate exercises to reduce their CVD risk. Borer (2008) reviewed evidence-based publications to evaluate the magnitude of weight and fat loss in response to exercise without any changes in food intake. It was concluded that 400 kcal daily energy expenditure would result in a loss of 0.9 kg/month, which was only one third of the amount expected. A further observation was that exercise without dietary changes did not result in rapid fat loss, but that increased fitness may convey many health benefits (Borer, 2008).

Table 2-3: Exercise modalities for treating obesity

	AUTHORS	DAYS PER WEEK	DURATION OF EXERCISE SESSION	INTENSITY OF EXERCISE
R e s e a	Balady *et al.* (2000)	5 days	40 to 60 minutes	40 to 70 percent of VO_2max
	Goldberg and Elliot (2000)	3 days	30 minutes	70 percent of HR_{max}
	Aerobic and weight training combined are recommended for obese individuals (Goldberg & Elliot, 2000)			

Research by Haram *et al.* (2009) evaluated the effectiveness of aerobic interval training *versus* continuous moderate aerobic exercise to reduce CVD risk factors in animals, namely rats. One group performed treadmill exercises one hour per day, five days per week, while the moderate-intensity training group ran continuously for one and a half to two hours per day for five days per week at 70 percent of VO_{2max}. The report indicated that interval training was more effective in reducing hypertension values and increasing in HDL-cholesterol than continuous aerobic training. Both types of exercise were equally effective in reducing body weight, body fat, triglyceride levels and free fatty acids (FFA). Both the high- and moderate-intensity exercise groups demonstrated improved insulin action, although the reaction was stronger in the interval-training group. Both groups reduced fasting glucose levels and increased glucose tolerance to a similar extent (Haram *et al.*, 2009).

Thirty-four sedentary adults participated in an eight-week low-intensity exercise training study (Butchler, 2008). The aim was to investigate whether or not low-intensity exercise would beneficially affect plasma lipid levels. Participants were divided either into a control (sedentary) group or an exercise group. The exercise programme consisted of walking 10 000 steps three times a week. Results indicated significant reductions in total blood cholesterol levels and significant increases in HDL-cholesterol (Butchler, 2008).

Thus, it cannot be denied that exercise may decrease the incidence of CD and, thereby, mortality rates. The question then arises whether or not benefits of exercise will last without regular training.

2.2.   EXERCISE COMPLIANCE IN CHRONIC DISEASE MANAGEMENT

According to the ACSM, exercise training should be conducted at a moderate to vigorous intensity for a minimum of three times per week for 20 minutes at a time (Franklin *et al.,* 1998).   Another source (McArdle *et al.,* 2001) recommends 30 minutes per day of moderate-intensity physical activity accumulated on most days of the week.

To derive benefits from any exercise programme, compliance is crucial (Covera-Tindel *et al.,* 2004). A third of the patients in exercise-training studies are non-compliant with the exercise protocol (Covera-Tindel *et al.,* 2004). According to Dishman (1988) dropout rates for most organised exercise programmes are 50 percent within the first 3 to 6 months. Most health-care providers are aware that compliance with an exercise regimen is critical to the patient's recovery or improvement of clinical parameters.

Based on the above, compliance with an exercise regimen, also referred to as exercise maintenance, has been a topic of recent interest among health-care providers (Seckin *et al.,* 2000). According to Frederich *et al.* (1998), health-care providers must thus be taught to manage adherence to exercise successfully, and to enhance patient motivation.

According to Alm-Roijer (2004) compliance with lifestyle changes is a complex and multi-faceted problem, and further research from a variety of perspectives is required to improve the understanding of compliance behaviour, and to deal constructively with it. A lack of valid and reliable measurement tools to assess the degree of patient compliance has also been noted (Robertson & Keller, 1992).

According to Dishman (1994) interventions carried out to increase physical activity, were short-lived and without permanent change in sustained activity. In a review publication (Hudon *et al.,* 2008) on interventions promoting

physical activity, MEDLINE, CINAHL and EMABSE were searched from 1966 to 2006. Of the 4 858 articles found, 62 were assessed and three were selected for further analyses. These were randomised, controlled or quasi-experimental controlled studies. Single-factor interventions to promote physical activity in adults with at least one CD formed part of the selection. The report (Hudon *et al.,* 2008) showed that in two of the three studies the interventions (Marshall *et al.,* 2005; Van Sluijs *et al.,* 2005) did not promote physical activity. Only one report showed a positive short term (one month) effect. It was concluded (Hudon *et al.,* 2008) that, due to varying results, more randomised and controlled studies were needed to intensively evaluate the efficacy of exercise-promoting interventions.

Exercise compliance as a behaviour pattern also requires attention. In a 10-year retrospective review (Steyn & Fourie, 2006) one of the research priorities that were listed for physical activity in South Africa, was to identify factors that could influence physical activity behaviour in various communities. This study also reported that the Department of Health set the promotion of healthy lifestyles in the general South African population, and changes from risky behaviour particularly among the youth as strategic priorities for the period 2004 to 2009 (Steyn & Fourie, 2006).

Exercise compliance as such is a complex construct, and thus there must be appreciation for the role that attitude, behavioural patterns and social skills play with adopting and maintaining regular exercise (Dishman, 1994). Also, the many factors influencing exercise compliance (Robertson, *et.al.*1992; Van Norman, 1998; Andersen, 1999; Hartigan *et al.,* 2000; Seckin *et al.,* 2000; Fraser & Spink, 2001; Burbank *et al.,* 2002) should be taken note of. However, due to the nature of the present study, namely a retrospective analysis of data captured on the Best Med Medical Aid and Access Health (SA) database, the factors following below that influenced exercise compliance could not be controlled. For the purpose of a comprehensive literature review, these factors will be reported on.

2.2.1. Factors influencing exercise behaviour

2.2.1.1. Self-efficacy

Self-efficacy is the belief that one has the ability to perform behaviours that will produce desired outcomes, despite situational difficulties (Dishman, 1994; Fraser & Spink, 2001). According to Hartigan *et al.* (2000), a reduction in a patient's perception of helplessness regarding exercise, together with reinforcing his or her perception of self-efficacy for exercise, can improve compliance with exercise.

Research by Pinto (2009) stated that baseline self-efficacy was a positive predictor for exercise adherence. In a study by Maddison and Prepavessis (2004), a social cognitive model was tested. This was based on the self-efficacy theory and intended to predict exercise compliance. It was concluded that positive and meaningful relationships were found among self-efficacy, intention and exercise behaviour. It was also stated (Madison & Prepavessis, 2004) that these social cognitive variables act as determinants rather than consequences of exercise behaviour. According to Conn *et al.* (2003) self-efficacy was the most significant predictor for exercise behaviour in older adults.

A review article by Woodgate & Brawley (2008) suggested the following topics for future research on self-efficacy:

• Self-efficacy as an outcome of rehabilitation
• Self-regulatory efficacy as a measure for behavioural change
• Moderators (ie age and gender) of self-efficacy
• Self-efficacy relative to compliance with exercise.

The concept self-efficacy is also often used within other social-cognitive models, as will be discussed in the remainder of this literature review.

2.2.1.2. Social support and group cohesion

In this text, social support refers to the support an individual receives from his or her family and friends while taking part in a disease-management programme. Group cohesion refers to the support an individual receives from fellow participants.

According to Van Norman (1998) social interaction fostered compliance and adherence to exercise, in a group of older individuals. Fraser and Spink (2001) examined the role of social support and group cohesion in a group of females (n = 49), who were required to exercise for health-related reasons. Exercise compliance and dropout behaviour were assessed. Participants with a high exercise attendance also presented with high scores in social support and group cohesion. In the prediction of exercise attendance, it was concluded (Fraser & Spink, 2001) that group cohesion and social support were convincing variables. In a research study by Estabrooks and Carron (1999) the relationship between group cohesion and exercise adherence in older adult exercisers was examined. Results indicated that group cohesion benefited exercise-class attendance in both the short and long term, and would be valuable to develop in groups of older individuals. A more recent study (Little & Lewis, 2006) explored attitude, social support and barriers influencing long-term exercise adherence among five older patients with cardiac disease. Results indicated that the patients valued the benefits of health-related exercise, and thus demonstrated a positive attitude towards exercise. Barriers for long-term exercise adherence were identified as poor health and body limitations. Support from family, friends and health professionals proved important for long-term exercise compliance (Little & Lewis, 2006).

2.2.1.3. Self-determination theory

According to the self-determination theory, human motivation "moves" along a continuum, in that it varies in the extent to which it is either automatic (self-determined) or controlled (Wilson *et al*., 2002). Thus, behaviours may be initiated freely and come from within oneself or may be controlled or regulated by external forces (Wilson *et al.,* 2002). Research by Fuzhong (1999) studied the development and validation of a multifaceted 31-item

exercise-motivation scale, and was based on the self-determination theory. Results provided empirical support for applicability of the self-determination theory in the context of exercise (Fuzhong, 1999). The use of the self-determination theory in the context of exercise adherence is also supported in more recent studies (Wilson *et al.,* 2002; Edmunds *et al.,* 2006).

2.2.1.4. Internal and external locus of control

An internal locus of control reflects the individual to be in control and responsible for his or her actions, while an external locus of control refers to external factors outside the individual being responsible and in control of his or her actions (Potgieter, 1997). Patients with an internal locus of control, ie those who believe that their health depends on their own behaviour, appear to be more compliant with exercise than those who think they can do little by themselves to improve their condition, and therefore rely on fate, institutions, medicine or other people, for example a physician or therapist to improve their health status or condition (Robertson & Keller, 1992).

2.2.1.5. Perceptions

Perception refers to the ability of the mind to allocate sensory information to an external object as its cause, or intuitive recognition of a truth (The Concise Oxford dictionary, 1990). According to Van Norman (1998) compliance with exercise in older adults is determined by their perception of exercise and the need thereof, which can then influence their exercise behaviour.

2.2.1.6. Quantifiable progress

To show that progress has been made, it must be quantitative. Thus measurable variables relevant to the progress that one wants to display need to be evaluated. In a study by Hartigan *et al.* (2000) no factors could be identified that definitely changed or reinforced exercise behaviours, although quantifiable progress was one of the potential factors identified.

In the context of this retrospective study, variables were measured at three-month intervals over a period of time, and the researcher acknowledges that

being measured might thus have influenced the participants' exercise compliance.

2.2.1.7. Health education and feedback

McAuley *et al.* (1994) reported that patients who were receiving maximum information regarding their exercise capabilities were more likely to adhere to recommended exercise programmes than those who did not receive such information. Additionally, positive feedback for successful completion of exercises and the progress that was made in the treatment, resulted in patients being more adherent to prescribed exercise programmes (Hartigan *et al.,* 2000)**.** Thus in a programme where education concerning a patient's medical condition, as well treatment (exercise, drugs and diet), is given, a positive effect on compliance with each one of these may be expected.

2.2.1.8. Lifestyle

Andersen (1999) defines lifestyle as the particular way of life of an individual, and in this context the way of life concerning an individual's health. It was found (Andersen, 1999) that promoting an active lifestyle, rather than focusing on an exercise regimen, would increase adherence to an exercise programme or regimen.

2.2.1.9. Anxiety and distress

Anxiety and distress can be defined as a state of excessive uneasiness. According to Seckin *et al.* (2000) positive correlations between compliance with the exercise and severity of disease and pain scores were found. Patients whose disease severity was classified as being moderate, and who exibited higher pain scores, complied better with home exercises. According to Frederich *et al.* (1998) level of distress may be a strong motivator for adherence at the start of an exercise programme. Thus, patients with more serious illnesses tend to be more compliant. Unfortunately this power evaporated as the research continued. Thus, if a certain level of distress could be maintained during the exercise programme it may positively influence adherence to training. However, such a practice would be ethically questionable.

2.2.2. Exercise-behaviour models

From some of the factors discussed so far, theoretical models have been developed to predict changes in health behaviour. Examples of these models are the Health Belief Model and Prochaska's Transtheoretical Model or Stages of Change Model (Kemper *et al.,* 2002). These models postulate that if one wants to promote a healthy lifestyle or change one's health behaviour, the long-term changes should be aimed at relevant determinants of health behaviour. These determinants, for example, are personality traits, knowledge, attitudes, social support, self-efficacy and perceived barriers (Kemper *et al.,* 2002). The theoretical models to be discussed are based on the following premises:

- Individuals will adopt a certain behaviour to prevent or control a disease, based on their perception that the disease is a threat to them, him, or her and that the behaviour adopted will reduce this threat.
- Individuals will make changes in lifestyle behaviour such as exercise patterns if they have a psychological readiness to make those changes, despite the fact that they may know that if changes are not made, it may be detrimental to their health (Dishman, 1994).

2.2.2.1.   Health Belief Model (HBM)

The Health Belief Model (HBM) was developed in the early 1950s by a group of social psychologists. The basic components were derived from psychological and behavioural theories. The value placed by an individual on a particular goal, and the individual's estimate of the likelihood that a given action will achieve that goal, are the two main variables in this model (The handbook of health behaviour change 2nd edition, 1998).

In the health-behaviour context this model states that an individual will adopt a certain behaviour to prevent or control a disease, based on the individual's perception that the disease is a threat to him or her and that the behaviour adopted will reduce this threat. The perceived efficacy of such an action then depends on the individual's perceived benefits, minus the perceived barriers of the preventative action (Dishman, 1994).

IDIVIDUAL PERCEPTIONS   MODIFYING FACTS   LIKELIHOOD OF ACTION

DEMOGRAPHIC VARIABLES   PERCEIVED BENEFITS
(AGE, SEX, RACE, ETC.)   OF PREVENTATIVE ACTION
SOCIO-PSYCHOLOGICAL VARIABLES *MINUS*

                                                        PERCEIVED BARRIERS
                                                        TO PREVENTATIVE ACTION

PERCEIVED SUSCEPTIBILITY
TO DISEASE "X"   LIKEHOOD OF TAKING RECOM-
                               PERECEIVED THREAT OF   MENDED PREVENTATIVE
                               DISEASE "X"   HEALTH ACTION
PERCEIVED SERIOUSNESS
(SEVERITY) OF DISEASE "X"

                               CUES TO ACTION
                               ➢ MASS-MEDIA CAMPAIGNS
                               ➢ ADVICE FROM OTHERS
                               ➢ REMINDER POSTCARD FROM PHYSICIAN
                               ➢ IILNESS OF FAMILY MEMBER OR FRIEND
                               ➢ NEWSPAPER OR MAGAZINE ARTICLE

Figure 2-1:The Health Belief Model

(The handbook of health behaviour change 2nd edition, 1998.).

According to Robertson *et al.* (1992) compliance is related to a patient's health beliefs. A direct relationship is indicated between compliance with the exercise programme and benefits in terms of reduced pain and disability (Andersen, 1999). A study by Girvan and Reese (1990) examined exercise behaviour of students (n = 159) at an university. The purpose was to determine whether or not the HBM would predict aerobic exercise behaviour. Results indicated that a 24 percent variance in exercise compliance between exercisers and non-exercisers could be explained by the HBM (Girvan & Reese 1990). Frewen and Schomer (1994) set out to determine both the common and different factors associated with compliance and non-compliance to a weight loss and cardiac rehabilitative programme, respectively. A HBM questionnaire was set up to accomplish the above aim. Results (Frewen & Schomer, 1994) indicated that short-term compliance was linked to enjoyment of the exercises, self-motivation and need to remain on the programme. Non-compliance was due to inconvenience, early starting time and ability to continue health recommendations independently.

2.2.2.2. Trans Theoretical Model (TTM)

The TTM was developed by Proschaska and DiClimente (1994). An analysis of leading theories of psychotherapy and behavioural change led to the development of the TTM. This model aims to facilitate behaviour changes by using stages of change and process of change (Gulliot *et al.*, 2004) The TTM originated in the study of addictive behaviours, but can be extended to other areas, including exercise adherence (Gulliot *et al.*, 2004). It was developed to understand how individuals may change their behaviour. Initially smokers who were attempting to change their behaviour without professional help were studied. Research indicated that the self-changers (smokers) taught themselves to progress through specific stages as they struggled to reduce or remove high-risk behaviours (Dishman, 1994). The concept of stages reflects the temporal dimensions in which change unfolds (Dishman, 1994). The stages give direction or temporal dimension to constructs such as self-efficacy, locus of control, decisional balance, barriers and facilitators, reinforcers and punishers, cues and consequences, cognitions and norms (Dishman, 1994). They can be characterised as falling between traits and states (Dishman, 1994). The traits are constructed as stable or not open to change, and the states are readily changed and typically lack stability (Dishman, 1994). Thus, stages can be stable and dynamic in nature. Although a stage can last for a long period, it is open to change (Dishman, 1994). Thus, stable over time, yet open to change. The TTM proposes that behavioural change takes place while moving through a series of the following six stages:

1. Pre-contemplation (those people who are not thinking about changing their behaviour)
2. Contemplation (those people who are thinking about changing their behaviour at some time within the next six months)
3. Preparation (those people who have decided to change their behaviour, or who are attempting to do so)
4. Action (those people who have overtly changed their behaviour, but for less than six months)
5. Maintenance (those people who have overtly changed their behaviour and maintained these changes for longer than six months)

6. Termination (the stage where there is no temptation to go back to old behaviours and 100 percent self-efficacy in all previously tempting situations was reached) (Dishman, 1994; Cardinal, 1997).

In the early 1990s the TTM was applied to exercise behaviour (Marcus *et al.,* 1992; Marcus & Simkin, 1993). Since then, several researchers have used the TTM to develop exercise interventions (Burbank *et al.*, 2002). In a study by Bock *et al.* (1997) individuals (n = 62) took part in a cardiac-rehabilitation programme. Models of behavioural change, such as the TTM were used to understand the process of exercise adoption and change. The participants (Bock *et al.,* 1997) reduced their exercise adherence after the 12-week intervention. However, significant progress was made in the explanation of exercise behaviour that was related to self-efficacy, and a reduction in the perceived barriers. Though the use of the cognitive process, namely the benefits of exercising (Stages one and two of the TTM) could not be explained. Thus, the authors (Bock *et al.,* 1997) suggested that exercise-compliance interventions could also focus on cognitive processes in addition to behavioural strategies in order to maintain health behaviour after cardiac rehabilitation.

From the literature (Marcus *et al.,* 1992; Marcus & Simkin, 1993; Bock *et al.,* 1997; Burbank *et al.,* 2002) it is clear that psycho-social factors may influence exercise compliance, and should be considered when attempting to manage compliance. Thus, in the present study it was expected that –

- individuals who believed that they only had a certain amount of physical fitness or ability would be more likely to be non-complaint in their exercise behaviour; and that
- individuals who believed that through effort they could become physical fitter, and thereby change their fitness status would be compliant with exercise behaviour.

These assumptions were based on a social-cognitive model developed by CS Dweck (Lochbaum *et al.*, 2006)

2.2.2.3. Implicit Theory Scale

The questionnaire on Implicit Theory Scale (ITS) is based on a social cognitive model of Dweck and Leggett (Henderson & Dweck, 1989;

Lochbaum *et al.,* 2006). The researcher (CS Dweck), argued that it was the mindset of athletes that distinguished great athletes from champions, thus the following two self-theories were proposed to develop the ITS:

- The first theory is referred to as the Entity Theory; where individuals have a fixed mindset regarding their abilities to perform a certain skill (eg mathematics, sport, intelligence, etc). These individuals believe that they only have a certain amount of talents or skills and that this cannot be changed. These individuals will not attempt to learn to improve their talents or skills.
- The second theory is the Incremental Theory of Ability. These individuals believe that their abilities can grow and develop throughout their lives. They believe that through effort and learning, they can become more talented or smarter (Dweck, C.S. 2005).

In a study by Spray (2006), the authors demonstrated a causal link between each theory and the individuals' belief about their ability to perform a certain task (for both theories). This was done in a sporting context. To apply this theory to regular physical activity, researchers (Lochbaum *et al.,*2006) used this social-cognitive theory to explain self-reported strenuous exercise participation. Although there were no causal statements, the researches stated that it was clear that interventions should be aimed at promoting the Incremental Theory.

To conclude, all of the above-mentioned models have been used successfully and unsuccessfully in the promotion of for exercise behaviour, or in explaining it. It seems that there is no universal consensus on what is the most preferred or effective theoretical basis for physical activity promotion. Thus, the application of more than one model in a research study might provide suitable answers regarding compliance and non-compliance with exercise (exercise behaviour).

CHAPTER 3

RESEARCH METHODOLOGY

3.1. RATIONALE, AIM AND OBJECTIVES OF THE STUDY

3.1.1. Rationale

From the literature available, it is clear that, not only is there a need for research in exercise compliance, but also a need for its management (Frederich *et al.,* 1998; Seckin *et al.,* 2000). This researcher views compliance with an exercise regimen as a problem that is based on her own experience in chronic-disease and lifestyle management. This typically affects the financial outcomes, not only of the patient, but also of the medical-aid scheme of such an individual (Council for Medical Schemes, Annual Report 2004-5 pg 54, REF Contribution table, 2005; Fourie & Steyn, 2006). Limited data, if any, that is relevant to a chronic-disease and lifestyle management cohort is available, specifically in the South African context.

In the current study the researcher analysed data collected from 400 participants of the Best Med/Access Health Chronic Disease & Lifestyle Management Programme (BM/AH-DM Programme). Thus, a retrospective data analysis was done.

Best Med Medical Aid entered into a contract with Access Health (SA) to manage the above-mentioned programme. The researcher was contracted as biokineticist by Access Health to work on the BM/AH-DM Programme. Thus, over a three and a half year period, the researcher, in her capacity as biokineticist, managed all the exercise programmes and collected all the data herself.

A non-equivalent group design (Thomas & Nelson, 1996) (most commonly used quasi-experimental design) was used in this study. It required a pre-test and post-test for an experimental (compliant) group and control (non-compliant) group, based on their exercise compliance. The groups were not created through random assignment. All of the members were enrolled in the BM/AH-DM Programme for over a period of time (July 2003 until the end of December 2006). Therefore the data was analysed retrospectively. This may

be considered a threat to internal validity. The purpose of the chosen quasi-experimental design was to fit a research design to the real world in order to increase external and ecological validity, while still controlling as many threats to internal validity as possible. The results can thus be generalised to similar settings where disease risk management was done.

The ultimate aim of the study was to determine whether or not the exercise intervention had an effect on the shifts measured in the clinical parameters. This design, incorporating corrections for difference that might have existed before intervention, thus determined the amount of change produced by the treatment. That is, did the clinical parameters of the compliant group change more than those of the non-compliant group (Thomas & Nelson, 1996)?

3.1.2. Aim and objectives of the study
3.1.2.1. Aim

Considering the literature overview and the nature of the study, the following research questions arose:
- Did exercise compliance or non-compliance have an influence on shifts measured in the clinical parameters (ie blood pressure, blood lipid levels, blood glucose levels, Body Mass Index, body fat percentage and cardiac risk percentage)?
- Over the course of the patients' participation in the BM/AH-DM Programme was there a correlation between level of psychological readiness to participate in an exercise programme and compliance with the exercise frequency as prescribed?

3.2. RESEARCH METHODOLOGY
3.2.1. Sampling

Data from 400 members, who were registered on the Best Med/Access Health Chronic Disease and Lifestyle Management Programme from July 2003 to December 2006, was analysed. The characteristics were as follows:

3.2.1.1. Age

Younger than 30 years: 10 individuals

31-40 years: 26 individuals

41-50 years: 93 individuals

51-60 years: 185 individuals

Older than 60 years: 85 individuals

3.2.1.2. Gender distribution

Male: 213 individuals

Female: 187 individuals

3.2.1.3. Presence of one or more of the following chronic conditions

Best Med Medical Aid decided to conduct a Chronic Disease and Lifestyle Management programme. The aim of the programme was to assist the medical aid scheme's members in the management of their chronic diseases by implementing a lifestyle-management programme. The project could only accommodate 400 members, and thus Best Med set the following criteria for participation in the programme:

3.2.1.3.1. High cholesterol

A member had at least to be diagnosed with high cholesterol levels or high blood lipid levels with the option of also being medicated for high cholesterol levels.

3.2.1.3.2. Hypertension

A member had at least to be diagnosed with hypertension and the option of also being medicated for hypertension.

Hypertension was defined as a resting systolic blood pressure higher than 140 mmHg and a resting diastolic blood pressure higher than 90 mmHg (McArdle *et al.,* 2001).

3.2.1.3.3. Diabetes mellitus

A member had to be diagnosed at least with diabetes mellitus or as being insulin resistant. The participants could also be treated for one of the above.

To diagnose this condition, a fasting plasma glucose test was done.

3.2.2. Ethical considerations

The Ethics Committee of the Faculty of Humanities at the University of Pretoria granted permission to the researcher to conduct this study.

Best Med Medical Aid invited certain members (according to their criteria, as mentioned before) to take part in the BM/AH-DM programme. When a member agreed to take part in the BM/AH-DM programme, the member then signed an informed-consent form with Best Med Medical Aid.

Both Best Med Medical Aid and Access Health (SA) are the owners of the data collected during the course of the BM/AH-DM programme. The researcher thus acquired letters from Best Med Medical Aid and Access Health SA according to the procedures of the Promotion of Access to Information Bill (PROATIA)(Sport science 5(1), sportsci.org/jour/0101/so.htm) where both companies granted permission for the researcher to conduct this study in accordance with their data (Annexures A and B).

3.2.3. Procedure

The researcher was contracted as biokineticist by Access Health to work on the BM/AH-DM Programme. Thus, decisions regarding the conduction of all assessments and exercise programmes were made as an informed and professional biokineticist.

3.2.3.1. Data collection

3.2.3.1.1. Registration

Based on the selection process already explained, the medical-aid scheme identified potential members who could take part in the lifestyle programme. Once a member agreed to take part the programme, the researcher, in her capacity as biokineticist, registered the members in the programme. In order to determine each member's level of readiness for change, a questionnaire was given to all members to complete. All members received this questionnaire before any physical assessments or testing were done (Annexure C).

3.2.3.1.2. Assessments

A baseline biokinetics assessment was done to establish the members' physical characteristics and clinical parameters. This assessment consisted of the measurement of the following:

- Height
- Body weight
- Body fat percentage
- Blood pressure
- Finger-prick, non-fasting (random) blood cholesterol levels
- Finger-prick, non-fasting (random) blood glucose
- Sub-maximal $V0_2$ fitness test

The participant's clinical parameters were re-evaluated at 3-month intervals.

Each individual abstained from food and all liquid for four hours prior to each assessment, except water could be drank until one hour before the assessment. The detail of the clinical parameters will be discussed in the section on dependent variables.

3.2.3.1.3. Exercise programmes

Between two to five days after the baseline assessment, participants received an exercise prescription programme from the biokineticist. The exercise programme was adapted for each individual. Each exercise programme consisted of at least 30 minutes of cardiovascular exercises. The minimum intensity was 50 to 60 percent of maximum heart rate. The maximum intensity was 75 to 85 percent of maximum heart rate. Resistance exercises were also added to some of the exercise programmes. The intensity of the resistance exercises were at least one set of 15 repetitions per muscle group. The pectoralis, lattisimus dorsi and gluteus muscle groups were the minimum number of muscle groups targeted during an exercise session.

The individualised exercise programmes were based on the following exercise modalities:

Table 3-1: Exercise modalities for CVDs namely, hypertension, DM, hyperlipidemia and obesity

MODE	INTENSITY	FREQUENCY	DURATION
1.HYPERTENSION			
Aerobic ⟹	50 to 80 percent of max HR_{max}	three to seven days a week	30 to 60 min
Strength ⟹ (Circuit training)	High repetitions low resistance		
2. Diabetes			
Aerobic ⟹	50 to 90 percent of max HR_{max}	four to seven days a week	20 to 60 min
Strength ⟹ (Free weights and weight machines)	High repetitions Low resistance		
3. Hyperlipidemia			
Aerobic ⟹	40 to 70 percent of max HR_{max}		40 to 60 min

4. Obesity			
Aerobic $\Rightarrow$	50 to 70 percent of max HR_{max}	five days a week	40 to 60 min

(Durstine & Moore, 2003).

The exercise programme was done at one of the following venues: The High Performance Centre (HPC) of the University of Pretoria, or at another exercise facility, or at home.

3.2.3.1.4. Exercise compliance

According to the ACSM exercises must be done at a moderate to vigorous intensity (Franklin *et al.,* 1998) a minimum of 3 times a week for 20 minutes at a time. A newsletter published by the ACSM (Winter 2003) recommended that exercises be done for 30 minutes on most days of the week.

A norm of at least twice a week training frequency was prescribed to all participants. Although literature suggests that compliance is defined as exercising at least three times a week, the researcher, in her capacity as biokineticist, and together with her employer decided to be lenient and changed the norm for purpose of the BM/AH-DM Programme.

If the participants didn't adhere to the norm they were considered to be non-compliant exercisers as opposed to being compliant.

The participants' compliance with the exercise programme was monitored by means of the following:
- A " Techno Gym System" software programme, utilised at the HPC
- Manually by e-mail, by means of an electronic logbook if the participant was exercising at another exercise facility or at home.

3.2.3.1.5. Multi-disciplinary team

During the course of the programme the participants were also assessed and councelled by a dietician. In addition the participants were interviewed and given member education by a multi-disciplinary team (medical doctor, dietician and health psychologist).

3.2.3.1.6 Debriefing

At the end of December 2006, the Implicit Theory Scale Questionnaire (Lochbaum *et al.,* 2006; Dweck, 2005) was given to all participants to complete (Annexure D).

3.2.3.2. Data management
3.2.3.2.1. Goals of data analysis

- Determining how many individual records corresponded with the present study's definition of exercise compliance, and thereby determining the number of compliant and non-compliant records
- To establish the baseline of each clinical parameter of each individual record
- To establish the shifts measured in each selective clinical parameter, as mentioned above, by comparing each clinical parameter's baseline value to its values recorded over time
- To determine if there was a difference in the shifts measured in the clinical parameters, when comparing it to the exercise compliance status of the group
- To determine if there was a difference in the level of readiness to change, when comparing it to the exercise-compliance status of the group
- To determine the differences in the answers from the Implicit Theory Scale questionnaire, and comparing the answers to the exercise compliance status of the group.

3.3. DATA ANALYSIS

Independent statisticians were consulted for the data-analysis process. It was envisaged that descriptive statistics (means, standard deviations, etc) were to be utilised, while the T-test or the Mann-Whitney Test (an equivalent non-parametric technique) would be applied to determine significant differences between groups.

Baseline and three-month interval assessment values for each clinical parameter (blood pressure; total cholesterol; blood glucose; BMI; fat percentage and cardiac risk percentage) were calculated for the entire group. Descriptive statistics were also used to determine the entire group's exercise compliance for the three and a half year time period. According to literature and the descriptive statistics, after 12 months the exercise-compliance trend (see box plots in Chapter 4 to view these results) for the entire group decreased to such an extent, that no statistical significant test could be done (Pi-Sunyer *et al.,* 2007Look *Ahead* Research Group; Goldberg & Elliot, 2000). Therefore, it was decided that only a 12-month analysis would be done on exercise compliance and clinical parameters.

Considering the non-random assignment of members into groups, inherent in the quasi-experimental design adopted for the study, the following procedures were done to ensure the best possible homogeneity between the groups in terms of the clinical parameters:

- Blood pressure
- Total Cholesterol
- Blood glucose
- BMI
- Fat percentage
- Cardiac risk percentage.

Each one of these clinical parameters was compared at baseline and in the three-month intervals (base to three months; base to six months and base to 12 months).

The shifts measured in every clinical parameter over the three-month intervals were compared to each group's exercise compliance. A T-test or Mann-Whitney Test (equivalent non-parametric technique) was applied to determine significant differences between groups.

Multiple tests (on baseline values) were done. The Bonferroni correction is a safeguard against multiple tests of significance on the same data. For example, we have tested three independent hypotheses on the same data at $\alpha = 0.05$ (significance level of 5 percent). Instead of using a $p-$value threshold of 0.05, one would use a stricter threshold of $\frac{0.05}{3} = 0.0167.$

3.4. DEPENDENT VARIABLES

3.4.1. Clinical and physical parameters

The following clinical parameters were measured during the course of the BM/AH-DM Programme, analysed and used for this study:

- Blood pressure
- Blood lipid profile (only random testing of total cholesterol)
- Blood glucose (random testing, thus not glucose tolerance test)
- Body Mass Index (thus the ratio of body weight to height)
- Body fat percentage
- Cardiac risk percentage

3.4.1.1. Blood pressure (BP)

This was measured at baseline and at every three-month interval assessment. A manual blood pressure cuff and sphygmonometer were utilised. All the blood pressure readings were measured on the member's right arm.

3.4.1.2. Blood lipid profile

The Cardio Check PA Analyzer and appropriate cholesterol strips were used to test total blood cholesterol values.

3.4.1.3. Blood glucose

Random (finger-prick) testing of blood glucose was done at every assessment. The Cardio Check PA Analyzer and appropriate glucose strips were used to test blood glucose values.

3.4.1.4. Body Mass Index (BMI)

BMI was measured at baseline and at every three-month interval assessment. This was calculated by dividing body weight in kilogram by body height in meters times square (Balady *et al.,* 2000).

3.4.1.5. Body fat percentage

Body-fat percentage was measured by means of bioelectrical impedance analysis (BIA). BIA is a non-invasive low-frequency electrical current. Gel electrodes are placed onto the hand and foot and the electrical frequency is conducted from the hand to the foot. BIA measures the impedance or the resistance to the flow of the electrical current. Muscle tissue and water assist in conducting the current, while fat tissue creates resistance to the current (McArdle *et al.,* 2001).

Impedance is proportional to body water volume. Measured impedance is converted to a corresponding estimate of body water volume (based on previous prediction equations). The muscle mass is then calculated from the above estimate, using an assumed hydration fraction for muscle mass. The fat percentage is then calculated as the difference between the body weight and muscle mass. Thus no member was allowed to drink any fluids an hour prior to the assessment (Installation and user guide Lipotrak ™ LipoTrak for Windows ver 1.01 English).

Table 3-2: Norms for body fat percentage for males and females

RATING	MALES	FEMALES
Good	11 to 14 percent	16 to 23 percent
Acceptable	15 to 20 percent	24 to 30 percent
Overweight	21 to 24 percent	31 to 36 percent
Obese	25 percent or over	37 percent or over

(Williams, 2005).

3.4.1.6. Cardiac risk percentage

The cardiac risk input data is based on research in the Framingham Study (Installation and user guide Lipotrak ™ LipoTrak for Windows ver 1.01 English). Framingham refers to a place (a town) where the study took place, and not to a researcher. The study was launched in 1950 and 5 000 to 6 000 adult men and women were to participate in it over a period of 24 years (Dawber, 1980).

Initially the aim of the Framingham Study was to develop and test methods for the early detection of heart disease. Thus the aim was to determine risk factors for coronary heart disease. The Framingham Study was an epidemiological study. Data was obtained solely from the clinical evaluation of patients in a one-to-one relationship with a physician or other health worker. During each visit the following data particulars were collected (Dawber, 1980):

- Medical history
- Physical examination
- Blood studies
- Other laboratory work
- Symptoms of illnesses that developed since previous visit
- Interim hospitalisation or medical visits

After the first examination, individuals with no evidence of coronary heart disease were followed up for 24 years to determine who would develop such a disease. During the study an effort was made to characterise each of the subjects in terms of a number of bodily traits, life habits or other factors

which were believed to relate in some way to the development of the disease (Dawber, 1980).

The cardiac risk percentage determines the percentage risk of an individual having a heart attack in the next ten years (from the date the cardiac risk is done). Certain risk factors were measured and each one carried a certain "weight" which contributed to the total risk percentage (see figure 3-1).

These factors were divided into the following two groups:

A. Unavoidable risk factors (hereditary/non-modifiable):
   Family history
   Age
   Gender
B. Avoidable risk factors (modifiable/lifestyle):
   Blood pressure (systolic and diastolic pressures separately)
   Cholesterol (random testing, thus total cholesterol reading)
   Smoking habits
   Body weight
   Activity level
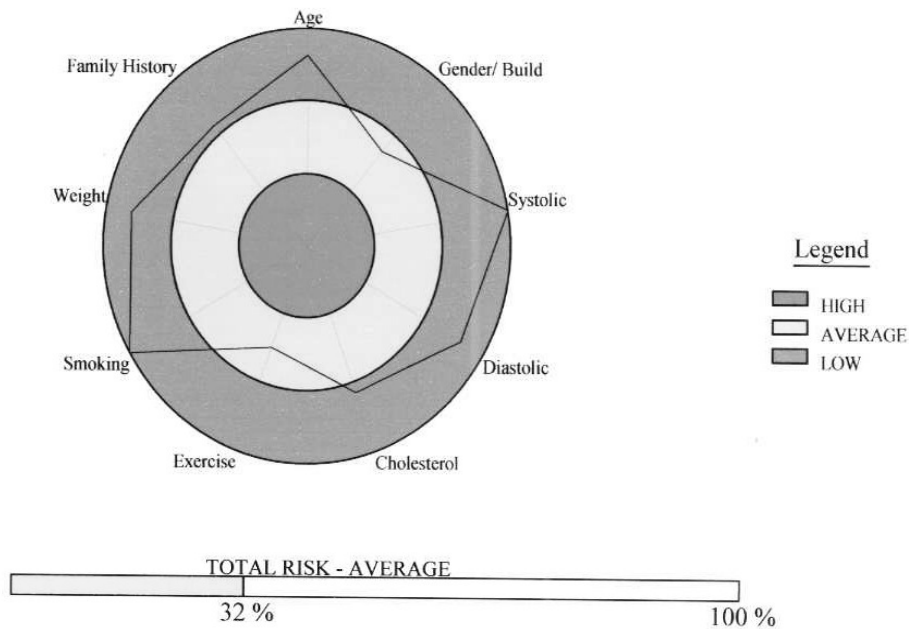
Figure 3-1: Cardiac risk profile
(Installation and user guide Lipotrak ™ LipoTrak for Windows ver 1.01 English).

54

3.4.2. Level of Readiness to Change

In the early 1990s, Marcus Kilpatrick (PhD) and others began to apply the Trans Theoretical Model (TTM) to exercise behaviours. Since then, several researchers have used the TTM to develop exercise interventions (Burbank *et al.,* 2002). The Level of Readiness Questionnaire measures an individual's readiness to change his or her exercise behaviour. The questionnaire was an adjusted version of the TTM questionnaire. The questions that were applicable to exercise behaviour in its own right were used (see Annexure C). Thus, the questionnaire used for the BM/AH-DM programme was not tested for validity and reliability. Data was analysed retrospectively, and thus could not be controlled by the researcher.

In analysis of the questionnaire, the answers were categorised into a stage (Dishman, 1994). There are five stages namely: the pre-contemplation stage (ie, those people not thinking about changing their behaviour), the contemplation stage (ie, those people who are thinking about changing their behaviour at some time within the next six months), the preparation stage (ie, those people who have decided to change their behaviour, or are attempting to do so), the action stage (ie, those people who have overtly changed their behaviour, but for less than 6 months) and the maintenance stage (ie, those people who have overtly changed their behaviour and have maintained these changes longer than six months) (Cardina, 1997).

3.4.3. Questionnaire on the Implicit Theory Scale

In addition, the Implicit Theory Scale Questionnaire (Dweck, 2000) was handed to all members in December 2006. The questions for ITSQ were adapted from questionnaires by CS Dweck (Dweck, 2000) to be applied for exercise training. The questionnaire handed out had not been tested before (Annexure D). As explained earlier, data was analysed retrospectively, and thus could not be controlled by the researcher.

The answers to the above questionnaire were reviewed to determine whether or not –

- individuals who believed that they only had a certain amount of physical fitness or ability were less likely to be non-complaint in their exercise behaviour; and

- individuals who believed that through effort they could physically become fitter, and thus change their fitness status would be compliant with exercise behaviour.

The ITSQ was based on a social-cognitive model developed by CS Dweck (Lochbaum *et al.,* 2006).

CHAPTER 4

RESULTS OF DATA COLLECTION AND STATISTICAL ANALYSIS

4.1. SUBJECTS

In the current study, data was collected from 400 members of the Best Med/Access Health Chronic Disease & Lifestyle Management Programme (BM/AH-DM Programme). The data analysis was done for a 12-month period, and not for the entire three-and-a-half-year period. See Chapter 3, Data Analysis, for an in-depth discussion of the above. Alpha is set at $p < 0.0167$ for data analysis (Chapter 3).

4.1.1. Registration and resignations

All 400 members were not registered at the same time, and deregistrations from the programme also took place at random. Thus the descriptive analysis of the members' registrations and deregistrations was as follows:

Table 4-1: Number of members on the BM/AH-DM Programme registered per year, and the number of deregistrations of members per year

	REGISTRATION YEAR	MEMBERS NOT DEREGISTRETERD	DEREGISTRATION YEAR	
			2005	2006
N	.	4	0	1
N	2003	81	9	31
N	2004	148	24	35
N	2005	51	10	6
N	TOTAL	284	43	73

Symbols: **.** *Indicates that the recorded data was void*
N *Is used to indicate number of members*

The above table indicates that of the 400 members, there were members who had no registration or resignation dates. One member resigned in 2006 and had no registration date. Nine of the 400 members who registered in 2003 resigned in 2005. Thirty-one of the 400 members who registered in 2003,

resigned in 2006. Twenty-four of the 400 members who registered in 2004, resigned in 2005. Thirty-five of the 400 members who registered in 2004, resigned in 2006. Ten of the 400 members who registered in 2005, resigned in 2005. Six members who registered in 2005, resigned in 2006 and 284 (71 percent) did not deregister from the programme. Thus the total resignations for 2003-2006 were 29 percent.

4.1.2. Gender and age distribution

Table 4-2: Gender distribution for members on the BM/AH-DM Programme

GENDER DISTRIBUTION		
GENDER	N	PERCENT
MALE	206	51.5
FEMALE	194	48.5
Symbols: **N** Is used to indicate number of members		

There were 206 male members and 194 female members.

Table 4-3: Age distribution for members on the BM/AH-DM Programme

AGE GROUP DISTRIBUTION		
AGE GROUP	N	PERCENT
<=30	21	5.26
31-40	25	6.27
41-50	118	29.57
51-60	166	41.6
>60	69	17.29
Symbols: **N** Is used to indicate number of Members **<** Is used to indicate "less than" **>** Is used to indicate "more than" **=** Is used to indicate "equal to"		

The above table shows that 21 members were of an age of 30 years and younger, 25 members were between the ages of 31 and 40, 118 members were between the ages of 41 and 50, 166 members were between the ages of 51 to 60 and 69 members were older than 60 years.

4.1.3. Chronic disease distribution

The members had to comply with the criteria of being treated for or diagnosed with one or more of the following chronic diseases:

- High cholesterol
- Hypertension

Table 4-4: Distribution of chronic diseases among members on the BM/AH-DM Programme

CHOLESTEROL	HYPERTENSION	DIABETES MELLITUS	N	PERCENT
.	.	√	29	7.25
.	√	.	86	21.5
.	√	√	15	3.75
√	.	.	200	50
√	.	√	4	1
√	√	.	59	14.75
√	√	√	7	1.75
Symbols: **.** Indicates that the recorded data was void				
N Is used to indicate number of members				
√ Is used to indicate cholesterol, hypertension and diabetes mellitus				

Table 4-4 indicates that of the 400 members 29 had been diagnosed with diabetes mellitus only. Eighty-six members were hypertensive only and 200 members had been diagnosed with high blood cholesterol only. Fifteen members were hypertensive and diabetic, four members were diabetic and had high blood cholesterol, 59 members were hypertensive and had high cholesterol and seven participants were hypertensive, diabetic and had high cholesterol.

4.2. DESCRIPTIVE STATISTICS
4.2.1 Clinical and physical parameters

Table 4-5: Values of clinical parameters of the members on the BM/AH-DM
Programme measured at baseline, 3, 6, 9 and 12 months

VARIABLE	N	MEAN	MEDIAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
SYST0	340	125.8	120	18.7	80	180
DIAST0	340	85.3	85	10.6	60	110
BMI0	333	28.9	28.3	5.4	18.2	55
FAT0	339	30.5	28.4	9.5	5.19	55
GLUC0	329	5.8	5.5	1.5	1.2	17.8
CHOL0	339	5.4	5.4	1.1	2.95	9.64
CRISK0	340	42.1	42	7.2	15	64
SYST3	156	117.9	120	13.9	90	150
DIAST3	156	81.3	80	8.6	60	100
BMI3	155	28.3	28.1	4.8	19.6	44.6
FAT3	156	30.3	28.9	9.3	12.9	51.9
GLUC3	156	5.7	5.5	1.3	3.5	12.1
CHOL3	153	5.1	4.97	1.1	2.59	8
CRISK3	154	37.9	38	6.3	19	54
SYST6	225	118.0	120	14.7	90	160
DIAST6	225	82.0	80	9.5	60	106
BMI6	222	29.4	28.8	5.9	17.2	52.6
FAT6	225	30.9	27.6	9.8	12.4	60
GLUC6	213	5.8	5.4	2.0	3	20.6
CHOL6	225	5.1	5.09	1.1	2.59	7.66
CRISK6	226	39.1	39	6.9	18	57
SYST9	175	116.4	120	14.4	90	160
DIAST9	175	81.5	80	8.7	60	100
BMI9	175	28.7	28.2	5.0	18.3	45.5
FAT9	175	30.6	28.5	9.4	12.1	53.4
GLUC9	171	5.3	5.3	1.0	2.5	9
CHOL9	175	5.2	5.08	1.1	2.73	8.64
CRISK9	174	38.2	38	6.9	15	57
SYST12	141	113.6	110	14.9	85	160
DIAST12	141	79.9	80	9.5	55	100
BMI12	141	28.5	28.3	4.7	17.9	43.2
FAT12	141	30.5	29	9.6	13.6	52.9
GLUC12	139	5.4	5.1	1.4	2.4	13.8
CHOL12	140	5.2	5.275	1.1	2.59	8.16
CRISK12	140	38.3	39	6.6	18	54

Symbols: SYST indicates systolic blood pressure
            DIAST indicates diastolic blood pressure
            BMI indicates Body Mass index
            FAT indicates body fat percentage
            GLUC indicates serum (blood) glucose levels
            CHOL indicates serum (blood) cholesterol levels
            CRISK indicates cardiac risk percentage
            0, 3, 6, 9, 12 indicates the months at which assessments were done

All the clinical parameters were measured at three-month intervals. Table 4-5
indicates the mean, median, standard deviation, maximum and minimum

values for the entire group's clinical parameters measured at three-month intervals.

One of the aims of this study was to establish the baseline and three-month interval values for each of the clinical parameters. The above was done in order to do statistical analyses in association with exercise compliance of each sub-group, namely compliant and non-complaint groups.

4.2.2. Exercise compliance

For the reading and understanding of the boxplot figure on p. 62, the following symbols are defined:

Symbols: ▯ - Indicates 50 percent of the members' recorded data.
▯ - Indicates the median value for the group for the specific month.
⊤ - The whiskers on both ends of the rectangle plus the outliers indicate 2nd half (50 percent) of the members' recorded data.
○ - Indicates a value that is an outlier

The compliance summary for the 400 members on the BM/AH-DM Programme indicated that the minimum amount of exercise sessions per month per member was nought and the maximum was 25.

(Figure 4-1 will follow on next page).
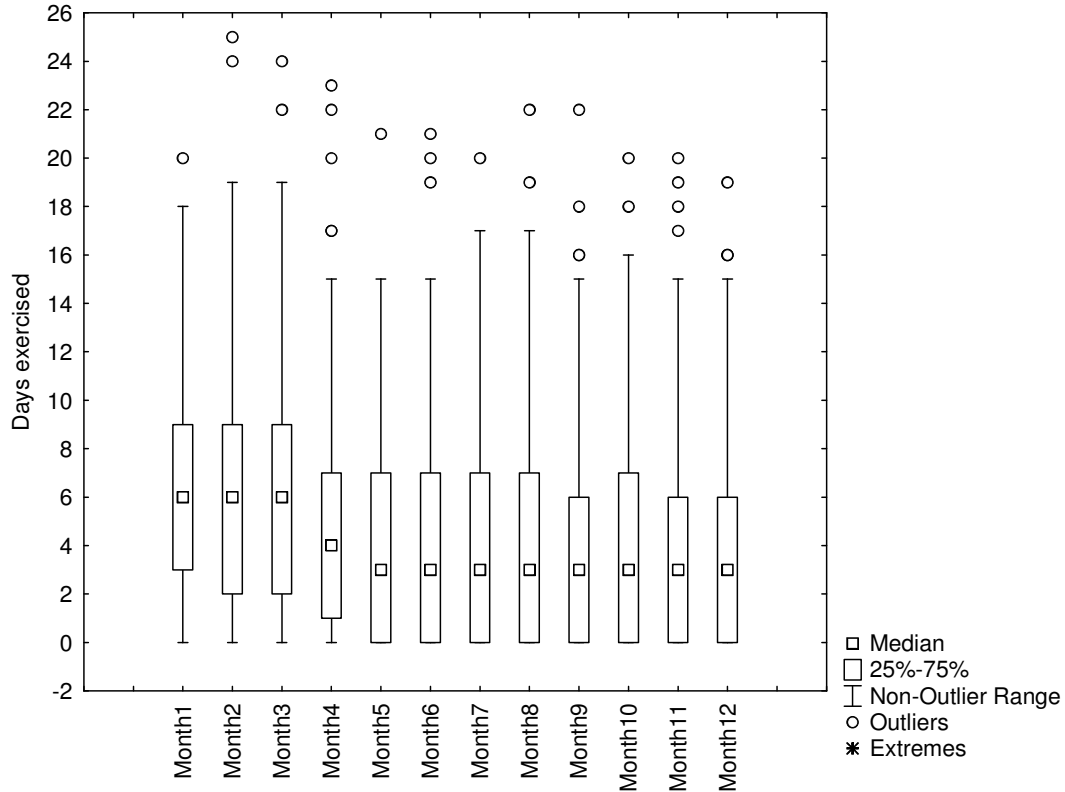
Figure 4-1 The exercise compliance for the group over a 12-month period.

For the purpose of this study, the definition for being complaint with an exercise regimen was set at training two days a week as explained in Chapter 3 (2.3.14 Exercise Compliance). The y-axis represents the number of days trained per month, thus eight days a month represents the norm for this study. In Months 1 to 3, the members were most complaint, with the median being six days a month. From Month 4 to Month 12 the members' exercise compliance decreased with training three days a month less than in the first three months. This also then assists in the explanation of only doing a twelve-month analysis, and not for the entire period (See Chapter 3, Data Analysis). The final analysis will follow at the end of this chapter.

Table 4-6 The number (and percentage) of members on the BM/AH-DM Programme who were in the compliant and non-compliant exercise groups for time periods baseline – 3, 4 - 6, 7 - 9, and 10 – 12 months

TIME PERIODS	EXERCISE GROUP	N	PERCENT
Baseline - 3 months	Compliant group	105	30.9
	Non-compliant group	235	69.1
4 - 6 months	Compliant group	74	21.8
	Non-compliant group	266	78.2
7 - 9 months	Compliant group	55	16.2
	Non-compliant group	284	83.8
10 – 12 months	Compliant group	45	13.6
	Non-compliant group	286	86.4

Table 4-6 is a summary of the total amount of members who were in the compliant exercise group (exercised twice a week or more) and in the non-compliant exercise group (exercised less than twice a week). From baseline to 3 months, 30.9 percent of the members were in the compliant exercise group and by Months 10 to 12, there were only 13.6 percent members in the compliant exercise group.

4.2.3. Questionnaire on the Level of Readiness for Change

At the start of the programme, the questionnaire on the Level of Readiness (LOR) was handed out to all 400 members. The LOR questionnaire was designed in advance of the BM/AH-DM Programme, that is before the study commenced, and has never been proven to be valid or reliable.

Only 233 members completed the LOR questionnaire. This may be attributed to the fact that some of the members might not have understood the questions. Thus only 101 completed questionnaires could be statistically analysed.

Table 4-7: Classification of the members on the BM/AH-DM Programme between phases of the LOR questionnaire

LEVEL OF READINESS QUESTIONNAIRE						
N	Pre-contemplation	Contemplation	Preparation	Action	Maintenance	Total
	0	6	43	5	47	101
Symbols **N** Is used to indicate number of members						

According to Table 4-7, 47 members who completed the LORQ were in the maintenance phase, 43 were in the preparation phase, six in the contemplation phase, five in the action phase and zero/none were in the pre-contemplation phase.

4.2.4. Questionnaire on the Implicit Theory Scale

At the end of programme the Implicit Theory Scale (ITS) Questionnaire was emailed to all 400 members to be completed. The ITS questionnaire has also never been proven to be valid or reliable. Fifty one participants completed the ITSQ.

Table 4-8: Classification of the members on the BM/AH-DM Programme into two phases of the ITS questionnaire

IMPLICIT THEORY SCALE QUESTIONNAIRE			
N	ENTITY THEORY	INCREMENTAL THEORY	TOTAL
	6	45	51
Symbols **N** Is used to indicate number of members			

According to Table 4-8, 45 of the members who completed the ITSQ were in the incremental phase and six were in the entity phase.

4.3. INFERENTIAL STATISTICS
4.3.1. Association between clinical & physical parameters, and exercise compliance

According to the members' exercise-compliance status, they were divided into two groups. If a member's average compliance was less than twice a week, that member would be assigned to the non-compliant group. If a member's average compliance was twice a week or more, that member would be assigned to the compliant group.

Each group was then compared to the shifts measured in each clinical parameter to determine if there was any statistical significance between the shift measured and the specific group. Therefore, the question may be asked: Did the compliant group change more than the non-compliant group in terms of each clinical parameter? It should be noted that a one-sided hypothesis was tested for each clinical parameter, ie H_a : shift (compliant group) < shift (non-compliant group). Also note that a p – value threshold of 0.0167 was chosen (as discussed in Chapter 3, Data Analysis). The comparisons between each group and changes in clinical parameters were only done for baseline (Month 0) to Month 3, baseline (Month 0) to Month 6 and baseline (Month 0) to Month 12. The reason for this was not to overtest the same data set, which would have decreased the possibility of statistical significance.

The following explanation is for the interpretation of Tables 4-8, 4-9 and 4-10:
- The non-compliant group is highlighted in pink.
- The compliant group is highlighted in green.
- Any statistical significance in a shift measured in a clinical parameter, will be marked in red in the specific clinical parameter's row.
- "Effect size" measures the magnitude of a treatment effect.
- SBP indicates systolic blood pressure
- DBP indicates diastolic blood pressure
- BMI indicates body-mass index
- FAT indicates body-fat percentage
- GLUC indicates serum glucose value
- CHOL indicates serum cholesterol value
- CRISK indicates cardiac risk percentage
- WT indicates body weight
- 03, 06 and 012 indicate shift measured, namely Baseline to Month 3, Baseline to Month 6 and Baseline to Month 12

- Standard deviation: A measure of the dispersion of a set of data from its mean. The more spread apart the data, the higher the deviation. Standard deviation is calculated as the square root of variance.

- Mean percentage: It is calculated by adding up all the values in a set of data and then dividing that sum by the number of values in the dataset, expressed as a percentage.

Table 4-9: Summary of changes in clinical parameters from Baseline to Month 3 for the compliant and non-compliant groups

Variable	NON-COMPLIANT				COMPLIANT				STATISTICAL COMPARISON		
	N	Mean	Mean%	Std Dev	N	Mean	Mean%	Std Dev	p-value	p <0.0167	Effect size
SBP03	98	4.78	3.91	15.444	58	11.24	8.65	16.011	0.0069	Significant	Small-Medium
DBP03	98	2.67	3.19	9.212	58	3.26	3.84	9.193	0.3509		
BMI03	97	0.14	0.48	0.875	56	0.36	1.26	1.650	0.1738		
FAT03	98	0.06	0.18	3.148	58	0.09	0.31	4.301	0.4778		
GLUC03	97	0.04	0.64	1.408	57	0.11	1.99	1.317	0.3728		
CHOL03	96	0.36	6.58	1.183	56	0.38	7.30	1.133	0.4581		
CRISK03	97	3.30	7.92	4.388	57	4.43	10.66	5.874	0.1045		
WT03	97	0.34	0.41	2.263	57	0.93	1.09	4.321	0.1709		

In Table 4-9 the only statistical significance was for systolic blood pressure, where the compliant group showed more change. The decrease in the compliant group's systolic blood pressure was 11.24 mmHg (8.65 percent) and the $p-$value was 0.0069.

Table 4-10: Summary of changes in clinical parameters from Baseline to Month 6 for the compliant and non-compliant groups

Variable	NON-COMPLIANT				COMPLIANT				STATISTICAL COMPARISON		
	N	Mean	Mean%	Std Dev	N	Mean	Mean%	Std Dev	p-value	p <0.0167	Effect size
SBP06	176	6.24	5.03	16.734	49	9.82	7.60	16.350	0.0924		
DBP06	176	2.64	3.12	11.023	49	6.65	7.54	10.696	0.0122	Significant	Small-Medium
BMI06	168	0.04	0.13	1.309	48	0.60	2.03	1.668	0.0072	Significant	Small-Medium
FAT06	175	-0.32	-1.04	4.880	49	0.39	1.31	5.553	0.1906		
GLUC06	159	-0.02	-0.29	2.005	47	0.14	2.35	1.706	0.3182		
CHOL06	176	0.32	5.80	0.976	49	0.52	9.76	1.123	0.1008		
CRISK06	177	2.85	6.71	4.722	49	5.57	13.02	6.305	0.0033	Significant	Small-Medium
WT06	177	-0.11	-0.13	3.491	49	1.90	2.16	3.689	0.0003	Significant	Small-Medium

In Table 4-10 the following clinical parameters were statistically significant:

- Diastolic blood pressure, where the compliant group showed more change. The decrease in the compliant group's diastolic blood pressure was 6.65 mmHg (7.54 percent) and the $p-$value was 0.0122.

- Body Mass Index (BMI), where the compliant group showed more change. The decrease in the compliant group's BMI was 0.60 (2.03 percent) and the $p-$value was 0.0072.

- Cardiac Risk Percentage, where the compliant group showed more change. The decrease in the compliant group's Cardiac Risk Percentage was 5.57 (13.02 percent) and the $p-$value was 0.0033.

- Body weight where the compliant group showed more change. The decrease in the compliant group's body weight was 1.9 kg (2.16 percent) and the $p-$value was 0.0003.

Table 4-11: Summary of changes in clinical parameters from Baseline to Month 12 for the compliant and non-compliant groups

Variable	NON-COMPLIANT				COMPLIANT				STATISTICAL COMPARISON		
	N	Mean	Mean%	Std Dev	N	Mean	Mean%	Std Dev	p-value	p <0.0167	Effect size
SBP012	122	9.92	8.05	17.270	18	13.33	10.43	12.574	0.2106		
DBP012	122	5.80	6.79	11.591	18	7.94	8.83	11.280	0.2313		
BMI012	118	-0.07	-0.25	1.167	18	1.00	3.37	1.246	0.0003	Significant	Medium
FAT012	122	-0.42	-1.38	3.719	18	1.31	4.39	3.470	0.0327		
GLUC012	115	0.46	8.04	1.641	17	0.14	2.30	1.936	0.2268		
CHOL012	120	0.16	3.00	1.099	18	0.25	4.71	1.002	0.3732		
CRISK012	121	2.72	6.61	5.377	18	5.22	12.32	5.494	0.0344		
WT012	120	-0.32	-0.39	3.136	18	3.17	3.58	3.802	0.0000	Significant	Medium

In Table 4-11 the following clinical parameters were statistically significant:

- Body Mass Index, where the compliant group showed more change. The decrease in the compliant group's BMI was 1.00 (3.37 percent) and the $p-$value was 0.0003.

- Body weight, where the compliant group showed more change. The decrease in the compliant group's body weight was 3.17 kg (3.58 percent) and the $p-$value was 0.0000

4.3.2. Association between exercise compliance and the LOR

When comparing the LOR with the compliant group versus the non-compliant group, there were no statistically significant results.

4.3.3. Association between exercise compliance and ITS

When comparing the ITS with the compliant group versus the non-compliant group, there were no statistically significant results.

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1. EXERCISE COMPLIANCE IN DISEASE-MANAGEMENT PROGRAMMES

The lack of compliance with exercise, or adherence to a prescribed exercise regimen, has been a challenge to physical therapists and health-care providers since the 1970s (Dishman, 1988; Frederich *et al.,* 1998; Seckin *et. al.*, 2000). According to Covera-Tindel *et al.* (2004) for an individual to derive benefits from any exercise programme, it is crucial to comply with his or her training programme. Thus, as mentioned in Chapter 2, health-care providers should be educated in managing exercise compliance (Frederich *et al.,* 1998) in order to assist their patients or clients to achieve goals that have been set in terms of their health status and/or rehabilitation.

According to Dishman (1988), dropout rates for most organised exercise programmes are 50 percent within the first three to six months. In the present study, the total dropout rate was 29 percent, after the three and a half year period of the BM/AH-DM Programme (Table 4-1). Only one member dropped out of this programme by the end of the first 12 months (Table 4-1). The reason for this lower dropout rate may be ascribed to the fact that this was a sponsored disease-management programme, where Best Med Medical Aid covered all the relevant costs. The only costs to the members were for their own travelling expenses to the facility and for purchasing training gear (clothes and shoes). However, the exercise-compliance trend for the entire group decreased after the first three months, and continued to decrease over time (see Figure 4-1).

According to information gained from an international physical activity questionnaire as part of the World Health Survey, less than one third of South Africans exercised 30 minutes a day on most days of the week (Steyn & Fourie, 2006). This data from the South African population was collected between December 2002 and May 2003. The data included samples from urban and rural communities (n = 2014) (Steyn & Fourie, 2006). Thus, the South African population did not comply with the ACSM's recommendations

for health-enhancing physical activity, namely that exercise should be done for at least 30 minutes on most days of the week.

In the present study, as explained in Chapter 3, the requirements for being compliant was set at exercising two days or more a week. From baseline to 3 months, 30.8 percent of the group was compliant, but by Months 10 to 12 only 13.6 percent of the compliant members remained (Table 4-6). Thus, the exercise-compliance statistics for the present study are in coherence with literature (Steyn & Fourie, 2006; Covera-Tindel *et al.*, 2004) in as far as only a third of patients are compliant with their exercise regimen, and in the present study even less than a third remained compliant as time went by.

In a study by De Jong *et al.* (2008), it was found in an exercise-intervention programme for rheumatoid arthritis patients, that most patients (84 percent) who followed a two-year high-intensity intervention programme were still exercising after 18 months. However, by then (18 months later) only 23 percent of these were still exercising twice a week. In another study (Rogers *et. al.*, 2009), where compliance was measured over a short term (eg 12 weeks) the physical activity behaviour increased over a short period. Thus, it seems that exercise compliance can be expected to increase over the course of a short training period, will reach a plateau, and will then begin to decrease as time goes by. This trend was also demonstrated by Mayoux-Benhamou *et al.* (2008) where rheumatoid arthritis patients were provided with exercise education and prescription. In the first six months of the training programme the patients' exercise compliance increased, but during the next six months their compliance decreased again. It is interesting to note that the exercise programmes were home-based, and did not take place at a specific training facility. Thus, it seems that exercise compliance in different settings demonstrate the same trend, namely, an initial increase, followed by a plateau, and then a decrease towards the end of the intervention period.

It is clear from the above results that exercise compliance should be closely monitored and managed. Proposed strategies to increase exercise compliance will be discussed at the end of this chapter. Future research regarding exercise compliance, especially in the health-industry setting is strongly suggested.

5.2. EXERCISE COMPLIANCE AND HYPERTENSION

As mentioned in Chapter 2, hypertension is considered to be a risk factor for the development of CVDs (Goldberg & Elliot, 2000; McArdle *et al.*, 2001; ACSM, 2001; Briganti *et al.,* 2003;).

Evidence suggests that exercise may improve both systolic and diastolic blood pressure levels during rest (Coliac *et al*, 2007; Fagard *et al.*, 2007; Baines & Brown, 2009). In a study by Coliac *et al.* (2007) 52 middle-aged volunteers who were treated for hypertension were divided into two groups (a continuous-exercise group and an interval-exercise group). Both groups showed a decrease in systolic and diastolic blood pressure after a single bout of exercise. In a 12-week study (Baines & Brown, 2009), 50 hypertensive women were divided into either an exercise group or a control group. The exercise group participated in a low-intensity steady-state walking programme five days a week, while the control group continued with their usual daily activities. On average, the exercise group complied with four walking sessions a week, and demonstrated decreases both in resting systolic and diastolic blood pressure (Baines & Brown, 2009). In a meta-analyses of randomised controlled trials (Fagard *et al.*, 2007), which included endurance training (72 trials, 105 study groups), and resistance training (9 randomised controlled trials, 12 study groups) significant reductions in resting systolic and diastolic blood pressure for both analyses were demonstrated (Fagard *et al.,* 2007). It was also concluded that exercise was "a cornerstone therapy for the prevention, treatment, and control of hypertension" (Fagard *et al.,* 2007). The journal articles used for this meta-analyses included publications up to December 2003, and the intervention periods were a median of 16 weeks for both endurance and resistance training.

In the current study, only the compliant group demonstrated statistically significant reductions in mean pre-exercise systolic blood pressure (SBP) by 11.24 ± 16.01 mmHg ($p = 0.007$) in Months 0 (baseline) to 3 and in mean pre-exercise diastolic blood pressure (DBP) by 6.65 ± 10.70 mmHg ($p = 0.012$) in Months 0 (baseline) to 6. This result indicates that exercise compliance of two days a week or more may significantly improve resting blood pressure values in a chronic-disease population. A major limitation of this study was that only resting pre-exercise blood pressure readings were recorded. It is recommended

that future research studies document the changes in both pre-exercise and post-exercise blood pressure values.

5.3. EXERCISE COMPLIANCE AND HYPERCHOLESTROLEMIA

Research has shown that exercise may increase HDL-cholesterol (Kodama *et al.,* 2008). In a review article Durstine (2008) determined what characteristics of an exercise programme, and which exercise population groups, demonstrated the most favourable results as far as increases in HDL-cholesterol were concerned. The author (Durstine, 2008) searched MEDLINE for research studies that were done from 1966 to 2005, with the inclusion criterion being a comparison between an aerobic exercise group *versus* a non-exercise control group. The analysis (Durstine, 2008) showed that participation in an aerobic exercise programme for eight weeks or more increased HDL modestly (from 0.035 mmol/ℓ to 0.096 mmol/ℓ). The results also indicated that exercise duration (and not frequency or intensity) was the strongest predictor for change in HDL-cholesterol. The duration of the exercise sessions ranged from 23 to 74 minutes. When the exercise duration was less than 30 minutes the difference in HDL-cholesterol was less. The exercise was most effective in participants with higher total cholesterol levels combined with lower body weight (Durstine, 2008).

However, the above research has shown that exercise increases HDL-cholesterol; the physiological process by which exercise affects triglycerides and actually VLDL-triglycerides needs to be understood. The physiological mechanisms responsible for lowering triglycerides "have just recently started to be explained", and still need further research (Magkos, 2009).

The next important question is also what exercise characteristics (eg type, intensity, frequency, duration and energy expenditure) are necessary for lowering triglycerides and ultimately serum cholesterol? According to Magkos (2009), total energy expenditure of an exercise session is the most important factor that causes changes in VLDL metabolism. Energy expenditures of 500 to 600 kcal per session may lead to decreases in triglycerides, however, when doing resistance exercise, the energy expenditure may be less. Another

research study indicated that energy expenditures of 1 200 to 2 200 kcal/week (aerobic exercise) were associated with decreases in triglycerides and increases in HDL-cholesterol. The study also indicated that exercise seldom alters total cholesterol and LDL-cholesterol, and that dietary fat intake must be reduced together with body weight to decrease these values (Durstine, 2002). In a study (Tokmakidis & Volaklis, 2003) where aerobic and strength exercises were combined to measure effects on blood lipids in patients with coronary artery diseases (CADs), after an eight-month training programme the triglyceride and total cholesterol levels decreased and HDL-cholesterol increased. After three months of detraining, the changes in blood lipids were reversed (Tokmakidis & Volaklis, 2003).

In this study only total serum cholesterol values were measured, and not the ratio of LDL to HDL. In the comparisons between exercise compliance and total cholesterol values measured over time, the total cholesterol of the compliance group changed (decreased) more than the non-compliance group, although this change was not statistically significant. The reason for these non-significant changes in total cholesterol values may be attributed to the fact that the members' dietary fat intake and body weight were not managed in the BM/AH-DM Programme. In the study by Durstine (2008), it was indicated that total cholesterol and LDL-cholesterol levels were unlikely to decrease in the absence of reduced dietary fat intake and body weight. Also, each member on the BM/AH-DM Programme followed an individualised training programme of which the energy expenditure was neither monitored nor recorded. Thus, caloric expenditure might have been less than the 500-600 kcal per session as recommended by Magkos (2009).

Thus for future research studies of this nature (lifestyle management studies), it is suggested that not only the total cholesterol be measured, but also HDL, LDL and triglycerides. Also the participants' dietary fat intake and body weight need to be managed. In addition, more attention should be paid to total energy expenditure of the exercise programme to ensure continued benefits to serum cholesterol levels.

5.4. EXERCISE COMPLIANCE AND BODY MASS INDEX

Body Mass Index (BMI) is used to determine whether an individual has a normal body weight, is overweight or obese.

BMI is calculated as follows:

$$\frac{\text{Body weight in kilograms}}{(\text{Height in meters})^2}$$

where a value of –

- < 18 is considered to be underweight;
- 19 to 25 is considered normal;
- 25 to 30 is considered as overweight; and
- > 30 indicates obesity (Balady *et al.,* 2000).

Thus, a rise in body weight will result in a rise in the BMI of an individual.

Obese individuals are at risk of developing CVD, DM, depression, and cancer (Anderson *et al.,* 2005). This statement is supported by a review article where the authors (Booth *et al.,* 2000) presented statistics on the prevalence of CVD and indicated that obese women had a 93-fold risk increase, and obese men a 42-fold risk increase for the development of Type 2 DM. It was also stated that with a 20 percent rise in body weight, the risk for developing CVD increased by 86 percent in men and 3.6-fold in women (Booth *et al.,* 2000). A significantly higher prevalence of hypertension, LDL cholesterol and Type 2 DM was also demonstrated with an increase in BMI in a group of 68 001 individuals (mean age 45 years, 54 percent female) (Molenaar *et al.,* 2008).

In the present study the members' mean BMI was 28.9 ± 5.4 (Table 4-5), thus falling within the overweight category. The members who participated in the BM/AH-DM Programme were also diagnosed with either one or more of the following risk factors: elevated blood cholesterol levels, hypertension and diabetes mellitus. Thus, in accordance with findings by Molenaar *et al.* (2008) a positive correlation seems to exist between the members' BMI and their disease status.

In a study (Krousel-Wood *et al.,* 2007) where participants with Type 2 DM were assigned to either a home-based exercise group (intervention group) or usual

care group (control), results indicated that home-based exercise had the potential to reduce BMI. The participants were instructed to exercise for 30 minutes five days a week for three months. Results indicted that thirty-eight percent of the intervention group complied with 80 percent of the exercise prescriptionn, and improved their BMI status (Krousel-Wood *et al.,* 2007). The dependent association between physical activity and BMI was also tested in a research study (Hemmingson & Ekelund, 2007), where the authors analysed multiple levels of physical activity. A distinction was made between four levels of physical activity namely, sedentary, light, moderate and vigorous physical activity. The sample included 85 obese men and women with a mean age of 43 ± 12.6 years for the experimental group and 193 men and women in the control group (mean age 41.6 ± 13.0 years). The results showed that BMI was significantly inversely associated with all levels of physical activity in obese individuals, although the association was weak in non-obese individuals (Hemmingson & Ekelund, 2007). Thus exercise does decrease BMI, especially for individuals in obese categories.

In the present study significant improvements were demonstrated in the compliant group's BMI (p = 0.007) and body weight (p = 0.0003) in the base to 6-month comparison (Table 4-9). There were also significant improvements for both BMI (p = 0.0003) and body weight (p = 0.0003) for changes measured over the time period baseline to 12 months (Table 4-10). The improvements in BMI and body weight are interdependent, due to the calculation formula of BMI. Thus, according to literature (Hemmingson & Ekelund, 2007; Krousel-Wood *et al.,* 2009), exercise could have been one of the causal factors for the improvements in BMI measurements.

 It is important to notice that dietary intake of fat and total energy intake of food were not measured or recorded or managed in the present study. In a study (Anding *et al.,* 2001) where diet, BMI and physical activity of 60 female students were measured, 25 percent of the female students were classified as overweight. The majority of these participants exceeded the dietary guidelines for fat, sugar and sodium intake and 66 percent had a sedentary lifestyle (Anding *et al.,* 2001). These statistics indicate the importance of measuring and managing food intake in participants of a chronic-disease management programme in future research.

5.5. EXERCISE COMPLIANCE AND BODY FAT PERCENTAGE

Obesity can be described as an accumulation of excess body fat (Hansen *et al.,* 2005). According to McArdle e*t al.* (2001) obesity or overfatness is classified as a body fat percentage of above 20 percent in men, and above 30 percent in women. Obesity, as mentioned in the previous section and in Chapter 2, poses a high risk for the development of CVD (Booth *et al.,* 2000; Balady *et al.,* 2000; Tutor & Campbell, 2004; Anderson *et al.,* 2005; Molenaar *et al.,* 2008). In the present study, the mean body fat percentage for the group at baseline was 30.5 ± 9.5 percent (Table 4-5). Separate body fat percentages for men and women were not calculated. Thus, the members' high mean body fat percentage can be viewed as a contributing factor to their chronic-disease status (hypertension, DM and high blood cholesterol).

In the present study the fat percentage decreased more in the compliant group than in the non-compliant group (Table 4-8, 4-9 and 4-10), but these changes were not statistically significant. The baseline to 6-month and baseline to 12-month analyses (Tables 4-9 and 4-10) indicated a rise in the non-compliant group's fat percentage. These findings thus support the existing body of literature (Osei-Tutu & Campagna, 2004; Hansen *et al.,* 2005) indicating that exercise compliance may decrease body fat percentage.

As mentioned before, participants in the BM/AH-DM Programme followed individualised exercise programmes. It is recommended that for future research studies, attention be paid to each exercise characteristic, and especially to the total energy expenditure of the exercise session.

5.6. EXERCISE COMPLIANCE AND BLOOD GLUCOSE

A meta-analysis of 103 studies (Saudek & Margolis, 2008) showed that individuals suffering from Type 2 DM, and who increased their physical activity levels, indicated improved blood glucose levels. More recently, Hiyane *et al.* (2008) found that exercise programmes performed at higher intensities resulted in better blood glucose control both during and after exercise in Type 2 diabetics with no cardiovascular complications.

In the present study the blood glucose levels of the members in the compliant exercise group decreased more 0.11 ± 1.32 mmol/ℓ (baseline to 3 months) and 0.14 ± 1.71 mmol/ℓ (baseline to 6 months), than in the non-compliant group 0.04 ± 1.41 mmol/ℓ (baseline to 3 months) and –0.02 ± 2.01 mmol/ℓ (baseline to 6 months) (Table 4-8 and 4-9). However, these changes were not statistically significant. Similar results were found in a short-term (four weeks) exercise-intervention study (Hordern *et al.,* 2008) where Type 2 diabetics (aged 18 – 75 years) with no complications were assigned to either a usual care group (n = 112) or an exercise group (n = 111). The exercise programme consisted of moderate intensity (RPE of 12 - 13), aerobic and resistance exercises. Small non-statistically significant improvements in blood glucose levels were reported (Hordern *et al.,* 2008).

It is important to note that the present study was limited in the following ways:

- Only 55 of the 400 members (Table 4-4) on the BM/AH-DM programme had diabetes mellitus and the mean baseline value for the entire group was 5.8 ± 1.5 mmol/ℓ (Table 4-5), which was within the normal range for blood glucose (< 6 mmol/ℓ).
- Members also only fasted for four hours before the assessment, and thus blood-glucose levels might have still been elevated from a previous meal. It is thus suggested that for future studies like this one, that blood glucose levels be fasting levels.
- Insulin levels were also not measured and because insulin influences blood glucose levels (Turcotte & Fischer, 2008), this must also be managed during a chronic-disease intervention study such as this one.
- Finally, it is suggested that for reporting and statistical reasons, that separate reporting must be done on blood glucose levels for individuals with DM.

5. 7. EXERCISE COMPLIANCE AND CARDIAC-RISK PERCENTAGE

The cardiac-risk percentage, referred to in Chapter 3, was calculated by means of a software program (Lipotrak ™ LipoTrak for Windows ver 1.01 English). The software program took into consideration both non-avoidable risk

factors (age, gender, family history of heart attack, and stroke) and avoidable risk factors (systolic blood pressure, diastolic blood pressure, total blood cholesterol values, physical activity level, body weight and smoking status).

All of the avoidable cardiac risk factors, with the exception of smoking status, were measured independently and compared to exercise compliance. Because, over time, there were statistically significant improvements in blood pressure (systolic and diastolic) and BMI, the cardiac risk percentage in the compliant group from baseline to 6 months (p = 0.003) improved significantly. Also the decrease in total blood-cholesterol values demonstrated by the compliance group during this time (Tables 4-8, 4-9 and 4-10), further improved the cardiac risk percentage, although these changes in cholesterol were not statistically significant.

The cardiac-risk calculator used in the present study, is only one of many similar calculators available on the world-wide web or other software programs. Most of these risk calculators are based on the Framingham study (Quaglini *et al.,* 2004), as is the one used in the present study. A simulation study by Quaglini *et al.* (2004) found that different risk calculators found on the world-wide web and literature (all taking into consideration, family history, age, gender, blood pressure, total blood cholesterol, HDL, LDL and triglyceride levels, DM and smoking) that were applied to the same individual, produced very different result profiles. Thus, researchers are in need of well-described, well-referenced, and non-ambiguous cardiac-risk tools (Quaglini *et al.,* 2004).

5.8. EXERCISE COMPLIANCE AND LEVEL OF READINESS TO CHANGE

Globally, it seems that there is no agreement on the most efficient theoretical model to promote and/or manage exercise behaviour. As previously explained, the TTM for behavioural change was utilised by Best Med Medical Aid to draft the LOR questionnaire for participants in the BM/AH-DM Programme. The use of the original TTM questionnaire is considered to be a valid and reliable method to evaluate research participants' levels of readiness to change (Kirk *et al.,* 2004).

Only 233 of the 400 members on the BM/AH-DM Programme completed the LOR questionnaire (Table 4-6). Of these, most probably due to the questionnaire's validity and reliability not being established beforehand, only 101 members answered the LOR questionnaire correctly. Thus, the results cannot be viewed or interpreted as indisputable evidence. Members viewed themselves as already being in the maintenance phase of behavioural change, even before they started to take part in the BM/AH-DM Programme. Thus, theoretically they had already adopted exercise as part of their lifestyle. This might have been true because a sedentary lifestyle was not a prerequisite for participation in the BM/AH-DM Programme. Of the members 42.5 percent (Table 4-6) indicated that they were in the preparation phase of the behavioural change, and thus were ready to change. Bulley *et al.* (2008), in their pilot study on 30 female students, demonstrated support for the hierarchical relationship of the stages of exercise behavioural change. In other words, those individuals who indicated that they were in higher stages of behavioural change exercised more than those in the lower stages (Bulley *et al.,* 2008). In the present study, no statistically significant correlations were demonstrated between the compliant or non-compliant groups and the stages of exercise behaviour exhibited. Once again, this might be attributed to design flaws of the LOR questionnaire. The stage-based approach to exercise intervention poses a further challenge, in that Briddle (2005) found it beneficial in promoting physical activity in only one out of seven trials. Marshall *et al.* (2001) who published reports on the use of the TTM in the physical-activity domain, found it to be generally applicable, but not outrightly valuable.

In conclusion, it seems that research (Marshall *et al.,* 2001; Briddle, 2005; Bulley *et al.,* 2005) supports the stages of the behavioural change approach as indicative of an individual's exercise behaviour. Thus, the more an individual exercises, the easier that individual will reach a higher stage of the behavioural change model. With regard to the present study, a more scientific approach to the drafting of the LOR questionnaire should have been followed. The original validated version of the TTM should have been considered. Also, comparative research on the different behavioural change models and their applications within the various areas of physical activity is warranted.

5.9. QUESTIONNAIRE ON EXERCISE COMPLIANCE AND THE IMPLICIT THEORY SCALE

The questionnaire on the Implicit Theory Scale (ITS) is based on a social cognitive model of Dweck and Leggett (Henderson & Dweck, 1989; Lochbaum *et al.,* 2006). This model argues that if an individual believes that he or she has a certain amount of ability, talent or skill, and this cannot be changed, the individual will not attempt to learn to improve that ability, talent or skill. This is referred to as the Entity Theory. Secondly the Incremental Theory states that if individuals believe that they can change or grow or develop throughout their lives, they will put in efforts to improve their abilities, talents and skills. In the present study, it was hypothesised that the exercise-compliant group would possess the Incremental Theory, and that the non-compliant group would possess the Entity Theory. Thus, members who exercised more frequently would have been those members who believed that they could improve their ability to exercise or do physical activities. In a sporting context, authors (Spray *et al.,* 2006) found a causal link between each implicit theory and an individual's belief of success in performing a certain task. Individuals who believed that they only possessed a certain genetic ability to perform a sport such as golf, reflected the Entity Theory, and those who believed they could improve their sporting task through training reflected the Incremental Theory (Spray *et al.,* 2006). In an earlier study Kasimatis *et al.* (1996) found the same result in a study to determine whether or not the ability of athletic coordination would influence an individual's motivation to continue to do a novel exercise task under difficult circumstances. One group of athletes were told that they had genetically determined athletic coordination (Entity Theory), and the other were told that their athletic coordination was mostly learned (Incremental Theory). Results (Kasimatis *et al.,* 1996) proved that the group adhering to the Incremental Theory exhibited a higher level of motivation than the Entity Theory group. According to Lochbaum *et al.* (2006) exercise-intervention programmes promote the Incremental Theory.

Contrary to expected results, the present study demonstrated no statistically significant correlations between either of the two exercise groups (compliant and non-compliant) and these theories. Again, after the data was accessed on the Best Med system, it transpired that only 51 of the 400 members completed

the ITS questionnaire at the end of their training period (12 months) (Table 4-7). Furthermore, the ITS questionnaire that was used in the data-collection process was not tested for validity or reliability. Of the 51 members who completed the questionnaire, 45 members reflected the Incremental Theory, in other words they believed that they could improve their ability to do exercise or physical activities. According to the researcher, little research seems to have been done to test the implicit theories as models or tools for exercise behaviour or exercise compliance.

5.10. CONCLUSION AND RECOMMENDATIONS

In conclusion, limitations of the current study were that only once-off blood pressure readings were taken with assessments, and no blood pressure readings during training sessions were taken before and after exercise. Therefore no trend could be established. There was also no recording and management of dietary fat intake and total calorie intake of food, which could have influenced the percentage readings of total blood cholesterol, BMI and body fat. Furthermore, no attention was paid to the total energy expenditures of exercise programmes, which also could have influenced these readings. The LOR and ITS questionnaires were neither valid nor reliable tools for determining the reasons for exercise compliance or non-compliance.

Statistically, the present study reported significant decreases in systolic and diastolic blood pressure, BMI, body weight, and cardiac risk percentages when measured over time (Tables 4-8, 4-9 and 4-10). All these improvements in clinical and physical parameters were demonstrated by the exercise-compliant group who were only training two or more days a week. The results therefore confirmed conclusions reached in previous literature that training at least twice a week or more frequently may improve blood pressure values (Coliac *et al.,* 2007), BMI, and body weight (Krousel-Wood *et al.,* 2007). Larger improvements in total cholesterol, body fat percentage, and blood glucose values, were also demonstrated by the exercise-compliant group, although these finding were not statistically significant ($p < 0.05$). Thus, compliance with the programme at least twice a week is necessary for deriving significant benefits from a chronic-disease management exercise programme (Covera-*Tindel et al.*, *2004*).

Long-term exercise compliance in the chronic-disease management context poses a significant challenge to biokineticists. The present study indicates that the quality of data records and exercise compliance of the medical-aid members on the BM/AH-DM Programme progressively deteriorated over the three and a half year period, and that data collected after 12 months was scarce and often incomplete. The LOR and ITS questionnaires used by the Best Med Medical Aid and Access Health were unsuccessful in predicting exercise compliance. It is suggested that future studies make use of valid and reliable psycho-social models that were tested within the chronic-disease management context.

The following recommendations are made for similar research studies:

- The measurement of total blood cholesterol levels should be supplemented with the measurements for serum LDL, HDL and triglycerides.
- Blood pressure trends, rather than 3-months interval readings, should be established.
- Dietary fat intake and total calorie intake should be recorded and managed.
- Prudent prescriptions with regard to exercise characteristics, especially total energy expenditures of exercise sessions, should be established.
- Members with DM blood glucose readings should be reported on separately from the others.
- A valid and reliable cardiac risk tool should be designed.
- Valid and reliable LOR and ITS questionnaires should be used, or, if not available, be designed.

In a publication of Discovery Health, a prominent medical-aid scheme in South Africa, Professor Tim Noakes (winter 2009) reported that individuals who took part in the Discovery Vitality Programme (a rewards programme of the medical- aid scheme), and who exercised regularly saved this scheme significant costs in terms of shorter hospitalisation times and faster recovery from surgery. However, apart from personal attention, it seems that the best motivational tool for exercise compliance in a chronic-disease management programme is yet to be discovered.

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ANNEXURES

Annexure A: Letter of Permission from Best Med Medical Aid

Annexure B: Letter of Permission from Access Health (SA)

Annexure C: Level of Readiness Questionnaire

Annexure D: Implicit Theory Scale Questionnaire

Informed Consent

I, *Petrus Adriaan du Plessis* (full name of undersigned) consent that Riana du Plessis may use clinical parameters and compliance data of Bestmed's members previously and currently enrolled in the Chronic Disease Management Program, for the sole purpose to complete her Masters Degree at the University of Pretoria.

I have been informed of the aims and objectives of the study as well as the data analysis of the above data.

I hereby declare that no information has been held from me that can place the Medical aid or individual members at risk, or that can withheld Bestmed from consenting to make the above data available to the above party.

I furthermore authorize the UNIVERSITY of Pretoria to publish and use the above data with anonymity guaranteed of the Bestmed members previously and currently enrolled in the Chronic Disease Management Program, and declare that I have no claim to any remuneration or compensation thereof.

Signed at ......*Pretoria*......on this.....*15*.....day.....*July*......of ....2006.

.........*du Plessis*.........
Signature of representative of Best med department of Health Management

Tel: (h)................. (w)....*339 9804*..... Cel:.*083 235 c268*.....

Witness:

1.........................

2.........................

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ACCESS HEALTH

09th April 2008

TO WHOM IT MAY CONCERN

In response to Ms du Plessis' request to utilize the data from Access Health database that was recorded during the course of the BestMed Chronic Disease Management Program, I hereby give consent that she may use this data with the following understanding:

1.   The data that she may use will be defined as all data recorded from BestMed members for the BestMed Chronic Disease Management Program that was managed by Access Health South Africa during the period July 2003 to December 2006;

2.   All of the above information will be strictly confidential and used for her research towards acquiring her Master's degree at University of Pretoria thesis only;

3.   All data from Access Health database and software systems remains the property of Access Health SA (Pty) Ltd;

4.   The final research report will not include any personal details of the individual participants or of the company.

I herewith also confirm that Riana du Plessis was employed by Access Health South Africa as a biokineticist to do biokinetic evaluations on all the BestMed members that were taking part in the BestMed Chronic Disease Management Program. We employed her during the period July 2004 till the end of June 2007.

Kind Regards

Dr. Jacqui Joubert
CEO: Access Health (SA)

Level of Readiness

	TRUE	FALSE
1. I don't see the need to exercise regularly to be healthy. I can manage my health in other important ways.	Pre-contemplation	
2. I have been doing regular exercise for longer than a year and I plan to continue.	Maintenance	
3. I have started exercising regularly within the last 6 months	Action	
4. I have been thinking lately that I might want to start exercising regularly at some stage in my life.	Contemplation	
5. I have only recently started exercising regularly (within the last month)	Action	
6. I am very busy right now and don't have the time or energy to exercise regularly.	Pre-contemplation	
7. I have already set up specifics days and times in the week to start exercising regularly and want to start exercising within the next few weeks.	Preparation	
8. I have managed to keep exercising regularly through the last 6 months.	Maintenance	
9. I have been re-evaluating my personal circumstances in order to accommodate my exercising program.	Preparation	
10. I really think it is important to get started with a regular exercise program, but it could only be possible in the next 6 months.	Contemplation	

Implicit Theory Scale Questionnaire

Read each sentence below and then circle the *one* number that shows how much you agree with it. There are no right or wrong answers.

1. You have a certain amount of physical fitness ability; you really can't do much to change it.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

2. Your physical fitness ability is something about you that you can't change very much.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

3. You can learn new things, but you can't really change your basic physical fitness ability.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

4. No matter who you are, you can change your physical fitness ability a lot.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

5. You can always greatly change your physical fitness ability.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree

6. No matter how much physical fitness ability you have, you can always change it quite a bit.

1	2	3	4	5	6
Strongly Agree	Agree	Mostly Agree	Mostly Disagree	Disagree	Strongly Disagree