A Description of Dyslipidaemia and Selected Risk Factors for Cardiovascular Disease in Patients Attending Port Elizabeth Hospital Complex.

by
Vanessa Kotzé

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Supervisor: Prof M.G. Herselman
Co-supervisor: Ms E van Tonder
Statistician: Prof DG Nel

Faculty of Medicine and Health Sciences
Department of Interdisciplinary Health Sciences
Division of Human Nutrition

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DECLARATION

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ABSTRACT

CVD is a global as well as national burden of disease.

Aim: To identify and describe dyslipidaemia as well as the selected risk factors for cardiovascular disease in patients diagnosed with dyslipidaemia attending Port Elizabeth Hospital Complex (PEHC).

Setting: Port Elizabeth Hospital Complex, Port Elizabeth, South Africa.

Sample: Adult patients (18 years of age or above; both sexes; all races) attending PEHC and diagnosed with dyslipidaemia. Convenience sampling was used.

Methods: Observational descriptive cross-sectional study in the quantitative domain. Each participant was interviewed, anthropometric measurements taken, and patient files consulted. Variables investigated included lipid profiles, glucose control, a family history of cardiovascular diseases, presence of hypertension (HPT) and diabetes mellitus (DM), android obesity, smoking status, physical activity (PA) levels, and fat (total, saturated and cholesterol) intake. Dietary intake was compared to the therapeutic lifestyle change program. Clinical signs of dyslipidaemia were assessed to detecting familial hypercholesterolaemia (FH). Each referral to the dietetics department was counted. Descriptive statistics were used. Regression analysis and contingency tables were used to analyse relationships between variables.

Results: N=103 patients (59% female) with a mean age of 59.9 years were included. Coloured and Caucasian ethnic groups represented the majority (45% and 33% respectively). Hypercholesterolaemia was present in 98%. A third presented with elevated LDLC. Caucasians (50%) presented with decreased HDLC and/or elevated LDLC levels. Africans (80%) presented with decreased HDLC levels whilst 91% of the Indian ethnic group presented with elevated LDLC levels. DM had the lowest frequency in the sample (36%) and 60% presented with hypertension. Android obesity was present in 82% of participants; more females were obese than overweight and vice versa in males. Forty-four percent (44%) had a smoking history; 22% was current smokers. No significant relationship was found between low HDL levels and smoking status. Thirty percent followed a diet in excess of the recommended SFA intake of <7%, whilst the majority had low PA levels. There was a high prevalence of FH (1/34 compared to the national prevalence of 1/70). Only 35% of participants were recently referred to the dietetics department.

Conclusion: The CVD risk factors HPT, elevated LDLC levels, smoking, low PA and dietary intake high in SFA were found to be present. Possible FH had a high frequency. Dietitians could be utilised more effectively in managing patients with CVD risk.

OPSOMMING

KVS is a wêreldwye asook nasionale siektelas.

Doel: Om dislipidemie sowel as gekose risikofaktore te identifiseer en te beskryf in pasiënte gediagnoseer met dislipidemie en wie Port Elizabeth Hospitaalkompleks (PEHK) besoek.

Omgewing: Port Elizabeth Hospitaalkompleks, Port Elizabeth, Suid Afrika

Proefsteek: Volwasse pasiënte (18 jaar en ouer; albei geslagte; alle rasse) wat PEHC besoek en gediagnoseer met dislipidemie. Geriefsteekproef was gebruik.

Metodes: Waarnemings, beskrywende, deursnee studie in die kwantitatiewe domein is uitgevoer. Elke deelnemer is ’n onderhoud mee gevoer, antropometriese metings geneem, en pasiënt lêers nagegaan. Die veranderlikes ingesluit was lipied profiele, glukose beheer, 'n familiegeskiedenis van kardiovaskulêre siektes (KVS), teenwoordigheid van hoë bloeddruk en diabetes mellitus (DM), androïde vetsug, rook status, fisiese aktiwiteit (FA) vlakke, en vet (totaal, versadig en cholesterol) inname. Dieet inname is vergelyk met die terapeutiese lewenstyl veranderings program. Kliniese tekens van dislipidemie is ondersoek vir die identifisering van familiële hipercholesterolemie. Elke verwysing na die dieetkunde departement is gereken. Opsommingstatistiek is gebruik om veranderlikes te beskryf. Regressieanalise en gebeurlikheidstabelle gebruik is om verwantskappe tussen veranderlikes te ontleed.

Resultate: N=103 pasiënte (59% vroulike) is ingesluit met 'n gemiddelde ouderdom van 59.9jaar. Die Kleurling en Blanke etniese groepe was in die meerderheid (45% en 33% onderskeidelik). Hipercholesterolemie was teenwoordig in 98%. 'n Derde het met verhoogde LDLC voorgedoen. Blankes (50%) het met verlaagde HDLC en/of verlaagde LDLC vlakke vertoon. Afrikane (80%) het met verlaagde HDLC vertoon terwyl 91% van die Indiese etniesegroep met verhoogde LDLC vlakker vertoon het. DM het die laagste frekwensie (36%) in die steekproef gehad en 60% het met hoë bloeddruk voorgedoen. Androïde vetsug was teenwoordig in 82% van die deelnemers; meer vroue was vetsugtig as oorgewig en vice versa vir mans. Vier en veertig persent (44%) het 'n rook geskiedenis gehad; 22% was huidige rokers. Geen beduidende verband is tussen lae HDL-vlakke en rook status gevind nie. Dertig persent het 'n dieet ingeneem wat meer as die aanbevole VVS inname van <7% was, terwyl die meerderheid ook lae PA vlakke gehad het. Daar was 'n hoë voorkoms van FH (1/34 deelnemers vergelyking met die nasionale voorkoms van 1/70). Slegs 35% van die deelnemers was onlangs verwys na die dieetkunde departement.

Gevolgtrekking: Die KVS risikofaktore HPT, verhoogde LDLC vlakke, rook, lae FA en ‘n dieet hoog in VVS was algemeen. Moontlike FH het 'n hoë voorkoms. Dieetkundiges kan meer doeltreffend benut word in die bestuur van pasiënte met KVS risiko.

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CONTRIBUTIONS BY PRINCIPAL AND FELLOW INVESTIGATORS

The principal researcher, Vanessa Kotzé developed the idea and compiled the protocol. The principal researcher planned the study, undertook data collection captured the data for analyses, analysed the data with the assistance of a statistician and wrote up the thesis.

The co-supervisors provided input and guidance during all stages of the research process.

Data was collected with the assistance of two research assistants.

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LIST OF ABBREVIATIONS

apoB	Apolipoprotein B
BF	Body fat
BMI	Body mass index
CAD	Coronary artery disease
DBP	Diastolic blood pressure
CDC	US Centre for Disease Control
CEpHEus sa	CEntralised pan-south african survey on tHE under-treatment of hypercholesterolaemia (South Africa)
CHD	Coronary heart disease
CRF	Cardiorespiratory fitness
CVD	Cardiovascular disease
DASH	Dietary Approach to Stop Hypertension
DM	Diabetes Mellitus
dYsis	dYslipidaemia international study
ET	Exercise training
FFA	Free fatty acids
FH	Familial hypercholesterolemia
HBA1c	Glycated haemoglobin (HBA1c)
HDL	High density lipoprotein
HeFH	Heterozygous familial hypercholesterolemia
HF	Heart failure
HoFH	Homozygous familial hypercholesterolemia
HPT	Hypertension
IDF	International Diabetes Federation
IHD	Ischaemic heart disease
LBM	Lean body mass
LDL	Low density lipoprotein
LDLC	Low density lipoprotein cholesterol
Lp(a)	Lipoprotein a
MI	Myocardial infarction
MUFA	Mono-unsaturated fatty acid
NCD	Non communicable diseases
PA	Physical activity
PEHC	Port Elizabeth Hospital Complex
PUFA	Poly-unsaturated fatty acid

SANHANES-1	South African National Health and Nutrition Examination Survey
SBP	Systolic blood pressure
SFA	Saturated fatty acid
T1DM	Type 1 Diabetes Mellitus
T2DM	Type 2 Diabetes Mellitus
TC	Total cholesterol
TGL	Triglyceride
TLC	Therapeutic lifestyle diet
WC	Waist circumference
WHO	World Health Organisation
WHR	Waist-to-hip ratio

GLOSSARY

Atherosclerosis	A condition where plaque builds up inside arteries[1]
Cardiovascular disease	Disease affecting the circulatory system[1]
Cardiorespiratory fitness	The highest level of estimated metabolic equivalents achieved during maximal exertion such as on a treadmill test[37]
Corneal arcus	A white, or yellowish opaque ring in the corneal margin of the eye. In young people it can be a sign of elevated cholesterol levels.
Coronary heart disease	A disease in which plaque builds up inside the coronary arteries. Also termed ischaemic heart disease
Diabetes Mellitus	A condition where the body is not able to regulate blood glucose levels.
Dietitian	A person trained in the field of human nutrition. In South Africa registration of such a professional with the Health Professions Council of South Africa is essential to be able to practice
Dyslipidaemia	A significant alteration in the lipid and lipoprotein levels, as measured in the blood, which increases the risk for developing atherosclerosis
Dyslipoprotenaemia	An alteration in lipoprotein levels in the blood
Exercise	Planned, structured, repetitive, and purposeful physical activity[36]
Hypercholesterolaemia	A total cholesterol value in the blood of more than 5 mmol/L
Hyperglycaemia	Serum glucose levels above ≥6.1mmol/L or an HbA1c ≥ 6.5%.
Hypertension	A long term medical condition in which the blood pressure in the arteries is persistently elevated
Hypertriglyceridaemia	Elevated levels of triglycerides in the blood
Non communicable diseases	A medical condition or disease that is not caused by infectious agents. It can refer to chronic diseases which can progress slowly over a long period of time

Low density lipoprotein cholesterol	Low-density lipoprotein is one of the major lipoprotein and results in atheroclerosis.[5]
Occupational activity	Physical activity during working hours
Physical activity	Any bodily movement produced by skeletal muscles that result in energy expenditure[36]
Step 1 and Step 2 diet	Part of the Therapeutic changes for lifestyle diet. It focusses on fat intake and more specifically on saturated fat intake as well as cholesterol.
Stress	A state of physiological or psychological strain caused by adverse stimuli, physical, mental, or emotional, internal or external, that tend to disturb the functioning of an organism and which the organism naturally desires to avoid[39]
Tendon xanthomata	Skin lesions caused by the accumulation of fat.
Therapeutic lifestyle diet	Therapeutic Lifestyle Changes (TLC) is a program that can assist in lowering cholesterol. The lifestyle changes include diet, exercise, weight loss, and not smoking
Type 1 Diabetes Mellitus	Now called insulin dependent diabetes mellitus. This is where the pancreas do not produce insulin to assist with glucose control.
Type 2 Diabetes Mellitus	Now called non-insulin dependent diabetes mellitus. This is where the pancreas does not produce enough insulin to assist with glucose control or there is insulin resistance by the body cells.

CHAPTER 1:
INTRODUCTION

1.1. BACKGROUND

Cardiovascular disease (CVD) is on the increase and contributes to 17.3 million deaths per year worldwide.[1] The increase in CVD is not only seen in the developed countries but also in developing countries and the question arises as to why this is observed. Is it due to the westernisation experienced along with a change in eating patterns and physical activity levels? Or is it possibly due to the increase in lifespan as a result of an improvement in medical care of the twenty first century?

The investigator's interest in this phenomenon and where the beginnings for this study were founded had its origins in her years as dietitian working in the Port Elizabeth Hospital Complex (PEHC) and surrounding clinics. Here the realisation was made that Port Elizabeth and its population did not escape this worldwide phenomenon.

With atherosclerosis and its humble observation by Leonardo da Vinci in the late 1400's to the discovery of the theory of atherosclerosis by Nikolai N. Anichkov in 1913 the impact of atherosclerosis is of importance to wellness and health. It is in this last mentioned discovery where the link between atherosclerosis and cholesterol was made by Nikolai Anichikov. However, Anichkov's world recognition only came in 1950 when Dr John Godman published a paper in the Journal *Science* on atherosclerosis in which he emphasized that Anichkov made the discovery that cholesterol contributed to atherosclerosis. Dr Gofman later on not only confirmed Anichkov's initial findings but also discovered the 2 cholesterol fractions, low density- and high density lipoproteins and showed that low density lipoproteins were responsible for the rapid progression of atherosclerosis in humans.[2]

The next logical question was what actually influences cholesterol and the cholesterol fraction levels in the human body, an issue that very much remained a controversial issue in current medical research. In 1952, Dr. Lawrence Kinsell and his associates showed that the ingestion of plant foods and avoidance of animal fats significantly decreased the blood level of cholesterol in most human beings. Later, the reason for this observation was shown to be the unsaturation of the vegetable fats and this lead to a worldwide trend where millions of people tried to substitute vegetable for animal fats in their diet. This trend is still evident today and has resulted in a rapid growth of industries that offer foods rich in unsaturated fats. With people being more aware of healthy eating it has also become essential for these industries to have the unsaturated and cholesterol content of the food product sold to the consumer on the food label. (2) Recently the evidence for the effect of fat and cholesterol intake on human health has been questioned and numerous meta-analysis and research projects have been done on this topic. [3,4]

Dyslipidaemia is a major CVD risk factor in South Africa. The 2001 Census reported that about 5,7 million people in South Africa had hypercholesterolaemia (TC >5mmol/l) of whom 2,5 million

were from the Caucasian population, 1,5 million from the African population, 1,2 million from the Coloured population and only 400 000 from the Indian population.[5] According to the Department of Health, the prevalence of hyperlipidaemia in the Eastern Cape was reported at 1,3% for men and 1.1% for women. The incidence was reported in the 12 months preceding the survey and was 787 per 100 000 in the Eastern Cape with the incidence being 134, 3135, 367 among Africans, Caucasian and Coloureds 367 respectively per 100 000. [5]

In South Africa 59% of the ischaemic heart disease (IHD) mortality and disease burden was attributable to elevated total cholesterol levels above 3.8 mmol/l.[6] Such preventable losses in the productive labour force clearly constitute a major cost to the country's economy.[5] In 1991 the estimated indirect costs with regards to CVD in South Africa amounted to between 4135.71 million rand and 5035.03 million rand excluding the cost of rehabilitation and follow-up of patients with CVD.[7]

1.2. MOTIVATION FOR STUDY

At the PEHC there is a large cardiology clinic with neither data on the profile of the patients attending the clinic nor the CVD risk factors that they present with such as the previously mentioned dietary intakes of cholesterol and fats. Such knowledge is essential and can help in establishing the important risk factors that play a role in the development in CVD in the population attending the PEHC that needs to be prioritised and addressed. Secondly, as an outflow from the first mentioned problem, current strategies employed in CVD prevention programmes need to be re-evaluated to determine whether the appropriate risk factors are being addressed and emphasised. This study can then lay the grounds for further studies in establishing effective preventative management programmes.

1.3. STRUCTURE OF THESIS

The dissertation is presented in chapter format. It was technically edited in the style required by the University of Stellenbosch, and has been edited by a competent language editor.

This introductory chapter is followed by chapter 2 that consists of the literature review. In this review, the risk factors for CVD will be discussed with emphasis on the influence they have on lipid fractions as well as CVD risk. An overview on the pathophysiology as well physiology of normal as well as abnormal lipid metabolism will be presented. Lastly, an in depth discussion on the diet as a contributory or protective factor for CVD will be presented.

Chapter 3 describes the study design, the sampling and characteristics of the sample, as well as

the methods used for the data collection and the type of data collected, which included anthropometrical measurements, laboratory blood values, clinical signs, screening for fat intake and lastly, analysis and statistical methods. In addition, ethical issues and approval of the study will also be included.

The results of the study along with the discussion there-off will be presented in chapter 4. Firstly the baseline characteristics of the sample will be presented followed by a description on the types of dyslipidaemias the sample presents along with a description on the clinical, behavioural and biochemical risk factors for CVD the sample presents with. Included in the clinical risk factors are Diabetes Mellitus (DM), hypertension (HPT), obesity, clinical manifestation of coronary heart disease (CHD) or atherosclerosis and a family history of CHD. Smoking status, level of physical activity and total cholesterol and saturated fat intake are some of the risk factors described under the behavioural risk factors. Lastly, the proportion of the sample are referred to the dietetics department will be reported on.

The results will be followed by a discussion in Chapter 5. The results of the study are compared with the available literature and possible reasons for the results obtained given. This is followed by a review of the strengths and limitations of the study.

Lastly in chapter 6, a conclusion along with recommendations for future research is presented.

CHAPTER 2:
LITERATURE STUDY

In this literature study, the aetiology, pathophysiology and pathology of CVD will be discussed. The focus will be on the risk factors for CVD and how each contributes to the development of CVD. Differences in ethnic groups with regards to the risk factors will also be investigated as to determine any noticeable differences. Lastly the role of the Dietitian with respect to CVD risk management as well as the need of referral to the Dietitian for this role will be explored.

2.1. INTRODUCTION

CVD is one of the leading causes of adult mortality worldwide, resulting in approximately 17.3 million deaths per year which roughly amounts to 31% of all deaths. The other major contributors to adult mortality include other non-communicable diseases (NCDs) contributing 33% of annual deaths whilst communicable, maternal, perinatal and nutritional conditions contribute 27% and injuries 9%.[1]

According to the Statistics South Africa (StatsSA) report of 2011, the statistics differ slightly in South Africa as diseases of the circulatory system contributed 16,2% of all reported deaths in 2011. This is an increase from the 2009 numbers where diseases of the circulatory system contributed 14,7%. [3]

The occurrence of strokes and coronary heart disease has been increasing in South Africa due to health behaviours adopted from the developed countries, such as smoking, hypertension and a poor diet. (2006) According to StatsSA, 83 000 people died of diseases related to the circulatory system in South Africa in 2010.[5]

The World Health Organisation (WHO) classifies CVD into two classes. Firstly, CVD due to atherosclerosis and then the second class, other CVDs. CVD due to atherosclerosis include IHD or coronary heart disease (e.g. heart attack), cerebrovascular disease (e.g. stroke) and diseases of the aorta and arteries (e.g. HPT and peripheral vascular disease). These diseases are interrelated and often co-occur. Other CVD's include congenital heart disease, rheumatic heart disease, cardiomyopathies and cardiac arrhythmias.

In 2008, out of the 17.3 million cardiovascular deaths globally, heart attacks were responsible for 42% (7.3 million) of the deaths and strokes were responsible for 35.8% (6.2 million) of the deaths. From this it can be concluded that CVD due to atherosclerosis are by far the main contributor to CVD mortality. The underlying disease process occurs in the blood vessels where the major blood vessels supplying the heart muscle become blocked or constricted, and results in ischaemic heart disease or coronary heart disease (e.g. heart attack) and cerebrovascular disease (e.g. stroke), a condition referred to as atherosclerosis.[1] As depicted in figure 2.1, atherosclerosis is a complex pathological process in the walls of blood vessels that develops

over many years in response to risk factors such as elevated levels of low-density lipoprotein cholesterol (LDLC).[5] Fatty material and cholesterol are deposited inside the lumen of medium- and large-sized arteries where plaques cause the inner surface of the blood vessels to become irregular and the lumen to become narrow, causing the blood vessel to become less pliable and constricted. As a result the blood flow to the heart is decreased and it causes chest pain (angina) due to the resulting ischemia. The other alternative is that the atherosclerotic plaque ruptures and a thrombus is formed. This thrombus then cut-off the blood flow which result in the decrease in the supply of oxygen and nutrients which in turn can damage the heart muscle, resulting in a heart attack.[1] Other life threatening clinical outcomes that can result from this condition are limb ischemia, claudication or gangrene when in the peripheral circulation, angina, myocardial infarction when present in the coronary arteries. In the cerebral arteries, atherosclerosis can lead to a stroke or an ischemic heart attack.[1,5]

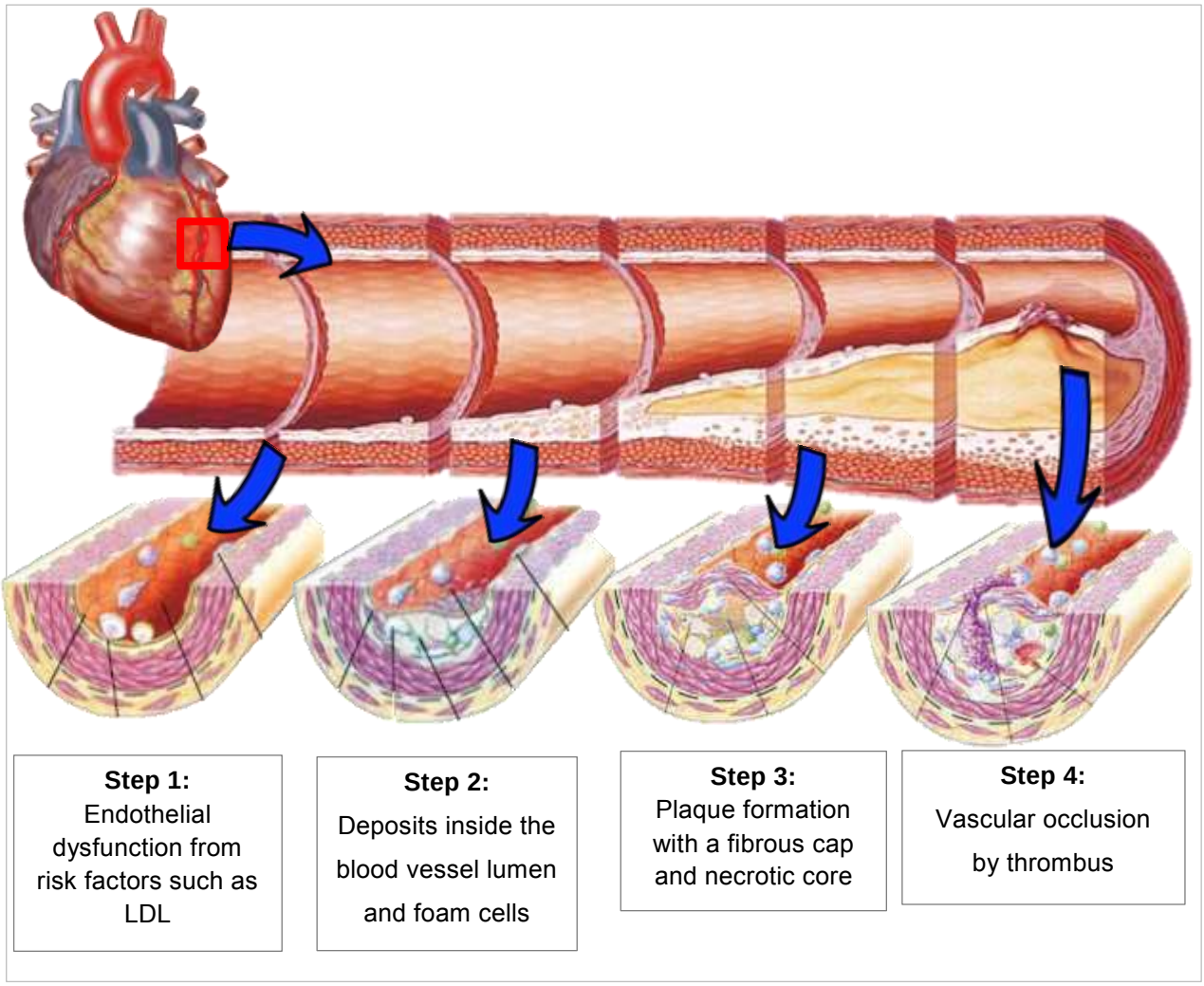


Figure 2.1: The atherosclerotic process Adapted from 1,6,7

When looking at elevated levels of LDLC as a risk factor for atherosclerosis, the link was established by Dr John Godman who discovered the 2 lipoprotein fractions, low density- and high density lipoproteins and showed that low density lipoproteins were responsible for the rapid progression of atherosclerosis in humans.[2] A lipid profile that increases the risk for developing atherosclerosis is termed dyslipidaemia. Dyslipidaemia is defined as a significant alteration in the lipid and lipoprotein levels, as measured in the blood, which imparts risk to health. It includes a variety of abnormalities such as hyperlipidaemias and dyslipoprotenaemia. The term hyperlipidaemias include hypertriglyceridaemia and hypercholesterolaemia. Dyslipoprotenaemia refers to the abnormalities of the various lipoproteins in the blood.[5,8]

In South Africa, 59% of the ischaemic heart disease (IHD) mortality and disease burden was attributable to elevated total cholesterol levels above 3.8 mmol/l. Such preventable losses in the productive labour force clearly constitute a major cost to the economy. In 1991 the estimated indirect costs with regards to CVD in South Africa amounted between 4135.71 million rand and 5035.03 million rand excluding the cost of rehabilitation and follow-up of patients with CVD.

Over the past two decades, cardiovascular mortality rates have declined substantially in high-income countries. There is clear evidence that population-wide primary prevention and individual health-care intervention strategies have both contributed to these declining mortality trends. For example, during the 10-year period covered by the WHO Multinational Monitoring of Trends and Determinants of Cardiovascular Disease initiative (WHO MONICA Project), mortality from coronary heart disease and stroke declined dramatically in many of the 38 MONICA populations. The decline in mortality has been attributed to reduced incidence rates and/or improved survival after cardiovascular events due to prevention and treatment interventions. Across all populations with declining coronary heart disease mortality, reduced cardiovascular risk contributed to 75% and 66% of the change in men and women, respectively; the remainder being attributed to providing health care resulting in improved survival in the first four weeks after the event. The above data and similar experiences in other countries strongly support the view that population- wide primary prevention and individual healthcare approaches go hand-in-hand to reduce the population burden of CVDs. [4]

The remainder of the literature review will deal with the risk factors of CVD and its' influences on disease progression and mortality as guided by the risk factors depicted in table 2.1 below. This will be followed by a more in depth discussion on dietary fat as a risk or protective factor for CVD and the role of the dietitian in the management of CVD.

2.2. RISK FACTORS FOR CARDIOVASCULAR DISEASE

Factors that promote the process of atherosclerosis and CVD are known as risk factors and can be categorised into biological, clinical, behavioural, biochemical and genetic / familial risk factors. In Table 2.1 the risk factors under each category are listed and a discussion of each risk factor follows ordered according to the presentation in table 2.1.

Table 2.1: Classification of CVD risk factors[1,9,10]

Risk factor group	Risk factor
Biochemical	Dyslipdaemia (Raised LDLC, Low HDLC) Hyperglycaemia High plasma concentrations of lipoprotein (a) Hyperfibrinogenaemia
Biological (nonmodifiable)	Older age Male Gender Post-menopausal women
Clinical	Existing atherosclerosis Coronary heart disease (CHD) Family history of CHD or atherosclerosis Non communicable diseases (NCD): Diabetes mellitus (DM); HPT Obesity
Behavioural (modifiable)	Smoking Lack of exercise Stress Dietary: Alcohol use; Atherogenic diet
Genetic or familial	Familial combined hyperlipidaemia LDL receptor defects Binding defective apoB100 Dysbetalipoproteinaemia

2.2.1. Biochemical risk factors

The biochemical risk factors for CVD include altered blood lipid values as well as altered serum glucose values. Along with the biochemical indicators, the conditions Diabetes Mellitus (DM) and atherosclerosis will be discussed.

2.2.1.1. *Dyslipidaemia, atherosclerosis and coronary heart disease (CHD)*

There are various components of the lipid profile that are considered atherogenic. These include alterations in lipid-, lipoprotein- as well as apolipoproteins levels and are believed to contribute to the development of atherosclerosis. The normal values along with the altered / abnormal values for each fraction are shown in table 2.2.

Atherosclerosis is in part due to endothelial dysfunction that is initiated when there is an insult to the endothelial of the blood vessels resulting in inflammation. This stimulates a response by the monocytes and once the monocytes permeate the endothelium of the blood vessel it evolves into macrophages that oxidises cholesterol delivered to the site of injury by the LDL particles. These macrophages become foam cells and later on fatty streaks. At the same time that the fatty streaks are forming, intracellular microcalcification occurs resulting in impaired endothelial function. It is suspected that reduced nitric oxide also plays a role in this endothelial dysfunction.

Table 2.2: Categorisation of lipid levels[8,11,12]

	Categories	Cut-offs
Total cholesterol	Normal	< 5.0mmol/L
	Moderate hypercholesterolaemia	5.0 – 7.5mmol/L
	Severe hypercholesterolaemia	7.6 – 15mmol/L
	Extreme hypercholesterolaemia	> 15 mmol/L
Triglyceride	Normal	<1.7 mmol/L
	Elevated	> 1.7 mmol/L
	Moderate hypertriglyceridaemia	5 – 15 mmol/L
	Severe hypertriglyceridaemia	> 15 mmol/L
LDLC	Normal LDL	< 2.5mmol/L
	Elevated	≥ 2.5 mmol/L
	Mild-moderate LDL hypercholesterolaemia	3 < LDLC < 5 mmol/L
	Severe LDL hypercholesterolaemia	> 5 mmol/L
HDLC	Normal	≥ 1.2 mmol/L
	Low	< 1.2 mmol/L
	Significant hypoalphalipoproteinaemia	<0.7 mmol/L
	Severe hyperalphalipoproteinaemia	> 2.5mmol/L

* The values reflected in table 2.2 are those utilised at Port Elizabeth Hospital Complex, South Africa

As mentioned earlier, Anichkov and Godman were the first to recognise the link between serum cholesterol and atherosclerosis. Godman further went on to establish the relationship between LDL and atherosclerosis in the 1950's.[2] This was further investigated by Dr Ancel Keys and was to become known as the diet-heart hypothesis. Keys established the Seven Countries Study in 1947 where the objective was to investigate the associations of diet, other risk factors and disease rates between populations and among individuals within populations. Interestingly enough South Africa formed part of the pilot study where informal surveys found a difference in heart attack rates between populations such as between South Africans of European descend and native South Africans.[13,14] The Seven Countries Study found a positive association between serum cholesterol levels and CHD incidence.[15]

The causal relation between LDL and CHD incidence was further strengthened when a randomised trial conducted by Shepard in 1995 found that LDL-lowering drugs reduced CHD incidence in the study population.[3] Due to this positive association between LDL and CHD incidence, decreased / lower LDL are seen as better for vascular health.

The inverse association between HDL levels and CHD was first noticed by the Framingham study investigators in 1977 after they found that individuals with CAD presented with lower HDL levels than did healthy participants.[16] This inverse association can be explained in that HDL is responsible for accepting oxidised cholesterol from the macrophages to prevent it from becoming foam cells. It also return the cholesterol to the liver to be excreted in bile. Additionally, HDLC may protect against atherogenesis by mechanisms not directly related to reverse cholesterol transport such as its antioxidant properties.[17]

Triglycerides are not directly atherogenic but represents an important biomarker of CVD risk because of its association with atherogenic remnant particles and apo CIII. [18]

In 2008, the global prevalence of raised total cholesterol among adults was 39% (37% for males and 40% for females respectively). The mean total cholesterol changed little between 1980 and 2008, falling by less than 0.1mmol/l per decade in males and females. The prevalence of elevated total cholesterol was highest in the WHO European Region (54% for both genders), followed by the WHO Region of the Americas (48% for both genders). The WHO African Region and the WHO South-East Asia Region showed the lowest percentages (23% and 30% respectively).[1]

In South Africa, 24% of the population had elevated total cholesterol values according to the South African National Health and Nutrition Examination Survey (SANHANES-1) of 2013 with the Eastern Cape having a prevalence of 27%. Nationally, around nineteen percent of South African men had total cholesterol levels above 5mmol/L whilst in females it was 28%.[5] Looking

at the various ethnic groups, the Caucasian ethnic group had the highest prevalence at 55%, followed by the Asian/Indian population (43%), the coloured population (34%) with the African ethnic group presenting with the lowest prevalence at 20%.[18] The abnormal LDL levels (>3 mmol/L) followed a similar pattern to that of the total cholesterol with a national prevalence being at 25% and that of Eastern Cape at 24%. More females presented with an elevated LDL (30%) than males.[18]

Twenty five percent (25%) of the population presented with elevated triglycerides levels with the males presenting with a higher prevalence than the females (24% versus 21%). Again the Caucasian ethnic group has the highest prevalence (56%) and the African ethnic group with the lowest prevalence (22%).[18]

Looking at the HDL fraction, 48% of the South Africa population presented with HDL levels below 1.2 mmol/L with the Eastern Cape having a similar prevalence (50%). The South African males tend to have a higher prevalence than the females. The Asian/Indian ethnic group had highest prevalence of the ethnic groups whilst the African ethnic group had the lowest prevalence.[18]

There are certain factors that can contribute to an altered lipid and/or lipoprotein profile and in these instances the resulting dyslipidaemias are classified as secondary dyslipdaemias.[19]

2.2.1.2. *Dyslipoprotenaemia*

Apolipoprotein B (apoB), the main apoprotein of atherogenic lipoproteins levels can be substituted for LDL cholesterol, but it does not add further to the risk assessment. Based on the available evidence, it appears that apoB is a similar risk marker to LDL cholesterol and a better index of the adequacy of LDL-lowering therapy. Also, there appears to be less laboratory error in the determination of apoB than LDL cholesterol, particularly in patients with hypertriglyceridaemia. However, apoB is not presently being measured in most laboratories as is the case in RSA.[19]

Apolipoprotein A1 (apoA1) is the major apoprotein of HDL. It is beyond doubt that the apoB/apoA1 ratio is one of the strongest risk markers. However, it is still not established whether this variable should be used as a treatment goal. The reasons being the measurement of apolipoproteins is not available to all physicians, it is more costly than currently used lipid variables, and does not add more information, its use is not as yet generally recommended.[19]

2.2.1.1. *Lipoprotein(a)*

Lipoprotein(a), abbreviated Lp(a) is a low-density lipoprotein to which is attached an additional

protein, apolipoprotein(a) and has some common characteristics with LDL. High concentrations of Lp(a) are associated with increased risk of CHD and ischaemic stroke, although there is no randomized intervention showing that reducing Lp(a) decreases CVD risk. There is no justification for screening the general population for Lp(a) at present except for the possibility in individuals with a family history of premature CVD, and no evidence that any value should be considered as a target.[19]

Table 2.3: Factors influencing Lipid and Lipoprotein values[19]

	Factors decreasing Lipid / lipoprotein fraction	**Factors increasing Lipid / lipoprotein fraction**
LDL*	Replacing SFA* with carbohydrate Replacing SFA with MUFA	Rapid increase in weight Hypothyroidism Acute intermittent porphyria Nephrotic syndrome Medications such as Amiodarone, thiazide diuretics, glucocorticoids, immunosuppressants
Triglyceride		Replacing SFA with carbohydrate Excessive energy intake Rapid increase in weight Anorexia nervosa Chronic renal failure Medications e.g. HAART*, beta blockers,
HDL*	Recent illness; Starvation and stress Smoking Obesity Lack of exercise Medications such as thiazide diuretics, steroids, and beta-blockers; HAART* Hypertriglyceridemia Elevated immunoglobin levels Replacing SFA with carbohydrate Intestinal malabsoprtion Chronic renal failure	Moderate ethanol consumption Insulin Estrogen. Regular aerobic exercise Smoking cessation Decrease in body mass index Statin therapy (mild) Replacing carbohydrate with MUFA/PUFA Medications e.g. oestrogens

* LDL = low density lipoprotein; HDL = high density lipoprotein, SFA = saturated fatty acid, HAART = Highly Active Antiretroviral Therapy

2.2.1.2. *Hyperfibrinogenaemia*

Plasma fibrinogen is elevated when intracoronary thrombosis occur, as in myocardial infarction (MI). It is considered an independent risk factor for CVD but there is uncertainty on whether fibrinogen is involved in the disease process (atherogenesis) or a marker of vascular damage (inflammation).[7]

Some of the other risk factors for CVD are also associated with elevated fibrinogen levels for example smoking, DM, HPT and obesity.[7]

2.2.1.1. *Serum glucose and Diabetes Mellitus*

Globally the incidence of DM is on a rapid increase as evident from the global burden of this disease that has amplified from 30 million people in 1985 to an estimated 383 million in 2014.[20] The International Diabetes Federation (IDF) Diabetes Atlas projects that in 2035, this number would have further increased to 592 million. Type 2 DM (T2DM) contributes disproportionately by far the most to this increase when compared to type 1 DM (T1DM).

The IDF statistics are derived from the 80 most populous countries of which South Africa is one.[21] The IDF divides the 80 countries included in the analysis and projections into 7 regions namely Africa (AFR); Europe (EUR); Middle East and North Africa (MENA); North America and Caribbean (NAC); South and Central America (SACA); South-East Asia (SEA); and the Western Pacific (WP). In 2014 the region of Africa was found to have the lowest prevalence of adults with DM at 5.7% but is projected to have the largest proportional increase by 2035 with an estimated 109% increase. South Africa had the second highest prevalence in the Africa region at 8.3%.[21] A previous estimate of DM prevalence in RSA was a conservative 6.5%.[22] The SANHANES determined the prevalence to be 9.5% by testing the glycated haemoglobin (HBA1c) and using a cut-off > 6.5% for the diagnosis of DM. Females were found to have a higher prevalence at 11% when compared to males at 7.9%.[18]

Diabetes Mellitus (DM), a disease itself is considered a risk factor for CVD and a close link exists between these two conditions. The risk for CVD is two to three times higher in diabetics than for the general population and it is estimated that around 60% of deaths in people living with DM is due to CVD.[1] The increased risk has been found to be applicable to both genders but it is disproportionately higher in diabetic women (in the general population the CVD risk is higher in men as discussed earlier).[1,23]

The link between DM and CVD is complex and multifaceted and encompasses various interactions between glucose and lipid metabolism. These interactions include diabetic dyslipidaemia, dyslipidaemia affecting glucose metabolism, statins and new onset DM and

lastly the interactions between glucose metabolism and familial hypercholesterolemia.[24]

Not all DM patients manifest with diabetic dyslipidaemia but up to 70% of patients can manifest with some lipid abnormality. Diabetic dyslipidaemia generally presents as elevated TGL, low HDL-C and small, dense LDL particles and this atherogenic lipid profile is probably the most important link between DM and CVD (mostly CHD).[1,7,24]

These lipid changes mentioned above may not only be a consequence of impaired glucose metabolism but can also cause them and in this regards TGL and HDLC are of importance. Elevated TGL can lead to increased free fatty acid levels that in turn contribute to the development of subclinical inflammation. This development in turn contributes to β-cell dysfunction and insulin resistance. HDL in turn may directly affect glucose metabolism and higher HDLC was associated with less hyperglycaemia in the Investigation of Lipid Level Management to Understand It's Impact In Atherosclerotic events (ILLUMINATE Study). Thus patients presenting with hypertriglyceridemia and low HDLC levels are at increased risk for developing T2DM.[24]

There is some evidence that patients receiving statins are at higher risk to develop DM than those receiving alternative medication or placebos.[25] Not only does the type of statin prescribed need to be considered but also the dose size. Higher doses increase the risk more than smaller doses but the evidence is however not conclusive (Table 2.4).

In contrast to the previously discussed factors, familial hypercholesterolaemia seems to have a protective effect against developing DM or new onset DM with the start of statin therapy.[24]

Another risk factor to consider apart from the diagnosis of DM is also the glycaemic control. In well-controlled T1DM the lipogram profile is similar to the general population but in poorly controlled type 1 diabetics, hypertrigliceridaemia and decreased HDL was observed. This atherogenic profile may be improved but not eliminated with improved diabetes control.[19,24] In T2DM on the other hand, the lipogram observed mimics that of insulin resistance such as elevated total cholesterol, triglyceride and sometimes lower HDL levels. The LDL is generally not significantly elevated but the LDL particle itself is smaller and denser which increases atherogenicity. Some of the increased CVD risk is also attributable to the presence of other CVD risk factors such as HPT and obesity.

Table 2.4: DM risk and statin use

Study	Population	Cut-off used for DM or hyperglycaemia	Statin used	Outcome
Justification for the use of statins in primary prevention: An intervention trial evaluating Rosuvastatin (JUPITER) (published 2008)[25]	Males > 50yr & Females > 60yrs, LDL < 3.4mmol/L with elevated C-reactive protein (CRP), not on lipid modifying drug; n=17802	Unknown, physician diagnosed	Rosuvastatin	Minimal difference in HbA1c between placebo and intervention group; 3% of sample developed DM (*P*=0.01)
Women's health Initiative (1993 - 2005) [26]	50-79yr old postmenopausal females without DM, n=153 840	Self-report of a new physician diagnosis of treated DM	Statin categories by relative potency of action to decrease low-density lipoprotein cholesterol. Low potency: (fluvastatin, lovastatin, pravastatin) High potency: (simvastatin, atorvastatin)	Statin use at baseline associated with an increased risk of DM (hazard ratio [HR], 1.71; 95% CI, 1.61-1.83). After adjusting for potential confounders: (multivariate adjusted HR,1.48; 95% CI, 1.38-1.59) Observed for all types of statin medications
West of Scotland Coronary Prevention Study (WOSCOP) (1995) (results on statin and DM published 2001)[27]	45 – 64 yr old males with dyslipidaemia and normal renal and liver function; n=5974	≥ 7 mmol/L	Pravastatin	30% reduction (*P*=0.042) in the hazard of developing DM
Collaborative Atorvastatin Diabetes Study (CARDS)[28]	40-75yr old patients, male and female, diagnosed with T2DM, LDL < 4.14 mmol/L, HbA1c < 12%, n=2721	Glycaemia progression: increase in HbA1c ≥ 0.05% or intensification of DM therapy	Atorvastatin	0.14% increase in HBA1c values Small but statistically significant

2.2.2. Biological risk factors

Biological risk factors are any risk factors for a specific condition that is related to life and living processes (biology).[10] The biological factors that influence CVD risk are age and gender (as seen in Table 2.1) with both factors classified as nonmodifiable risk factors.

According to the WHO CVDs were responsible for the largest proportion (39%) of NCD deaths in people below the age of 70 years of age.[1] The increased risk for CVD parallels increase in age although CVD is not a disease of aging. The effects of CVD are often measured later in life although the roots there-of are choices made throughout life such as smoking status, exercise and dietary habits.[7]

CVD age-related changes are extremely variable and are encompassed in the vascular aging continuum, an extension of the classic cardiovascular continuum as presented in figure 2.1 below. This continuum can be divided into 4 phases. In phase 1 (step 1 in figure), fatigue of the elastin lamellae in the proximal aorta occur that later results in the fracture there-off. This in turn leads to aortic dilation which transfers stress alternatively to collagenous fibres found in the aortic wall. In phase 2 (step 2 in figure) the resulting aortic stiffening and dilation results in isolated systolic HPT which in turn can lead to left ventricular hypertrophy, an increase in left ventricular mass. The isolated systolic HPT can also contribute to microvascular thrombosis and haemorrhage which in turn can lead to end-stage renal disease and dementia. This is phase 3 and is presented as step 3 in the figure. Phase 3 and phase 4 (step 4 in figure) proceed in parallel with phase 4 comprising the development of myocardial ischaemia due to impaired myocardial supply demand. From point 5 onwards the classic cardiovascular continuum and the vascular aging continuum processes are alike.[29]

Although the risk for CVD increases at all ages, gender however is a factor that needs to be taken into consideration. For men the risk for CVD increases by the age of 45 years whilst for women at 55 years of age.[7] One can also observe a difference in the cause of deaths according to the different types of CVD in males and females. In males IHDs contributed a higher percentage of CVD (almost 10% more than in females) whilst in females cerebrovascular and “other CVD” contributed slightly more than in males in 2011 globally.[1]

The reason for the delayed increased risk for CVD in older women (compared to men) is the onset of menopause which is characterised by a drop in levels of endogenous estrogen levels. High estrogen levels is believed to be cardio protective by preventing vascular injury as can be seen in the low rates of CVD in younger women, with the exception of younger women with multiple risk factors.[7] During menopause the altered lipid profile that presents include elevated total cholesterol, LDLC, and triglyceride levels along with a decrease in HDL cholesterol levels.

This is especially evident in women who gained weight during this period of menopause.[7] This can possibly also explain the differences observed between the type of CVD deaths observed between males and females.

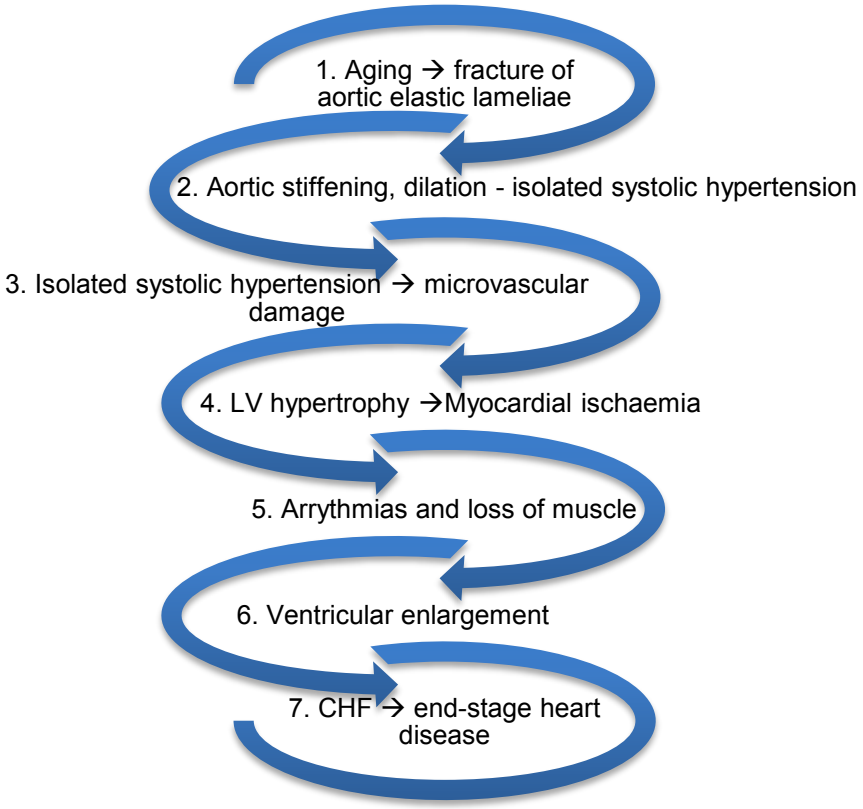


Figure 2.2: Aging Cardiovascular Continuum (Adapted from Rourke et al)[29]

2.2.3. Clinical risk factors

The following risk factors have all been implied to play a role in the development of CVD: existing atherosclerosis, coronary heart disease (CHD), family history of CHD or atherosclerosis, diabetes mellitus (DM), HPT and obesity.

Diabetes Mellitus and Atherosclerosis were discussed under the heading 2.2.2 *Biochemical risk factors*: glucose levels and dyslipidaemia. The remaining clinical risk factors HPT and obesity will be discussed here.

2.2.3.1. *Hypertension*

Hypertension (HPT) is a major problem worldwide and a significant although relatively recently established risk factor for CVD. It is defined as a systolic blood pressure (SBP) equal or above

140 mmHg and/or diastolic blood pressure (DBP) equal or above 90 mmHg (≥140/90 mmHg).[18]

One of the first studies to establish this association was the Framingham study conducted between 1949 and 1952. Study participants were followed for more than 6 years and it was found that men (aged 45 to 62 years) with HPT (then defined as a systolic blood pressure above 160mmHg or a diastolic blood pressure above 95mmHg) had a 3 times higher incident of IHD than men without HPT. For women of the same age group, the incidence was 6 times higher in the hypertensive group when compared with the normotensive group. The first strong evidence that lowering blood pressure reduces death came from the first Veteran Affairs Cooperative Study in the late 1960's where a combination of antihypertensive medications were compared against placebo in hypertensive individuals. The study was ceased due to high morbidity and mortality in the placebo group.[30]

The multiple risk factor intervention trial (MRFIT) from 1982 found that the risk for CVD relates to blood pressure in a continuous manner with no evidence of a threshold down to 120mmHg systolic. A similar conclusion with regards to diastolic blood pressure was made in a 1990 overview of 9 prospective observational studies. Diastolic blood pressure was continuously associated with risk of CHD and stroke events to a threshold of 70mmHg.[30] In some age groups, the risk for CVD was also found to double for each incremental increase of 20/10mmHg (systolic / diastolic) blood pressure.[1] As a result, blood pressure values are classified into classes / stages according to the risk of developing CVD.[7]. See Table 2.5 below for the classification system of HPT.

The patient is subsequently classified according to the highest category of either the systolic or diastolic blood pressure.

It is also known that individuals with an elevated BP more commonly have other risk factors for CVD (DM, insulin resistance, dyslipidaemia) and target organ damage. Due to the fact that risk factors may interact, the overall risk of hypertensive patients is increased in such cases although the BP elevation is only mild or moderate.

According to the WHO raised blood pressure is estimated to cause 7.5 million deaths worldwide amounting to about 12.8% of the total of all annual deaths. The prevalence of HPT worldwide is on the increase as can be seen from the 1 billion hypertensive people worldwide in 2008 compared to the 600 million in 1980. According to the WHO global atlas on cardiovascular diseases,[1] the highest prevalence of HPT is found in the Africa region (as defined by the WHO) at 46%. Across income groups of countries the prevalence was found to be similar except for the high income group countries where the prevalence was found to be 5% less than the rest.[1]

Table 2.5: Categorisation of blood pressure results[31]

	Category	mmHg
Systolic blood pressure	Normal	< 120
	Prehypertension	120-139
	Hypertension Stage / Grade 1	140-159
	Hypertension Stage / Grade 2	160-179
	Hypertension Grade 3	≥ 180
Diastolic blood pressure	Normal	< 80
	Prehypertension	80-89
	Hypertension Stage / Grade 1	90 - 99
	Hypertension Stage / Grade 2	100 - 109
	Hypertension Grade 3	≥ 110

According to SANHANES of 2013, 10.2% of the South African population has HPT (BP ≥ 140/90mmHg) with no difference found between genders. The Caucasian ethnic group had the highest prevalence at 12.2% and the Asian/Indian ethnic group the lowest at 8%. It was established that the prevalence of HPT increased with age from above 45 years as observed worldwide. Among the provinces, the Eastern Cape had the 5th highest prevalence of HPT in the country at 10.4%.[18]

2.2.3.2. *Obesity*

Obesity has become a global burden with negative consequences on health indicators of which CVD is one.

Obesity is seen as an independent risk factor for CVD as well as promoting changes in some of the other CVD risk factors such as HPT, dyslipidaemia and glucose tolerance to name a few. These intermediate risk factors increase the risk for cardiovascular events such as MI and cerebrovascular incident (CVI) (Figure 2.3).[32] All of these intermediate are often found clustered together and as a result have been termed metabolic syndrome. The syndrome is recognised by the presence of DM, HPT (or the use of anti-hypertensive medication), android obesity, decreased HDL levels and elevated triglyceride levels.[9]

Obesity as an entity though does not discern between body fat (BF) and lean body mass (LBM). Excess BF is more frequently associated with metabolic abnormalities than a high level of LBM. When assessing adiposity only on body mass index (BMI), one observes the 'obesity paradox' where clinical outcomes and mortality is associated with BMI in a U or J shaped curve.

This U or J shaped curve indicates that people with a mildly elevated BMI had better survival and fewer CVD events than those who were overtly obese or in the normal – to below normal BMI range.[32]

One explanation for this observed obesity paradox could be found in BF distribution. The major BF distribution pattern associated with increased CVD risk and mortality is abdominal obesity. Indicators of this pattern include elevated waist circumference (WC) and waist-to-hip ratio (WHR).

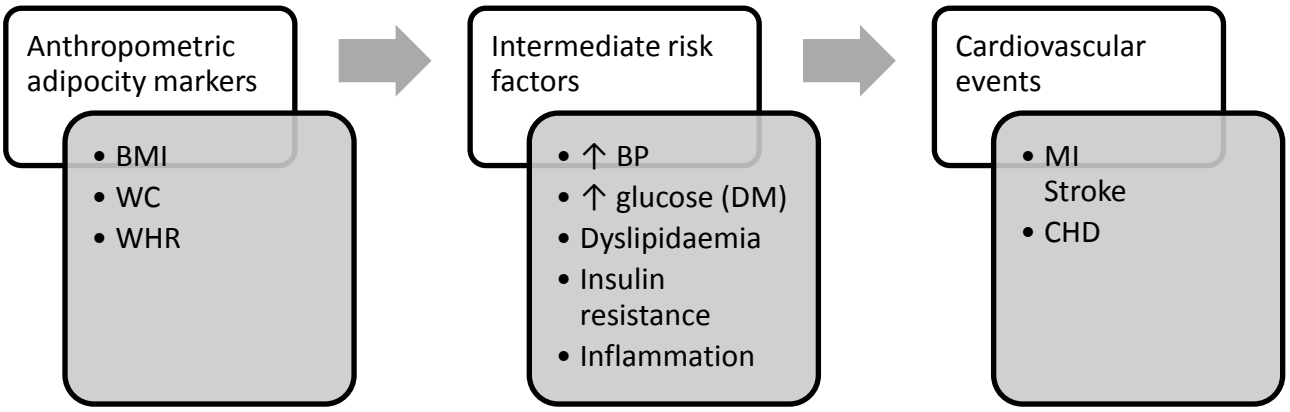


Figure 2.3: Relationship between adiposity indices and CVD[32]

In a state of a positive energy balance, excess free fatty acids (FFA) are preferentially stored in adipocytes. Once these adipocytes have reached their maximal expansion capacity, the circulating FFA start increasing resulting in an accumulation of fat in ectopic sites (visceral adipose tissue, intrahepatic, intramuscular, renal sinus, pericardial, myocardial and perivascular fat, etc.). Adipose tissue is now considered as a key organ regarding its ability to control overall energy flux and partitioning in the body, as the fate of excess dietary lipids (storage in subcutaneous adipose tissue vs. accumulation in lean tissues) may determine whether or not body homeostasis will be maintained (metabolically healthy obesity) or a state of inflammation/insulin resistance will be produced, with deleterious consequences on the vascular wall and the myocardium.[32]

Depending on their location, fat depots present distinct metabolic properties, different states of inflammation or adipo(cyto)kines excretion, leading to major individual differences regarding the impact of obesity on cardiometabolic risk (from protective to neutral to increased risk). Distinction should be made between the different adipose depots. The non-ectopic fat (or subcutaneous fat) are those find blow the skin and appears to be less metabolically deleterious,

its primary role being energy storage, whereas excess ectopic fat defined as an excess lipid accumulation in the visceral adipose depots and in normally lean tissues (intrahepatic, intramuscular, renal sinus, pericardial, myocardial and perivascular fat) is clearly a health hazard.

However, FFAs issued from the visceral adipose tissue are transformed into very low density lipoproteins (VLDL) enriched with triglycerides which leads to the formation of triglyceride-rich LDL particles, which, through the action of the enzymes hepatic lipase and cholesteryl ester transfer protein, become remodelled into small and dense LDL particles which are believed to promote atherosclerosis. For instance, smaller and denser LDL particles appear to be particularly atherogenic; they can penetrate easily within the vascular wall and are susceptible to oxidation. A high proportion of small and dense LDL has been associated with an increased risk of CHD. In a study done by Lamarche and colleagues, reference one third of patients with CHD had normal LDL concentrations, but showed an increased proportion of dense LDL. Apolipoprotein B is of particular importance to determine the risk associated with the small LDL phenotype.

It is now well-known that an excess of visceral adipose tissue in obese and non-obese patients is clearly associated with cardiometabolic abnormalities such as insulin resistance, hyperinsulinemia, glucose intolerance, T2DM, an atherogenic dyslipidemia (high triglycerides, apolipoprotein B, small and dense LDL, low HDL), inflammation, altered cytokine profile, impaired fibrinolysis and increased risk of thrombosis, as well as endothelial dysfunction.

Thus it is clear that one should assess both adiposity as well as adiposity distribution and increase disease risk according to increase in both indicators (Table 2.6).

Table 2.6: Classification of overweight and obesity by BMI, WC and associated diseases risk[33,34]

Classification	**Body mass index (kg/m^2)**	**Disease risk relative to normal weight and waist circumference**	
		Men ≤ 102cm Women ≤ 88cm	Men > 102cm Women > 88cm
Underweight	< 18.50	…	…
Normal	18.50 - 24.99	…	…
Overweight	25.00 - 29.99	Increased	High
Obese Class I	30.00 - 34-99	High	Very high
Obese Class II	35.00 - 39.99	Very high	Very high
Obese Class III	≥40.00	Extremely high	Extremely high

Globally in 2014, a staggering 1.9 billion adults (18 years and older) were overweight, amounting to 39% of the adult population globally being classified as overweight with the prevalence more or less equal between genders (38% of men and 40% of females were overweight).[1] Of those 1.9 billion classified as overweight, 600 million were classified as obese (a BMI greater than or equal to 30 kg/m^2). Eleven percent of men and 15% of women were obese in 2014 compared to 4.8% for men and 7.9% for women in 1980.[1,34]

In South Africa, the prevalence of overweight and obesity is significantly higher in females than in males with a higher prevalence of obesity compared to overweight for females (24.8% and 39.2% compared to 20.1% and 10.6% for females and males, respectively for overweight and obesity). When looking at fat distribution based on WC, 9.8% of males had a WC above 102cm whilst 51% of females had a WC above the cut off (88cm).[18]

Weight loss is considered to be an important aspect to be addressed in the management of a patient diagnosed with CVD as obesity is such a well-established and documented risk factor in CVD development. The American College of Cardiology/American Heart Association/The obesity Society guidelines recommend a sustained weight loss of 3-5% to produce clinically meaningful health benefits such as optimal HDL, LDL and blood pressure levels and to prevent CVD.[35] The European guidelines on CVD prevention recommends weight reduction in overweight and obese people as this is associated with favourable effects on blood pressure and dyslipidaemia, which may lead to a decreased risk for CVD.[36] There is a positive linear association of BMI with all-cause mortality with the lowest all-cause mortality found at BMI of 20–25 kg/m^2. Further weight reduction is not considered as CVD protective.[12] The South African Dyslipidaemia Guideline Consensus Statement recommends that an individual with dyslipidaemia achieve and maintain an ideal body weight.[12]

All of these weight reduction guidelines are aimed at preventing CVD as obesity is found to be associated with increased risk of CVD incidence and mortality at population level. On the other hand, the evidence for weight loss as part of the management in those with established coronary artery disease (CAD) is controversial with an “obesity paradox” being noted. The “obesity paradox” exists in those with established CVD and who are obese as they appear to have better prognosis than those who are underweight / normal weight with established CVD.[12,37]

Some possible hypotheses for this phenomenon are as follows. Obese individuals have more metabolic reserve, increased LBM, less unintentional weight loss and may take more protective CVD medication whereas normal weight or lean people may have a greater genetic

predisposition for CVD. The benefit of the increased metabolic reserve is that heart failure (HF) is considered a catabolic state with increased breakdown of protein and fat stores thus if the person has increased reserves the effect of this catabolism is not as profound. This then also relates to the next hypothesis that overweight/obese individuals have greater LBM stores and this act as cardio protective. Care must be taken in the older adult to maintain LBM making exercise a critical component in any rehabilitation programme to aid in doing so.[37] It seems that whether the weight loss is intentional or unintentional also plays a role in outcome of patients with established CAD. In a meta-analysis by Pack et al[38] it was found that unintentional weight loss (defined as observed weight loss in the meta-analysis) was associated with increased adverse cardiovascular events and should act as a warning sign for a poorer prognosis. Intentional weight loss was associated with lower clinical events and was especially of importance when done in association with the therapeutic for lifestyle changes (TLC) diet and exercise regimen.[38]

2.2.3.3. *Family history of atherosclerosis or coronary heart disease*

A family history of atherosclerosis or premature CHD in a first degree relative is a strong risk factor for CVD. It is a non-modifiable risk factor but influences the intensity of risk factor management.[7]

2.2.4. Behavioural risk factors

The behavioural risk factors are also known as modifiable risk factors and include dietary intake, physical activity (PA), stress and tobacco use.

2.2.4.1. *Tobacco use*

Nowadays the effect of smoking on CVD is undisputed but this was not the case until relatively recently. In 1959, the American Heart Association (AHA) Committee on smoking and CVD stated that there was not enough evidence to define the effect of smoking on the heart or coronary arteries. The defining evidence only came in 1963 when Doyle et al, combined the Framingham study data with data from the Albany, New York study and found a clear relationship between cigarette smoking and numerous cardiac outcomes such as MI, deaths from coronary disease, and all-cause mortality. The Framingham investigators subsequently published additional findings on this association along with information describing the benefits of smoking cessation for primary prevention, quitting smoking after MI, differences between cigarettes and other forms of tobacco, and advanced recommendations for clinicians in their practice of medicine[39]

Nearly six million people die from tobacco use and exposure to second hand smoke each year, accounting for 6% of all female and 12% of all male deaths in the world. The US Centre for Disease Control (CDC) maintains that compared to non-smokers, smoking increases the risk of coronary heart disease by 2 to 4 times and stroke by 2 to 4 times.[18] Smoking is estimated to cause nearly 10% of CVD but there is a large body of evidence regarding the beneficial effect of smoking cessation on coronary heart disease mortality. There is also clear indication that the age of smoking cessation also has an impact on survival: those who quit between 35 and 44 years of age had the same survival rates as those who had never smoked.[1]

Looking at the physiological effect of smoking on the cardiovascular system it seems that smoking has both short term and longer term effects. Initially the focus was on the short term effects of smoking and more specifically nicotine, a bioactive compound found in cigarettes that stimulates the sympathetic nervous system and thus increases systolic and diastolic blood pressure, cardiac output as well as heart rate. These short term effects led the Framingham investigators to initially hypothesise that smoking places acute stress on the cardiovascular system and so increases the risk for MI and death. This thought process was also supported by the fact that risk rapidly decreased with smoking cessation.[39]

Recently the thought process on the relationship between smoking and CVD also points to the long term contribution there-off on the development of subclinical atherosclerosis. This is thought to occur through the direct effect there-of on thrombus formation, plaque instability and arrhythmias. Smoking has been found to alter the lipid profile of individuals specifically by decreasing HDL levels slightly. The changes as a result of smoking are reversible and benefits are seen within 2 months of cessation.[19]

The above mentioned effects are not just seen in in subjects who smoked themselves but also in those exposed to smoking (second hand smoking). Second-hand tobacco smoke is estimated to kill 600 000 people worldwide each year (WHO 2011) with forty seven (47) percent occurring in women, twenty-eight (28) percent in children and twenty-six (26) percent in men. A surprising result considering that the prevalence of smoking is much higher in men than women.[18] Furthermore, the risk is also dependant on amount as well as the duration of exposure with an increase in risk being observed with an increase in the number of cigarettes smoked each day. [7,19]

It has also been found that smoking has a synergistic effect with other risk factors for example along with the use of oral contraceptives a woman's risk for CHD is 10 times greater compared to a woman who does not smoke or use oral contraceptives. The effects seem to be more prominent if adjusted for alcohol intake.[7,19]

Looking at the worldwide prevalence of smoking, the highest overall prevalence for smoking is estimated at nearly 31% in the WHO European Region while the lowest is in the WHO African Region at 10%.[1]

As per WHO 2011 statistics, 18% of RSA population smokes in comparison to the SANHANES of 2013 where 20.8% of the participants reported a history of smoking and 79.2% having never smoked. The smokers comprised of those who are currently smoking, ex-smokers and those who smoke less than daily (figure 2.6). The Eastern Cape participants have the 5th highest prevalence of smoking in the country.[18]

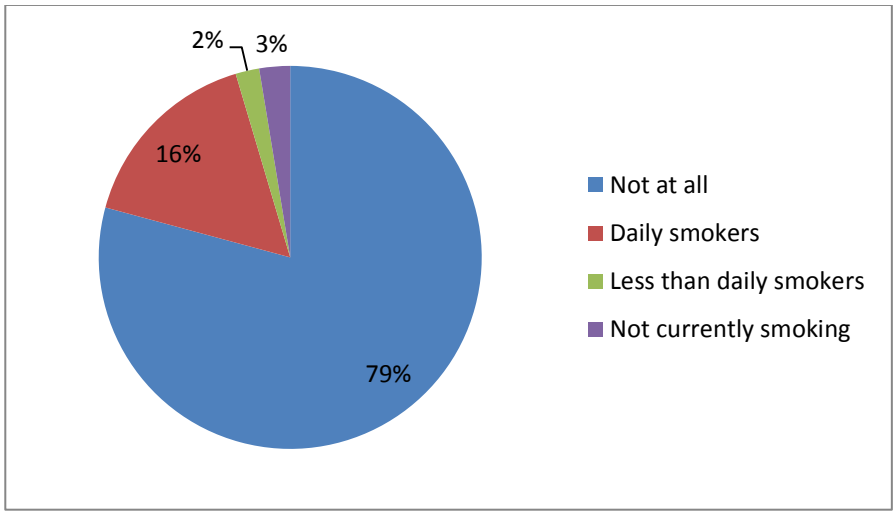


Figure 2.4: Prevalence of ever smoking tobacco, South Africa 2012 (Adapted from Shisana O et al)[18]

2.2.4.2. *Physical inactivity*

Both low physical activity (PA) as well as a low level of fitness is independent risk factors for CHD thus contributing to CHD development irrespective of the presence of other risk factors for CVD.[7].

PA can be defined as any bodily movement produced by skeletal muscles that result in energy expenditure. PA includes activities during daily living as well as any exercise. Exercise and physical activity has been used interchangeably although exercise is a subcategory of physical activity. Exercise is PA that is planned, structured, repetitive, and purposive in the sense that improvement or maintenance of one or more components of physical fitness is an objective. Physical fitness in contrast to physical exercise is a set of attributes that people have or want to achieve. Being physically fit has been defined as "the ability to carry out daily tasks with vigour and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and

to meet unforeseen emergencies. Components of physical fitness include health related fitness and skill related fitness. The health related fitness components that are of importance for public health are cardiorespiratory endurance or cardiorespiratory fitness (CRF), muscular endurance, muscular strength, body composition and flexibility.[40] CRF is defined as the highest level of estimated metabolic equivalents achieved during maximal exertion such as on a treadmill test.[41] Generally increased PA and exercise training (ET) is recommended to increase CRF.

An increase in PA levels decrease CVD risk by retarding atherogenesis, increasing vascularity of the myocardium, increasing fibrinolysis, reducing LDLC, improving cholesterol tolerance and insulin sensitivity, aiding in weight management, and reducing blood pressure by improving endothelial function that in turn enhances vasodilatation and vasomotor function in the blood vessels.[3,42] Epidemiological studies showed that sedentary adults, who increase their PA to moderate to vigorous levels, decreased their risk for CVD with about 40%. Current data suggest that occupational activity, as a subcategory of physical activity, is an independent contributor to CVD mortality risk. Slattery et al conducted a study in 1989 in the United States of America on railroad workers' activity levels using PA questionnaires and assessing CHD risk. They found that railroad workers who were sedentary (classified as < 40kcal/week expended energy) had a 39% greater risk of CHD compared to men with higher PA (3,632 kcals/week). Further evidence comes from data from Finish cohorts from the researchers Hu, Barengo and colleagues. Independent studies conducted by both Hu and Barengo on Finnish adults found that occupational PA was associated reductions in CHD risk in both men and women after adjusting for commuting and leisure time PA. In another study conducted by Hu et al amoung Finnish adults diagnosed with T2DM high moderate/vigorous occupational PA was independently associated with a 31% reduction in CV mortality, even after adjustments for age, sex, BMI, systolic blood pressure, and commuting and leisure-time PA.[41] PA is also a key factor when it comes to weight management as it is a determinant of energy expenditure.[1]

High levels of CRF have been associated with reduced prevalence of several CVD risk factors such as HTN, obesity, metabolic syndrome and T2DM. It has also been shown to have a positive effect on CVD end points such as mortality.[41] CRF is probably the better predictor of CVD and mortality.

Physical inactivity was historically defined as less than 150 minutes of moderate physical activity per week or less than three (3) twenty minute sessions (60 minutes) of vigorous activities per week. The latest physical activity recommendations by the American College of Cardiology/American Heart Association Task Force on Practice Guidelines are three to four sessions of at least 40 minutes of moderate to vigorous activities per week.[42] For this study the historical definition was used.

According to the WHO global status report on NCD's the highest prevalence of physical inactivity can be found in the Americas as well as Eastern Mediterranean regions. One also note the high prevalence of inactivity in both South African men and women. High income countries was found to have higher prevalence of physical inactivity than low-income countries.[1]

These findings are not supported by the SANHANES where it was found that 42% of females to be physically unfit and only 28% of the men physically unfit.[18] One should take note that the SANHANES used a more accurate index of CRF compared with the WHO that reported on PA.

The SANHANES reported that females in informal settings had higher CRF than those in urban settings whereas with men, both urban as well as informal setting dwellers had high CRF. The Eastern Cape was also one of the provinces that had a lower prevalence of CRF in both males (48.6%) and females (32.7%).[18]

2.2.4.3. *Stress*

Stress can be defined as "a state of physiological or psychological strain caused by adverse stimuli, physical, mental, or emotional, internal or external, that tend to disturb the functioning of an organism and which the organism naturally desires to avoid".[43]

Stress can elicit a state of threatened homeostasis in the body's endocrine system with which the body responds with an altered neurohormonal response after stimulation of the sympathetic nervous system (SNS). This stimulation results in an increased heart rate, blood pressure and cardiac excitability. One of the hormones released as a result of the stimulation of the SNS is angiotensin II which in turn accelerates the formation of plaque.[7] It is proposed that the effect of stress is similar to that of HPT.[7]

During physical stress a decreased total serum cholesterol levels and elevated triglyceride levels are observed. The reason for this remains unclear but the decreased total serum cholesterol levels may be due to diminished uptake and synthesis of cholesterol. This may continue for up to 3 months after the injury that caused stress.[19]

The effect of mental stress on lipid profile remains unclear but there is evidence that stress-management programmes improve risk factor levels and CVD outcomes.[12]

2.2.4.4. *Use of alcohol*

Alcoholic beverages can have both a protective as well as a detrimental effect on the incidence of CVD. The risk for CVD with alcohol consumption is influenced by the pattern as well as the

level of alcohol consumption.

Moderate alcohol consumption can be seen as alcohol consumption at the determined optimal intake of 10g of alcohol per day for women amounting to one drink per day and for men 20g/day, amounting to 2 drinks per day.[12] Moderate alcohol intake has been shown to have a protective effect against the development of CVD but this protective effect follows a J-shaped curve which is not explained by special characteristics of abstainers. Various mechanisms have been proposed for the protective effect of moderate alcohol consumption and includes the beneficial effects of alcohol on the HDLC (One and a half glasses of wine can increase HDLC levels by 0.03-0.05 mmol/L),[19] level of thrombolytic profile and platelet aggregation.[1]

On the other hand, alcohol is a risk factor for multiple health related issues as well as social issues. Under the health related outcomes HPT, acute MI, cardiomyopathy, pancreatitis and encephalopathy are included whilst violence and isolation from friends and family are mentioned as some of the social issues. Excessive alcohol consumption as well as binge drinking episodes (defined as 60 or more grams of pure alcohol per day) are directly associated with CVD risk.[12]

Alcohol is oxidized to energy in the postprandial state in preference for fatty acids which are normally the preferred substrate, contributing to hypertriglyceraemia. Alcohol can also indirectly contribute to elevated triglyceride levels as alcohol contributes to weight gain and obesity, which is itself associated with hypertriglyceraemia.[19]

South Africa has one of the highest levels of alcohol drinking in the world with specifically participation in binge drinking.[1]

2.2.4.5. *Atherogenic diet*

Diet is considered as one of the predominant causes of CHD and can have an effect on various CVD risk factors such as blood pressure, obesity, lipid profile and serum glucose. Diet can have an effect on CVD risk independent of these risk factors but also indirectly through dietary effect on these risk factors. Most evidence of these effects is based on observational studies and are reported at three levels. The first level looks at specific nutrients, the second at foods or food groups and the third at dietary patterns such as the Mediterranean diet. This last approach can be seen as the equivalent of the shift from evaluating single risk factors to evaluating total risk profiles.[12]

For the first level, the nutrients of interest with respect to CVD are fatty acids (which mainly affect lipoprotein levels), minerals (which mainly affect BP), vitamins, and fibre.

For the second level (food groups) the focus is on fruit and vegetables, fish, moderate alcohol consumption (10g/d for women and 20g/d for men) and limiting the daily consumption of soft drinks. Lastly, for the third level regarding dietary patterns the focus is on the Mediterranean- and Dietary approach to stop Hypertension (DASH) diet.[12]

The focus of this literature study will be nutrients (first level) and specifically fatty acid intake as a CVD risk factor. The reason for this is that the evidence for saturated fatty acid (SFA) intake as CVD risk factor is strong and a high intake of saturated fat and cholesterol are associated with elevated serum cholesterol and LDLC levels. This is known as the classical diet-heart hypothesis where the elevated serum cholesterol contributes to atheromatous plaques formation.[3] This hypothesis gained more support in 1957 when Ancel Keys et al launched the Seven Countries Study.[44]

To support the diet-heart hypothesis one needs to investigate all evidence. Unfortunately this is not always so clear cut as there are numerous limitations regarding the studies available: most of them are old, small in number, CVD is not always the target end point measured, single-24hr recall was used to assess dietary intake, and lack of adjusting for confounding factors such as total energy intake. The last point is of importance as fats contribute to total energy intake and one of the aspects of the diet that has an influence on CHD is excessive energy intake. The excessive energy intake is partially due to an increase in portion sizes during the past 20 years and has contributed to the increase in obesity which by itself is considered a risk factor.[3] A high energy intake is also associated with hypertriglyceridaemia.[4]

When looking at descriptive studies it can provide some evidence that diet is a causative factor of CVD. One firstly needs to make sure that it is not a genetic component that caused the large differences in CHD rates which was evident from studies that indicated that migrants from low-risk areas adopt the rates of the high risk areas they migrated to.[3] One of the first studies to investigate modifiable CVD risk factors across countries, cultures and time was the Seven Countries Study that was started in 1958. The Seven Countries Study was a cross-cultural prospective study of MI and stroke in more than 12 000 middle-aged men in 16 cohorts in 7 countries. They found that the SFA intake varied considerably by region and that the average saturated fat intake, average serum cholesterol level and 10-year CHD mortality rates in the cohorts were strongly correlated (figure 2.5).[3,15,44]

Another group of studies of importance in the classical heart-diet hypothesis are those where dietary changes and the effect there-of on CHD risk are investigated. One should take note that the effect of dietary changes on cholesterol and from there on CHD risk depends on the cholesterol fraction that was changed. One of these studies is the US National Diet-heart study from 1957-1978 that demonstrated a diet low in SFA and cholesterol intake could decrease

serum cholesterol by 11-15% in a free-living population.

Another such study is the Nurses' Health Study (1976) where various fat components and carbohydrate were interchanged with each other (each contribution change for the same amount of energy) during a 14-year follow-up of 80 000 women. The results are summarised in figure 2.5 where it can observed that replacing SFA with carbohydrate is not associated with increased CHD but replacing mono-unsaturated fatty acid (MUFA) or poly-unsaturated fatty acid (PUFA) with carbohydrate increased CHD risk. When replacing SFA with either MUFA or PUFA the risk for CHD was also found to be decreased and the same goes for replacing trans fatty acids with either PUFA or MUFA. Thus implying the association between SFA and trans fatty acids and CHD risk.[3]

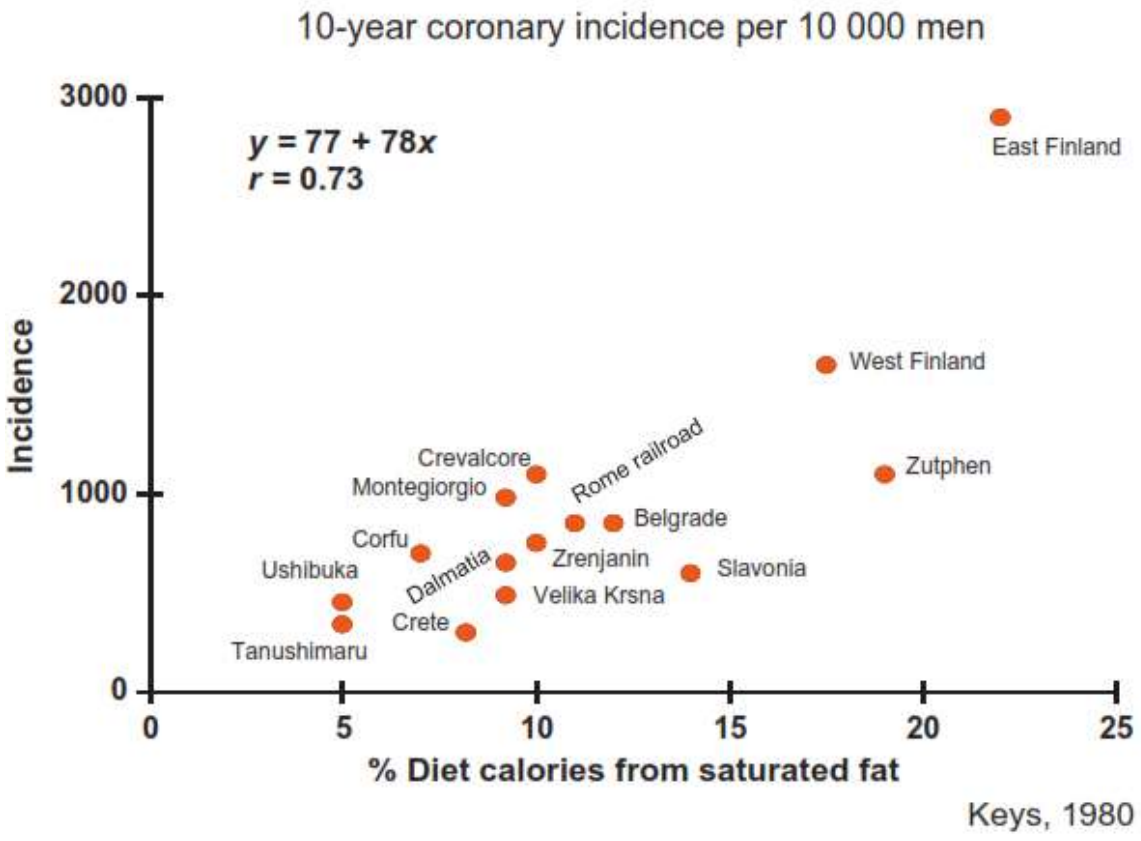


Figure 2.5: Ten-year coronary death rates of the cohorts plotted against the percentage energy supplied by SFA[3]

The most direct test of a diet-heart hypothesis is a randomised controlled trial amongst healthy people where dietary changes and the effect on CHD risk are determined. The limitations of most of these trials are that they are small in number and were conducted decades ago but they still remain important. In most of these trials two approaches were used: replacing SFA with PUFA and replacing SFA with carbohydrate. Two earlier trials conducted amongst

institutionalised men (residents of the Los Angeles Veterans Administration Hospital and two Finnish Mental Hospitals) where cholesterol intake was reduced and PUFA intake increased to 20% of total energy in place of SFA (in both studies). The Veterans study showed no difference in MI prevalence in the 2 groups but for cerebral infarction there was a statistical significant difference. In the Finnish study, CHD mortality rates were reduced with 51% for the experimental group receiving the modified diets.[3]

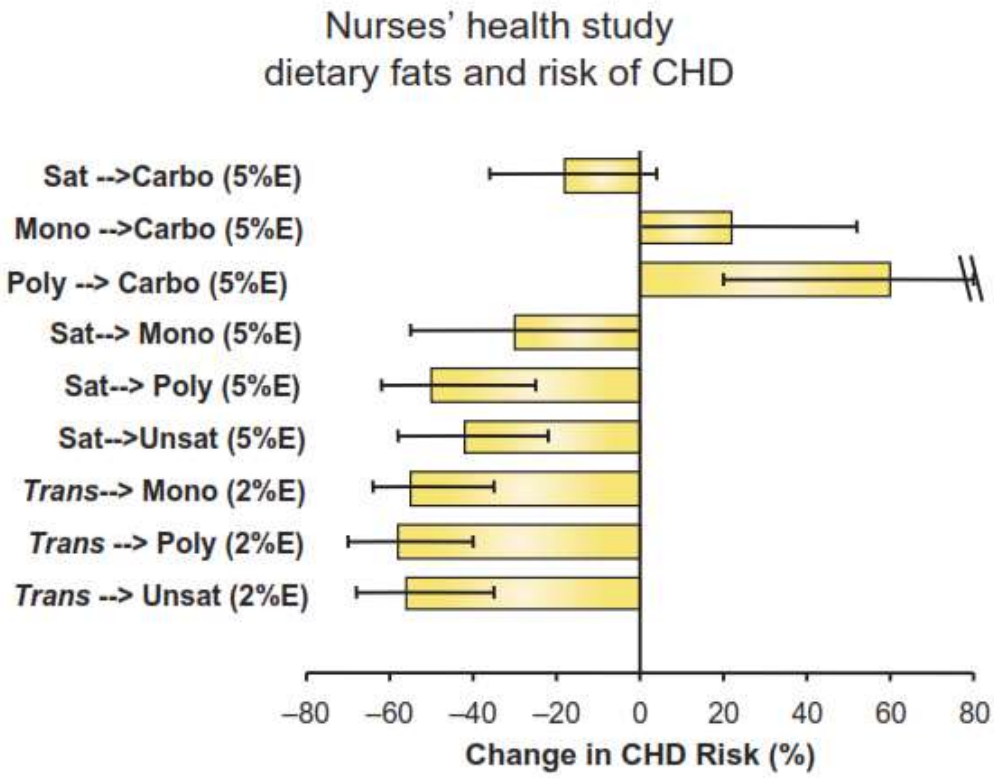


Figure 2.6: Estimated changes in risk of CHD for isocaloric substitution[3]

The sample size required for a randomised trial of CHD prevention involving only changes in dietary fats are large and due to this reason, large trials undertaken to investigate this effect include additionally modifications of other risk factors such smoking. This approach makes it difficult to interpret the results due to confounding and the effect could be due to any or all of the modifications. Two such trials were the Multiple Risk Factor Intervention Trial (MRFIT) and the Oslo Heart Study. The MRFIT trial was conducted from 1974-1982 where more than 360 000 men aged 35-57 years were screened for cholesterol levels, blood pressure and smoking. All the men were screened for CVD risk using the Framingham study criteria and 12 886 were identified as high risk. These men were randomised to special intervention (SI) entailing medical management of HPT, smoking cessation and specific dietary adjustments or to a control group. The adjustment included SFA intake < 10% TE, dietary cholesterol < 300mg and PUFA > 10% TE. In 1976 these recommendations were adjusted to SFA < 8% of TE and

dietary cholesterol < 250mg. These goals were nearly accomplished as can be seen in table 2.7.

Despite the dietary changes made in the intervention leg of the MRFIT there was only a modest difference in total cholesterol and LDL levels after 7 years of intervention. There also was no significant difference in CVD death, all-cause deaths or stroke between the 2 groups. The dietary intervention in the special intervention group of the MRFIT trial was unsuccessful in part due to the control group also making some dietary adjustments, the MUFA intake being below 20% and total energy intake not being controlled.[3,44]

Table 2.7: Dietary fat contribution to daily energy intake: results from MRFIT[44]

	Community -end of trial*	Special intervention	
		Pre-intervention**	End of trial***
Total fat (%)	38.1		34.1
SFA (%)	13.7	14.2	10.5
MUFA (%)	14.9		12.7
PUFA (%)	6.7	6.4	8.4
Cholesterol, mg/d	414	451	269

* Results in column indicates contribution of various dietary fat components to daily intake of the community serving as control group

** Results in column indicates contribution of various dietary fat components to daily intake of experimental group prior to intervention

*** Results in column indicates contribution of various dietary fat components to daily intake of experimental group post- intervention

What is of interest is a follow-up on mortality 16 years after cessation of the MRFIT. As can be seen from table 2.8 the estimated risk of death was far lower in the special intervention group (SI) when compared to the usual care (control group). That is true for CHD-, CVD-, as well as non CVD deaths. These differences are far greater than the corresponding figures from the end of the trial in 1982 and one of the major contributors to these differences is the vastly decreased mortality rates due to MI observed in the SI group.[4]

The observed difference in mortality rates after 16 years from the end of the MRFIT emphasizes the need for longer follow up of studies. It also shows the benefit of lifestyle modification emphasis for individuals at risk for CVD e.g. the SI group had a higher percentage of smoking cessation than the usual care group

Another study with similar entry criteria was the Oslo study conducted during 1972 in Oslo, Norway where the primary outcome measured was the first major CHD event (fatal or non-fatal). In this study, the target population was men aged 40-49 years and 16 202 men were screened for coronary risk factors.[45] The intervention used during the 5-year study was aimed at dietary modifications as well as smoking cessation but did not include HPT management as in the MRFIT trial.

Table 2.8: Death Rates per 1000 Person-years from Baseline through December 1990: Follow up on the MRFIT trial[4]

	Death rates per 1000 person-years				
	1982		1990 (16 year follow up post trial)		% difference in relative risk (RR)**
	Usual care	Special intervention *	Usual care	Special intervention *	
CHD death	2.64	2.49	5.82	3.03	-11.4%
CVD death	3.25	3.23	7.88	7.05	-7.9%
Non CVD death	2.67	2.78	7.41	6.99	- 3.3
All-cause deaths	5.92	6.01	15.29	14.03	- 5.7%

* Special intervention: Dietary adjustments, smoking cessation, managing HPT

** Estimated risk of death in the SI group relative to the UC group. Calculated as follows: [RR-1] x 100

The Oslo study provided more convincing support when the experimental group had a 47% reduction in 5-year fatal CHD mortality. A fifteen-year follow up on the Oslo trial concluded that the reported CHD mortality was 48% lower in the intervention group compared with the control group of the original study conducted in 1972.[45] The participants were men who was aged 40-49 years in the 1972-1973 Oslo study as well as a small sample (7%) of men aged 20-39 years.

In the most recent randomised controlled trial conducted in 2001, the Women's Health initiative 48 000 women were randomised to either receiving a low fat diet or their usual diet. No effect on CHD risk was observed but this must be interpreted with caution as no difference in HDLC or triglyceride levels was observed, as would have been expected if there was an actual difference in fat intake between groups.[3] Thus one could query the implementation of the intervention.

Despite some contradictory results and taking into consideration factors that affected the results of the studies, dietary aspects play an important role in preventing and managing CVD risk. Of specific interest is the intake of various fatty acids as well as the contribution of each to the total fat intake.

2.2.5. Genetic / Familial dyslipidaemia

Taking the etiology of dyslipidaemia into consideration, dyslipidaemias are classified as either primary or secondary dyslipidaemias. The etiology of primary dyslipidaemias is hereditary in nature and that of secondary dyslipdaemias, lifestyle factors and other diseases.

Primary dyslipidaemias are monogenic disorders that affect plasma lipoprotein levels by overproduction or decreased clearance of lipoproteins. Familial hyperlipidaemia, polygenic dyslipidemia and familial combined hyperlipidaemia are examples of primary dyslipidaemias.[10]

Secondary dyslipidaemias are dyslipidaemias that result from secondary causes such as lifestyle factors, drugs and endocrinopathies. Secondary causes of dyslipidaemia frequently co-exist with the familial dyslipidaemias in many patients and can aggravate and even cause dyslipidaemia. It is thus important to recognize and treat these causes since they are potentially reversible.

There are a number of genetic aberrations resulting in primary dyslipidaemia but the one of most interest is familial hypercholesterolaemia since the prevalence for this primary dyslipidaemia in RSA is high (1/70 compared to 1/500 for the rest of the world).[46] This high prevalence that is due to the founder effect, is noted in three ethnic South African communities namely the White South Africans of Afrikaner descent, Jews of Lithuanian descent- and Indians of Gujerati descent.[46,47]

The primary abnormality observed in the lipid profile of FH is an elevated LDLC. The extent of the elevation is dependent on whether the FH is heterozygous (heFH) of homozygous (hoFH). HeFH results from a mutation in a single allelle of a gene whilst hoFH resuls from mutations in both allelles of a gene. HeFH is far more common than hoFH but hoFH results in a far greater elevation of LDLC.[46]

The components most affected by genetic alterations that have an effect on the lipid profile of familial hypercholesterolemia are those affecting lipoprotein lipase (LPL) activity, low-density lipoprotein receptors (LDLR) activity and apoB expression.

The most common genetic abnormality that results in hyperlipidaemia is alterations in LDLR expression which can affect the number and activity of these receptors.[9] The resulting reduced clearance of LDL is generally recognised as heFH with LDL levels > 5mmol/L. The homozygous phenotype results in LDL levels > 14 mmol/L and is usually due to two (2) LDLR defects.[47]

To aid in distinguishing between primary and secondary dyslipidaemia, one should include tests for other diseases such as thyroid, renal and liver function tests as well as a random or fasting

glucose, serum albumin, and a urinary screen for protein, glucose and bilirubin. Other investigations may be indicated in less common settings of secondary dyslipidaemia, tailored to the clinical setting encountered. The identification of primary dyslipidaemias is of a clinical nature with the causal gene identified only by genetic testing.[46]

There are a number of clinical diagnostic tools for identification of FH namely the Dutch Lipid Clinics Network criteria, the MedPed criteria and the Simon Broome Registry criteria. All three of the tools evaluate the presence of tendon xanthomata, family history of premature CVD and LDLC levels. Premature CVD is generally defined as CVD occurring in men before the age of 55 years and in females before the age of 60.[46] The Dutch Lipid Clinics Network criteria diagnostic tool for adults (table 2.9) classifies patients as having 'definite', 'probable' or 'possible' FH.

The Dutch Lipid Clinics Network Criteria for identifying FH is not used at PEHC as LDLC values for relatives are seldom known and DNA analysis is not utilised due to expenses. Instead a diagnosis for FH are made on the presence of tendon xanthomata or corneal arcus < 45 years of age and elevated LDLC levels.

Table 2.9: The Dutch Lipid Clinics Network Criteria for identifying FH[46]

	Criteria		Points
Family history (first degree relative)	Premature CVD (M<55; F<60)		1
	LDLC > 95th centile for age and sex	Adult relative	1
		Relative < 18 years old	2
	Tendon xanthomata or arcus < 45		2
Clinical	Vascular disease	Patient has premature IHD	2
		Patient has premature peripheral or cerebrovascular disease	1
	Examination	Tendon xanthomata found	6
		Corneal arcus present before age 45 years	4
Laboratory	LDLC	LDLC > 8.5mmol/L	8
		LDLC: 6.5 – 8.5mmol/L	5
		LDLC: 5.0-6.4mmol/L	3
		LDLC: 4.0 – 4.9mmol/L	1
	DNA analysis	DNA testing confirms pathogenic mutation in LDLR, or other gene related to heFH	8
>8: definite FH **6-8: probable FH** **3-5: possible FH**		TOTAL SCORE	

2.3. THE ROLE OF THE DIETITIAN IN MANAGING CVD

Lately, the role of the dietitian in the management of CVD risk has been acknowledged with the publication of the American Heart Association/American College of Cardiology Guideline on lifestyle management to reduce cardiovascular risk in 2013. In this publication the need for a registered dietitian in preventative lifestyle intervention and weight management was acknowledged in order to facilitate personalised approaches to dietary planning, and nutrition therapy. These approaches are advocated to promote more effective short-term and long-term behaviour change in those at CVD risk.[42]

Evidence for individualized dietary counselling effectiveness can be seen in a study conducted by Weber et al in 2012 on the effectiveness of the Brazilian cardioprotective diet program. In this program, patients were allocated to one of three intervention groups. The first group joined the Brazilian Cardioprotective Diet program with weekly sessions with dietitians. The second group received dietary therapy in line with the Brazilian guidelines with weekly dietetic sessions whilst the third group also received dietary therapy in line with the Brazilian guidelines but with monthly dietetic sessions. It was found that there was a decrease in BMI as well as fasting blood glucose values in the first two groups (those with weekly dietetic sessions) with no change in BMI and an increase in fasting glucose in the third group (monthly session).[48]

Another study conducted in 2008 in the United Kingdom (UK) randomised 334 people at risk of CHD to either a control group, where standard information was shared, or to an intervention group where standard information (on exercise and nutrition) was given along with five face-to-face counselling sessions with a Physical Activity Specialist (PAS) and Registered Dietitian (RD) over a 6-month period. The mean sessions attended by those in the intervention group were 2 with 50% of the group attending at least three of the sessions. At 6 months the intervention group was found to be more active, had reduced BP, weight as well as cholesterol levels.[49]

Thus dietitians can play an integral part in the prevention and management of CVD risk factors. Up to date no such studies has been undertaken in South Africa.

2.4. THEORETICAL / CONCEPTUAL FRAMEWORK

CVD is a global as well as national burden of disease. There are numerous CVD risk factors with some having stronger evidence than others on their influence on CVD prevention and development. In this study, the focus will be on those risk factors that are frequently utilised in the government setting. These include age, sex, dyslipidaemia, glycaemic control, blood pressure, obesity, diagnosis of DM and HPT, smoking and total fat and SFA intake.

Depicted in the figure below a theoretical framework of the afore discussed risk factors. More details regarding each risk factor and what need to be investigated to gain a better understanding on each are included in the second, third and the fourth column of the figure.

Included in the diagram is the multidisciplinary team management of CVD risk but more specifically, the utilisation of dietitians in CVD risk management.

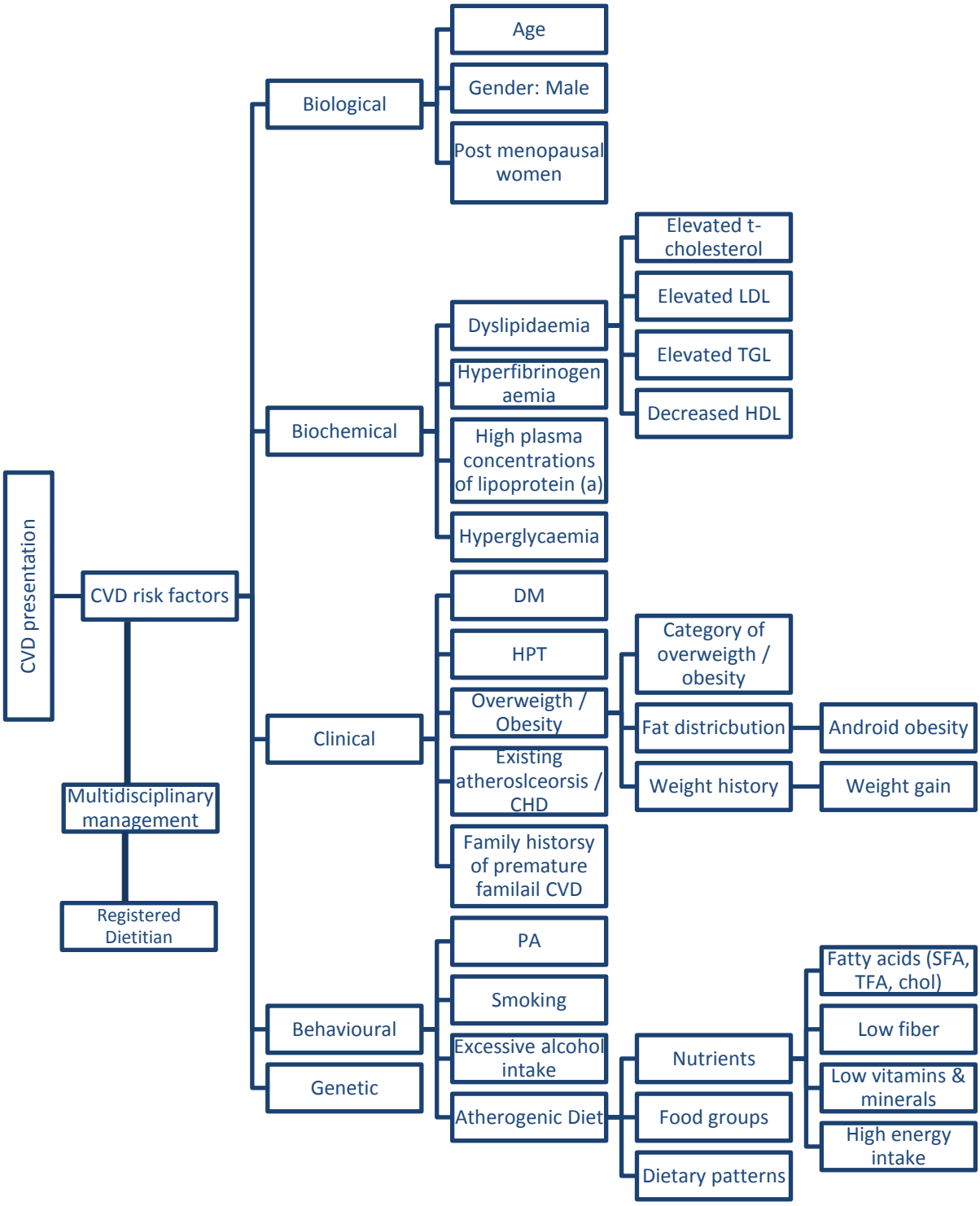


Figure 2.7: Theoretical framework

CHAPTER 3:
METHODS

This chapter describes the study design, the sampling and characteristics of the sample, as well as the methods used, which included anthropometrical measurements, laboratory blood values, clinical signs, physical activity, screening for fat intake and lastly, analysis and statistical methods. In addition, ethical issues and approval will also be part of this chapter. The results will be reported in chapter 4, the discussion in chapter 5 followed by the conclusion in chapter 6.

3.1. AIM

The main aim of the study was to identify and describe dyslipidaemia as well as the selected risk factors for cardiovascular disease in patients diagnosed with dyslipidaemia attending Port Elizabeth Complex (PEHC).

3.2. OBJECTIVES

The specific objectives were to:

- Describe the dyslipidaemias detected by chemical tests in the various ethnic groups (white, black, coloured, indian or asian ancestry) attending PEHC.
- Identify and describe selected risk factors for cardiovascular disease that are amenable to clinical evaluation and modification, in the subjects diagnosed with dyslipidaemia of each ethnic group. These include the following:
    - Biological (age, gender)
    - Biochemical (hyperglycaemia, lipid profile)
    - Clinical (presence of Diabetes Mellitus (DM), hypertension (HPT), obesity, clinical manifestation of CHD or atherosclerosis, a family history of CHD)
    - Behavioral (smoking, exercise level, adherence to Step I and Step 2 diet);
- To classify genetic or familial dyslipidaemia based on lipid profiles and clinical signs;
- Establish how many of those subjects identified with dyslipidaemia attending the PEHC are referred to the dietetics department for dietary counselling.

3.3. STUDY DESIGN

An observational descriptive cross-sectional study in the quantitative domain was conducted.

3.4. STUDY POPULATION

The study population was adult patients (18 years of age or above) of both sexes and all race groups attending PEHC diagnosed with dyslipidaemia. The three hospitals that PEHC are composed of include Livingston Hospital, PE Provincial Hospital and Dora Nginza Hospital. Included are both newly diagnosed as well as previously diagnosed patients attending as inpatients and outpatients.

3.4.1. Sampling and sample size

Non-random convenience sampling was used due to logistical and resource limitations.

The wards of PEHC were visited twice a week, once at the beginning of the week and followed up at the end of the week. The beginning of the week was selected as to include all new admissions over the weekend. The end of the week to include all admissions during the week and before discharge over the weekends.

A total of hundred and three patients (n=103) were included in the final sample size. The sample size was determined as n=97 based on a precision of Cp= 10% and a confidence interval of 95%

The actual sample size is larger than the estimated sample size as data collection continued until the end of the week in which 97 participants were obtained instead of stopping at participant number 97.

Data collection took place between June and December 2013.

3.4.2. Selection Criteria

Selection of the sample was done according to the following inclusion and exclusion criteria (figure 3.1).

3.4.2.1. *Inclusion criteria*

The following inclusion criteria applied to determine eligibility for study participation:

- Patients for whom a lipogram was requested
- 18 years or older
- The lipogram indicated abnormal blood lipid values (or a normal lipogram if on lipid modifying medication).

All subjects had to give written consent to be eligible to participate (See ADDENDUM A) in the

study.

3.4.2.2. *Exclusion criteria*

Patients were not eligible for the study in the following conditions:

- Pregnant,
- Incomplete lipogram results or normal lipid profile and not on lipid modifying medication.
- Patients that met the inclusion criteria but where written consent was not obtained was excluded from the study,
- Patient was not in hospital or at outpatient clinic anymore.

Eight participants were excluded from the study. The reason for exclusion was as follows:

- One (1) due to unavailability to complete data collection
- Three (3) due to pregnancy
- Four (4) due to incomplete lipid profiles or due to normal lipid profiles

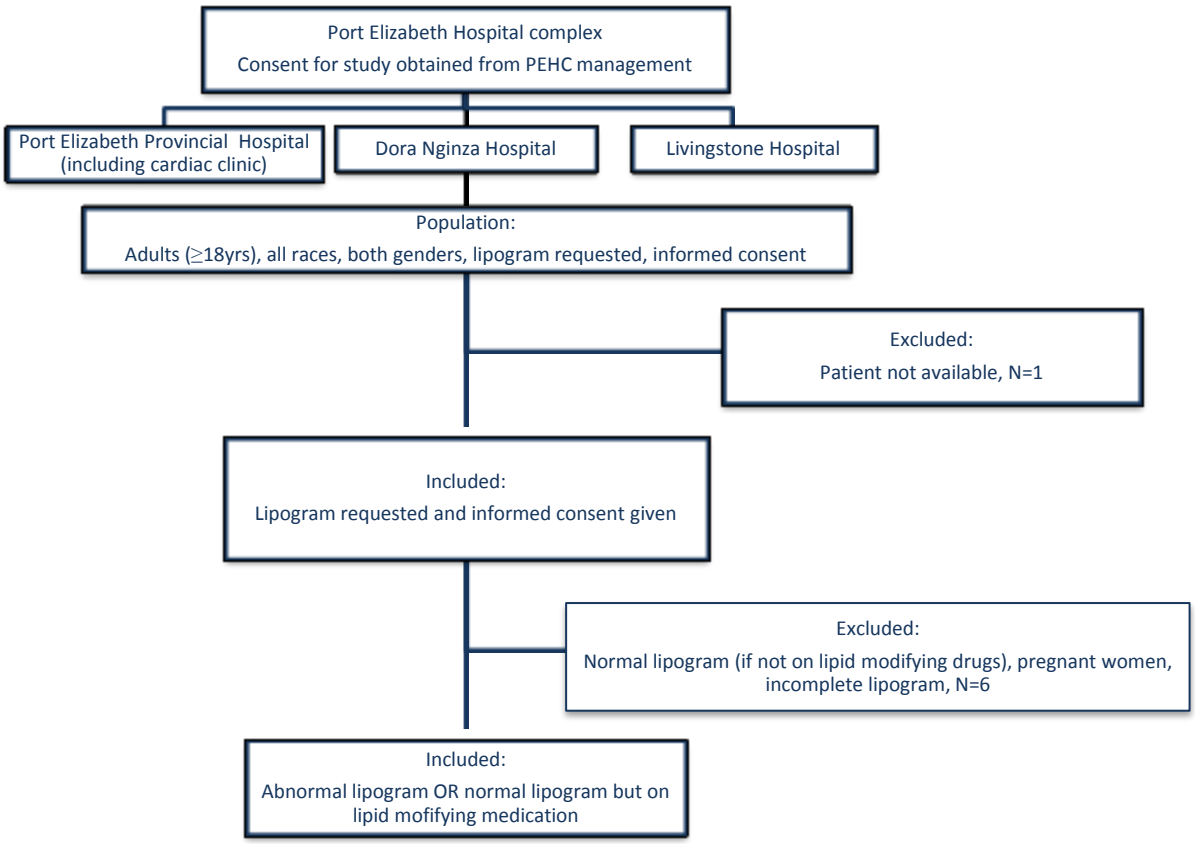


Figure 3.1: Flow diagram of study design

3.5. METHODOLOGY

Data were collected on individual level and completed during June to December 2013. Each subject was interviewed by a trained fieldworker during which the dietary fat intake screener (discussed in section 3.5.4.2) was completed. During the contact time anthropometrical measurements were also done (discussed in section 3.5.2.3).

Blood samples for biochemical values were taken by hospital staff as part of routine check-up of each patient or on a doctor's request for the newly diagnosed patients. Blood pressure was also taken as part of the routine monitoring by hospital nursing staff.

3.5.1. Logistics

Names for subjects were collected through either the identification of new patients from the National Health Laboratory Services (NHLS) request books in each ward of the hospitals or through the lists for requests from the cardiac clinic. These NHLS books are updated each day with doctor's requests for any laboratory tests. The cardiac clinic lists are also completed on a daily basis as patients come for follow-up visits.

Patients for whom a lipogram was requested were identified and contacted by the fieldworker or primary investigator. If the patient was still in the ward or at the cardiac clinic, written approval was obtained from the patient to be part of the study. The subjects were explained the purpose of the study and asked to give written informed consent to participate in the study. The subjects were seen individually in a separate office as to ensure privacy. If this was not possible for the subjects, the interview was commenced in the ward cubicle with the curtains closed for all inpatients.

If the patient was not available (has already left the hospital or clinic) or if written consent was not obtained, the patient was excluded from the study.

Next each subject's lipogram results was checked in her / his file. If the results were not available, it was checked by a nursing staff member on the HNLS system on the computer in the ward or outpatient clinic. If the results indicated a normal lipogram the subject's patient file was checked to note down whether he or she is on any lipid modifying drugs. If they were not on any, the subject was excluded from the study and no further data collection was completed. If they were on lipid modifying drugs or an abnormal results was obtained in the first instance, the subject was included and the investigators continued with data collection.

At the cardiac clinic data collection was done three times a week and at the hospitals twice a week. The reasoning for this was that in-patients tend to stay a few days as in-patients and that they will be included in the sample during their hospitalisation. At cardiac clinic, the patients

with dyslipidaemia come for follow-up consultations on specific days and by completing the data collection on those days, the investigator hoped to include the majority of the patients in this manner.

The investigator and fieldworkers who helped with data collection were all registered dietitians.

3.5.2. Data Collection and Measuring Instruments

Figure 3.2 below is the conceptual framework of the planned study with the measurements used in this study indicated in red. The basic causes and risk factors for CVD were investigated as well as the manifestation of the risk factors. For each subunit where applicable, categorisation systems that was utilised for data analysis were indicated. The categorisation was necessary as to assist in determining the manifestation of the risk factors.

To obtain all relevant information needed for data collection, each subject was interviewed, measurements were taken patient files were checked for additional information or for confirmation of information obtained during the interview.

Secondly, the utilisation of the dietitian in the management of CVD risk was determined by assessing the number of referrals of the patients to the dietetics department.

3.5.2.1. *Biochemical risk factors*

Information on all biochemical risk factors was obtained from participant files and captured on the self-designed questionnaire.

The lipid profile (lipogram), serum glucose and additional chemical profiles were either obtained from the subject's patient file or if not available, from the NHLS data base. A staff member of the PEHC was requested to obtain results from NHLS data base for the investigator. The blood sample was obtained by a nurse, employed by PEHC on request by a doctor employed by PEHC. The patients were fasted overnight when the blood sample of 4.5mL was taken.

Lipogram and other relevant biochemical profiles

The complete lipogram included total cholesterol, HDLC, LDLC and triglyceride levels. In addition serum glucose was also obtained since abnormal glucose values are indicative of uncontrolled glucose levels and could indicate the presence of diabetes mellitus.

If the patient was newly diagnosed with dyslipidaemia; thyroid-, liver and kidney function tests were also conducted as part of the routine workup so as to rule out other organ dysfunction that could have caused abnormal lipid results. A confirmed diagnosis of kidney or thyroid diseases

as well as the medical management there-off was also considered as a confirmation of disease. These tests are only done at initial diagnosis and then as requested during follow-up. These tests were used in the case of a participant being diagnosed with definite / probable or possible FH based on the elevated LDLC values as to exclude reasons other than genetics for the elevated LDLC levels.

Table 3.1: Categorisation of additional laboratory results

		Classification	Normal
Thyroid function	Thyroid stimulating hormone	Normal	0.34 - 5.60 mIU/L
		Elevated	≥ 4.2 mIU/L
		Low	< 0.27 mIU/L
	T4	Normal	4.6-12 ug/dl
		Elevated	> 12 ug/dl
		Low	< 4.6 ug/dl
Kidney function	Urea	Normal	2.1 - 7.1 mmol/L
		elevated	≥ 7.2
	Creatinine	Normal	49 – 90 umol/L
		Elevated	≥ 91umol/L

* The values reflected in table 2.2 are those utilised at Port Elizabeth Hospital Complex, South Africa

Serum glucose

Serum glucose was assessed so as to get an indication of glucose control. Information on diabetes mellitus was obtained from the subject's medical file as well as during the interview. A diagnosis of this disease, written in the medical file was accepted as a confirmation of diagnosis of if the patient was on either oral hyperglycaemic or insulin medication it was also taken as a confirmation of a diagnosis of diabetes mellitus.

Normoglycaemic control was considered as s-glc ≤ 6.0mmol/L or an HbA1C value <6.5% whilst hyperglycaemia was considered as s-glc value ≥6.1mmol/L or an HbA1c ≥ 6.5%.

3.5.2.2. *Socio-demographic information*

A self-designed questionnaire was used during the interview as well as the patient file as to obtain all social-demographic information

Education level

Subjects were asked during the interviews on their highest level of completed education level and results were categorised accordingly:

- primary (grade 1 – 7 / grade 1 – standard 5)
- secondary / high school (grade 8 – 12 / standard 6 – 12)
- Tertiary levels (any completed degrees / diplomas)

Income

Income categories was categorised according to Department of Health classification according to annual income:[50]

H0 / irratic: Social pensioners who receive the following grants: old age, child support, veterans, care dependency, disability grant, foster care, the formally unemployed, which means persons supported by the Unemployment Insurance Fund (UIF) who can produce a formal document issued by the Department of Labour.

Irratic was explained as an income for piece jobs.

H1: Less than R36 000 single income or R50 000 household income per year

H2: From R36 000 to R72 000 household income or R50 000 to R100 000 household income per year

H3: Individual income ≥ R72 000 or household income ≥ R100 000

3.5.2.3. *Biological risk factors*

Information on age, gender and race was obtained from the subject during the interview and captured on self-designed questionnaire.

Age was recorded in years with the participants' age at the date of data collection taken as correct.

Gender was classified into male and female. Race was categorised into Caucasian, African, Indian / Asian and Coloured according to the Census 2011 categorisation. If a participant could not classify themselves into one category, he/she was asked with which race he/she identified most with and classified accordingly.

3.5.2.4. *Clinical risk factors*

Disease conditions

Information on existing atherosclerosis, CHD, HPT and/or diabetes mellitus was obtained from the subject's medical file as well as during the interview. A diagnosis of any of these diseases, written in the medical file was accepted as a confirmation of diagnosis. If there was no diagnosis available in the file but the patient is on either anti-hypertensive, oral hyperglycaemic or insulin medication it was also taken as a confirmation of a diagnosis of either disease (HPT and/or diabetes mellitus).

Family history

A family history of first degree relatives presenting with the above mentioned diseases was obtained from the interview. A subject was asked if it was present in his/her family and if confirmed, asked which family member presented with it and at what age.

If a subject was unsure or if the family member is distantly related, it was noted as not present.

Blood pressure and Hypertension

Information on existing HPT was obtained from the subject's medical file as well as during the interview. A diagnosis of HPT, written in the medical file, and/or anti-hypertensive treatment was accepted as a confirmation of diagnosis.

The blood pressure documented in the subject's patient file as measured by the clinic/hospital staff was accepted as accurate and recorded on the data collection sheet. The blood pressure values was recorded to serve as confirmation of the diagnosis of HPT as well as to observe blood pressure control as elevated blood pressure is a risk factor for CVD.

Both diastolic and systolic blood pressure were noted. These are all continuous data but were categorised and coded according to Table 2.5 representing the South African hypertension practice guideline 2014 cut-offs The patient was subsequently classified according to the highest category of either the systolic or diastolic blood pressure.

Overweight and obesity

Anthropometric measurements were utilized to assess the presence of overweight and obesity of each subject. All anthropometric assessments were done according to procedures as summarized in Lee & Nieman.[51] Weight and standing height were measured in the study population by trained fieldworkers (the principal- and sub-investigators). From the measured

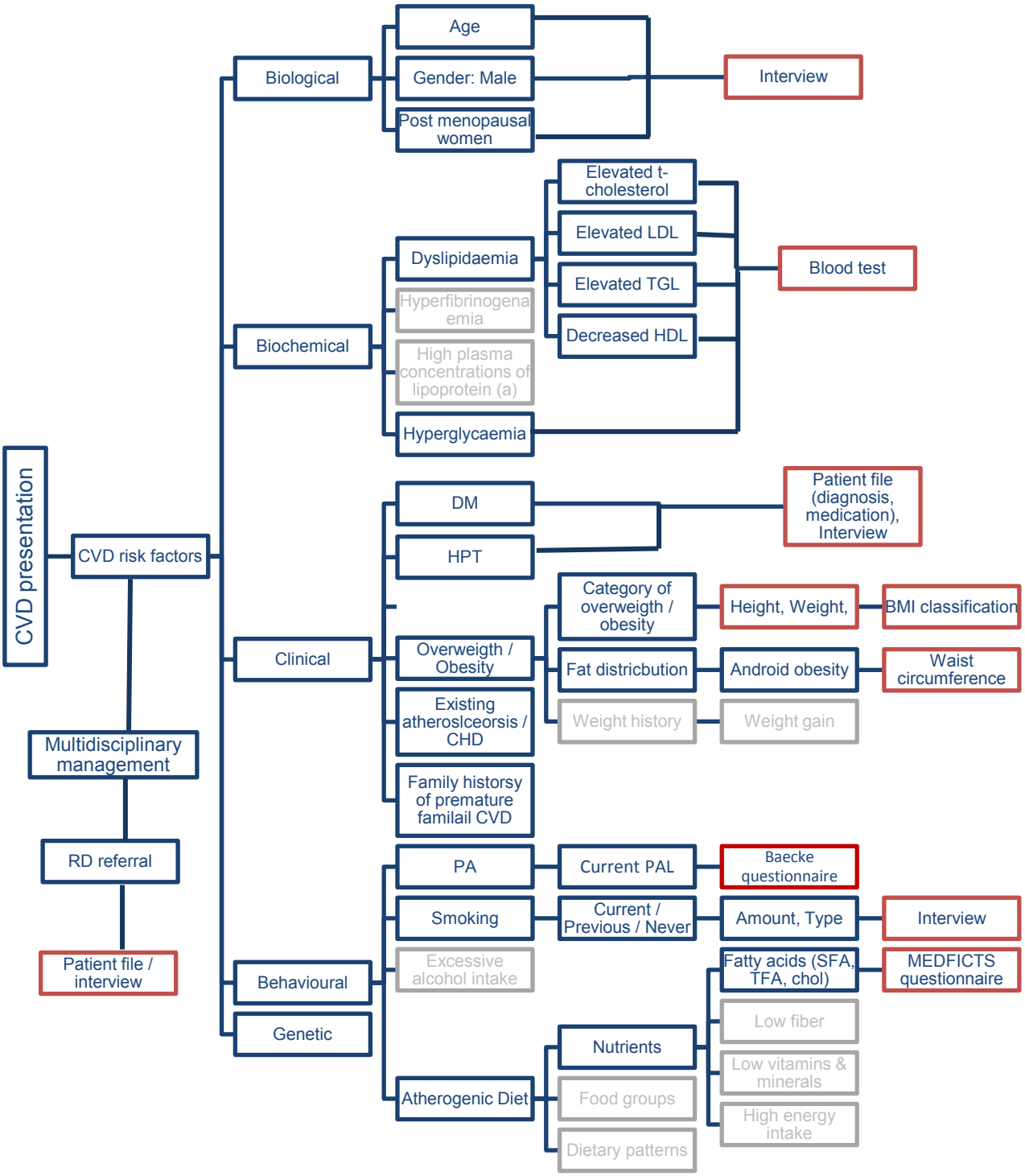


Figure 3.2: Study conceptual framework

height and weight, each subject's body mass index (BMI) was calculated. Explain in a separate sub-heading how the fieldworkers were trained / standardised.

Weight

Weight was determined by using a Tanita scale, model BC-543. This scale's unit of measurement is kilogram (kg) and is accurate to 0.1 kg. The weight capacity of the scale is 150kg.[52]

Procedure: The weighing procedure followed was conducted as summarized by Lee & Nieman:[51] the subjects' weight was measured to the nearest 0.1 kg. To improve the reliability of the measurements, weight was measured twice and the 2 measurements in succession had to agree to within 0.1 kg. An average of these 2 measurements was then calculated. If there was a larger difference (>0.1kg), the measurements had to be redone and neither one of the two (2) previous readings were considered.

Method: The scales were put on a flat, hard surface. The subject was asked to stand still and unassisted in the middle of the platform of the scale with weight distributed equally on both feet. The subjects' shoes was removed prior to the weighing procedure.

Validity can potentially be influenced by the clothing worn by the subjects, as well as by the time of day the measurements are taken. The variation in clothing was controlled by asking the respondent to remove all obvious extra layer of clothing, provided that the subjects were willing and comfortable in doing so. To ensure privacy, all anthropometric measurements was conducted in a private room or in a cubicle with the curtains drawn.

The time of day may also have an effect on the validity of the measurement. As far as possible the subjects was weighed during the mornings up to 12:00 since this is when all counseling bookings are made in PEHC. Generally the patients were fasted since this is a prerequisite for the blood works that needed to be done.

Height

Height of the participants was determined by a height measuring stand (scales2000) that can measure heights from 1.4m to 2m.

Procedure: Height was measured in meters to the nearest millimetre (0.01m). To improve the reliability of the measurements, height was measured twice and an average measurement was calculated. There should only be 1cm difference between the two readings. If there was a larger difference, the measurements had to be repeated and neither one of the two (2) previous readings were considered.

Method: The height was measured with subjects standing barefoot and upright with the head in the Frankfort horizontal plane. The subjects were asked to ensure that their heels were together, arms to the side, legs straight with the shoulders relaxed. Where possible the heels, buttocks, scapulae and back of head was against the vertical surface of the height measuring stand.[51]

Body mass index

Body mass index (BMI) was calculated as the weight in kilograms divided by the square of the height in meters (kg/m^2). From here BMI was calculated and rounded off to the closest one (1) decimal.

From here it was grouped into categories according to the WHO cut-off points (Table 2.6)[33, 34] For ease of data analysis the different categories under underweight was grouped together into one all-encompassing category namely underweight. This resulted in 6 categories namely underweight, normal weight, overweight, obese class I, obese class II and obese class III.

Waist circumference

To determine the distribution of the excess weight, the waist circumference was measured. This was also done with standard equipment and standardized techniques by trained fieldworkers (the principal- and sub-investigators).

The waist measurements were conducted in a private room along with the other anthropometric measurements to as to ensure privacy. To ensure validity the measurement was made with no clothing around the middle. If the subject was not comfortable with this procedure, a thin layer was allowed and recorded.[51]

Procedure: The measurement was taken on a normal expiration of the subject and measured to the nearest 0,1cm. To improve the reliability of the measurements, waist circumference was measured twice and an average measurement was calculated. If there was a larger difference than 0,1cm between readings, the measurements had to be redone and neither one of the two previous readings were considered.[51]

Method: The subject was asked to stand with arms relaxed at their sides and weight evenly distributed across both feet. The investigator then located the last palpable rib and the top of the iliac crest and got the midpoint between these 2 indices. The subject was asked to wrap a constant tension tape around themselves at the allocated midpoint making sure that the tape is wrapped over the same spot on the other side, parallel to the floor. The tape should fit snug but not too tight. [51]

The waist circumference of each subject was rounded off to the closest one (1) decimal and recorded. From here it was grouped into three (3) categories according to the WHO criteria (Table 3.1) separately for each gender.

Table 3.2: WHO classification of obesity[53]

Risk of metabolic complications	Waist circumference (cm)	
Comorbidity risk	Women	Men
Acceptable	< 80	< 94
Increased	≥ 80	≥ 94
Substantially increased	≥ 88	≥ 102

3.5.2.5. *Behavioural risk factors*

Smoking

A history on smoking habits was obtained during the interview where the subject was asked on their smoking habits with regards to type of smoking (cigarettes-bought or hand rolled, pipe), the amount per day and for how long they have been smoking. “Never smokers” are those participants that answered “never” to the question whilst those who smoked within the past 5 years from the interview were classified as current and those that stopped before this time were classified as former smokers. Those who are currently smoking or were past smokers were then classified according to duration of smoking (less or equal to 20 years or more or equal to 21 years). The number of cigarettes smoked per day were classified into 3 groups namely less than 20 per day, 21-30 per day or then any number above 31 per day. The amount of tobacco smoked was also investigated with the assumption that 1 cigarette or hand-rolled cigarette or pipeful contains 1 g tobacco.[54]

Physical activity

Information on physical activity was obtained through the administration of a questionnaire, based on the Baecke questionnaire[55], by the investigator conducting the interview.

The questionnaire consists of three categories namely occupational physical activity, physical activity in leisure time and lastly, leisure and locomotion activities. There is a total of 16 questions of which eight are on occupational physical activity, four questions on physical activity in leisure time and the remaining four questions on leisure and locomotion activities.

For occupational physical activity three levels are defined according to the Netherlands

Nutrition Council: the low level for occupations with a university education, such as medical practices and teaching, as well as clerical work, driving, studying, shop keeping and housework. The middle level for factory work, plumbing, carpentry and farming, and lastly the high level for occupations such as sport, dock- and construction work. Physical activity in leisure time is sporting activities of individuals over the past 12 months and the third category, leisure and locomotion activities refer to watching television, walking and cycling to/from work and shopping.

The questionnaire was validated in the Netherlands on adults aged 19 to 31 years. A total of 309 participants were included and women pregnant for 3 months or longer were excluded. With regards to the testing of the physical activity of each participant, three indices were considered to play a role namely activity at work, sport activity and leisure time activity. The test-retest reliability of each was 0.88, 0.81 and 0.74 respectively making the questionnaire useful. [55]

Hertogh EM et al validated the Modified Baecke Questionnaire on an elderly population aged 60 to 80 years. They compared the questionnaire to doubly labelled water method and concluded that the questionnaire validity for classifying individuals as low or highly active is good (43% of participants that was highly active and 71% of those with low activity were correctly identified)[56]

Atherogenic diet

The Meats, Eggs, Dairy, Fried foods, fat In baked goods, Convenience foods, fats added at the Table and Snacks (MEDFICTS) dietary assessment instrument (an adapted version of the meats, eggs, dairy, fried foods, fat in baked goods, convenience foods, fats added at the table, and snacks) was conducted by the interviewer during the contact time with the subject. The aim of this instrument is to evaluate the adherence of individuals to the Step 1 and Step 2 diets. These diets focus on decreased fat intake including total and saturated fats as well as lowering cholesterol intake in individuals diagnosed with CVD. In addition, the Step 1 diet is also recommended for all adults as an aid in the prevention of development of coronary heart disease as well as chronic diseases of lifestyle.[57]

The MEDFICTS instrument has been validated in a pilot study and two subsequent studies. In the pilot study, conducted at the Diet Modification Clinic, Baylor College of Medicine, Houston, Texas 16 sets of 4-day food records were selected and results compared to the MEDFICTS scores. In the first validation study, conducted during a diet intervention study at Mary Imogene Bassett Research Institute, New York, the MEDFICTS results were compared to 3-day diet records in 22 subjects. The second study was conducted at the Diet Modification Clinic, Baylor

College of Medicine, Houston, Texas and compared 3-day food records to the MEDFICTS scores in 26 participants.

In the pilot study, Pearson correlation coefficients between MEDFICTS and the 4-day food records for percentage energy from total fat and saturated fat were significant with P=.002 and P=.0003 respectively. The Pearson correlation coefficient for cholesterol content was also significant at P=.039. The correlation coefficients between the MEDFICTS and 3-day food records in the subsequent validation studies were again significant for energy from total fat (P=.006 and P=.0001) and saturated fat (P=.003 and P=.0001). For cholesterol content, the MEDFICTS scores correlated significantly with that of the 3-day food records in the Mary Imogene Bassett Research Institute study (P=.009) and showed a positive trend in the Baylor College of Medicine study.[57]

The benefit of the MEDFICTS design is that it allows for easy adaptations within the different food categories allowing for ethnic or regional food preferences. This benefit was made use of during the study as to accommodate the regional / ethnic food preferences that contribute to either total fat, saturated fat or cholesterol content.

A limitation on the other hand is that it does not accommodate additional demographic information for participants. This limitation however was dealt with in this study by obtaining the demographic information during the interview and capturing it on the data collection form.

The estimation of portion sizes may be improved with the aid of 2- or 3 dimensional food models and standard measuring utensils such as measuring cups and spoons.[57] For this reason the investigators made use of a kit containing kitchen utensils such as cups, a variety of spoons and plates in a variety of serving sizes. All of these utensils were marked at the back with the measured amounts each can contain. These measurements were similar to those found as options on the MEDFICTS screener.

Dietary analysis was done according to nutrient content of the foods as listed in the adapted MEDFICTS questionnaire. The nutrients that were evaluated for was saturated fat content, total fat content and cholesterol content. The intake of these nutrients was then compared to the Step 1 / 2 diet and classified into low or high intake according to the specified cut-offs recommended in the Step 1 / 2 diet.

Dietary changes

In addition to the administration of the MEDFICTS questionnaire, participants were asked during the interview whether they made any changes to their dietary patterns recently. This was noted as yes or no (categorical). This was done to assist in possibly explaining the results

obtained from the MEDFICTS questionnaire.

Table 3.3: MEDFICTS score and classification[57]

Medficts score	Classification	Dietary recommendations
0-39	Step 2	Total fat intake < 25-35% of daily total energy (TE) intake Saturated fat intake: < 7% of TE intake Cholesterol: < 200mg/d
40-70	Step 1	Total fat intake < 25-35% of daily TE intake Saturated fat intake: 8 – 10% of TE intake Cholesterol: < 300mg/d
> 70	High fat diet	Total fat intake > 35% of daily TE intake Saturated fat intake: > 10% of TE intake Cholesterol: > 300mg/d

As follow-up those who answered positively, were asked to indicate who they got their information regarding dietary changes from:

- Nurse
- Doctor
- Dietitian
- Other (such as magazines, radio, TV programmes)

Responses were noted as positive or negative for each option.

3.5.2.6. *Genetic or familial dyslipidaemia*

Primary / genetic hypercholesterolaemia are suggested by the presence of corneal arcus and tendon xanthomata. Corneal arcus was only considered if the subject was below 45 years of age.

Secondly, by the presence of severe LDL hypercholesterolaemia (LDLC > 5.0 mmol/L) was perused. If both factors were present the biochemical indicators for kidney and thyroid disease were perused (if available). Additionally, kidney or thyroid disease was confirmed with a written diagnosis in the patient medical file. If either clinical signs or severe LDL hypercholesterolaemia was present in the absence of kidney or thyroid disease, a diagnosis of FH was accepted. No distinction was made between definite, probable or possible FH.

For data analysis the clinical signs as well as family history were coded on a 2-point scale.

3.5.2.7. *Dietetic referral*

Referral to the dietetics department was noted from the participant's hospital file. If this information could not be found participants were asked whether they were referred to the Dietetic department for nutritional counselling recently (on the same day of consultation or in the past month).

3.6. DATA CAPTURING

Each participant's data were captured on a data collection form (see Addendum B) and during data capturing the following was done:

- All continuous data (with the exception of age) was put into categories as discussed above for each risk factor
- MEDFICTS score: Scores were allocated to each question's answer based on frequency and portion size. All the scores obtained for each category were added to get a total score. This total score was then categorised accordingly as discussed under 3.5.2.5.
- PAI: All responses are pre-coded on five-point scales with the exception of question 1 on main occupation and two questions in question 9 on types of sport played. These questions are coded on a three point scale. The separate occupational physical activity, physical activity in leisure and leisure and locomotion activity scores are added together to get to a continuous overall unit less physical activity score / index (PAI). The scores were then grouped into 4 categories according to the following cut-of points 0, 0.01 - > 4, 4 - <8, 8 - < 12 and lastly >12.[51] (Addendum A)

Data capturing was done on a microsoft excel spreadsheet (composed prior to data collection) during the data collection time period. It was double checked by one of the sub-investigators, after completion of the data collection period for thorough completion.

3.7. QUALITY CONTROL

The validity and reliability of each questionnaire as well as measures taken to ensure validity and reliability were discussed under each questionnaire and measurement in the fore mentioned.

For all anthropometrical measurements done, a standardised approach for each measurement was followed. In all instances two measurements was done and had to agree within a certain

degree of each other. An average was calculated between both measurements.

Before commencement of the study, the sub-investigators were trained and standardised on the techniques and procedures that had to be used for data collection. This was also repeated on a monthly basis as the principal investigator visited the data collection sites. A training document was given to each to assist with correct identification of the physical signs of FH (see Addendum C). In addition each sub investigator was given a kit with the same measuring spoons and cups as to assist participants in identification of serving sizes for the MEDFICTS questionnaire. The kit also included pens, boards and a non-stretchable measuring tape for WC measurements.

3.8. STATISTICAL ANALYSIS

MS Excel was used to capture the data and STATISTICA version 13 (Dell Inc. (2015). Dell Statistica (data analysis software system), version 13. software.dell.com.) was used to analyse the data.

Summary statistics were used to describe the variables. Distributions of variables were presented with histograms and or frequency tables. Medians or means were used as the measures of central location for ordinal and continuous responses and standard deviations and quartiles as indicators of spread.

Relationships between continuous variables were analysed with regression analysis and the strength of the relationship measured with Pearson correlation, or Spearman correlation if the continuous variables were not normally distributed.

The relations between nominal variables were investigated with contingency tables and significance between the nominal variables were tested with maximum likelihood chi-square tests.

In all hypotheses tested a p-value of $p < 0.05$ represented statistical significance

3.9. ETHICAL CONSIDERATIONS

Ethical approval was obtained from the ethics committee of the University of Stellenbosch (number S12/09/251, extended for 2013 and 2014).

Ethical approval was also obtained from the CEO of the PEHC. Managers of each hospital

were also informed about the study after obtaining approval from the CEO. Initially dietary counselling was to be given to each subject that consented to participate in the study but objection was raised since the investigators were not employed by the PEHC. The decision was made to exclude the counselling and in the place there-of the subjects were given feedback on their BMI, the classification there-of as well as their waist circumference.

The nursing department of the PEHC and the staff of the cardiac clinic were informed of the study and explained the purpose along with the procedures of the study. For the procedures it was noted that access to NHLS book with requests for blood works, was needed as well as the list at cardiac clinic so as to see for which patients lipogram tests were ordered.

The Dietetics departments of each hospital were also informed of the study even though they did not aid in anyway with the study.

On commencing with the study, once a participant was identified from the NHLS book and/or cardiac clinic list, the participant was asked to participate in the study. Once verbal consent was given, the participants name was added to a list where a study number was allocated to them. Only the principal researcher and two data collectors had access to this list. Identifying information was and will be kept confidential. Once verbal consent was given, the interview was continued in a closed-off counselling room where written ethical consent (see Addendum B) was obtained before commencing with the data collection.

Privacy and confidentiality was at all times respected by conducting the interview along with measurements in a counselling room where only the participant and interviewer were present. The data gathered were and will be used only for the purpose of this study.

3.10. PILOTING

A pilot study was conducted on a small sample of 10 patients' representative of the study population a month before commencing with the study. The participants were selected from the cardiac clinic at the Port Elizabeth Provincial Hospital for whom a lipogram was requested and they were either newly diagnosed with dyslipidaemia or had a current diagnosis of dyslipdaemia. These participants were excluded from the main study.

During the pilot study 24-hour recalls were conducted in conjunction with the MEDFICTS questionnaire as to identify foods that are eaten regularly by the various groups and are not accommodated on the MEDFICTS questionnaire or that are indicated on the MEDFICTS but not eaten by the population. The following foods were added to the questionnaire: calamari,

evaporated milk, the term amasi (the term buttermilk was there but amasi was added to help with exaplanation), cheese spread (low fat, full cream), cheese wedges, custard. These foods were checked on the program foodfinder for total fat content per average serving (as determined in the specific MEDFICTS food category) and classified accordingly.

The following foods were removed from the questionnaire: Ground turkey, Monteray Jack (cheese), Colby (cheese), American processed (cheese) as these product are not available in South Africa.

Examples of preparation methods were added e.g. boil, steam as to aid participants in distinguishing between frying and “other” cooking methods.

Standard portion sizes of each food consumed were also identified for further adaptations. The pilot study indicated that the portion sizes of the MEDFICTS were in line with the portion sizes of foods that the participants consume.

In addition the adapted MEDFICTS questionnaire was sent to four registered dietitians practicing in Port Elizabeth for comment on face and content validity. The comments received were in line with what was found during the pilot study.

The Baecke physical activity questionnaire was also completed to ensure that participants understood the questions. It was found that a clear distinction had to be made between leisure time activities and sporting activities. To assist in this all investigators were trained on how to explain this in a similar manner to all participants:

- Sporting activities: Joining a team to play a sport or participating in activites for a competition
- Leisure activities: Activities that you do in your free time to relax

The participants had problems understanding the question: “In comparison with others of my own age I think my physical activity during leisure time is:...” The question was therefore rephrased to: “When you think about your friends that are your age – do you think you are as active as them / less active / more active / much more active?” The options given were still the same as those from the original questionnaire.

A second pilot study was conducted prior to commencing the study by the principal researcher. During this pilot study logistics, data collection forms and questionnaires were tested for face validity and content validity. The participants (N = 5) were again selected from the cardiac clinic at the Port Elizabeth Provincial Hospital. As a result of this second pilot study, space was added on the questionnaire to the anthropometrical and biochemical indicators as to note the

value of each and then subsequently proceed to the categorisation of each. This was done to save time during the interview as well as ensure correct categorisation. Also the term dyslipidaemia was changed to “cholesterol” as most participants did not understand the term dyslipidaemia.

CHAPTER 4:
RESULTS

This chapter presents the baseline characteristics of the study population along with the CVD risk factors for the study population as an entity, for each gender and according to ethnicity.

4.1. SAMPLE DESCRIPTION

The study population was adult patients of both sexes and all race groups attending PEHC as inpatients and diagnosed with dyslipidaemia. The total sample size was 103. Eight (8) participants were excluded due to incomplete lipogram results or had a normal lipid profile and not on lipid modifying medication.

Of the 103 participants in the sample, 24 (23%) had primary schooling whilst the majority (n=63; 61%) had secondary schooling. Only 16 of the participants had tertiary education.

Fifty seven (n=57; 55%) of the sample had an erratic income or was dependent on government grants. Forty n=40; 39%) was classified in the H1 bracket whilst only 6 was classified in the H2 income bracket.

The sample characteristics age, gender and ethnicity are discussed under 4.2 CVD Risk Factors as the variables forms part of the CVD risk profile.

4.2. CVD RISK FACTORS

4.2.1. Biochemical risk factors

4.2.1.1. *Dyslipidaemia*

The mean total cholesterol for the sample falls on the cut-off between normal and moderately elevated levels. The highest value is in the extreme hypercholesterolaemia category. The median for HDL values falls within the category of normal HDL levels whilst the highest value falls in the category of severe hyperalphalipoproteinaemia. (Table 4.9)

The median for LDLC values falls within the category of elevated LDL levels with the highest in the severe LDL hypercholesterolaemia category. Mean triglicerides mean falls in the acceptable value category whilst the highest value only extends to the elevated category and not into the severe category as with the other 3 indicators. (Table 4.1)

The results for the lipid fractions of the entire sample, broken down according to gender and lastly

according to ethnicity is summarised in Table 4.2 below.

Table 4.1: Description of lipogram components

	Values (mmol/L)				
	Mean	Median	Minimum	Maximum	Std Dev*
T-chol	5.12	4.96	2.15	15.64	1.80
HDLC	1.27	1.23	0.33	2.84	0.42
LDLC	3.02	2.71	1.07	14.4	1.80
Triglycerides	1.64	1.49	0.6	4.03	0.09

The majority of the sample (n=81; 98%) had elevated total cholesterol levels of which halve (n=57,55%) presented with moderately elevated total cholesterol levels, forty percent (n=41) had severely elevated total cholesterol levels whilst 3% (n=2) had extremely elevated total cholesterol levels (table 2.2 and table 4.10).

Sixty percent (n=61) of the sample had raised LDL levels of which 23% (n=24) was moderately raised, 32% (n=33) severely raised and 4% extremely raised. Of those with elevated LDL cholesterol values, 4 (6.5%) of the participants had the comorbidity of hypothyroidism (diagnosed with blood tests – elevated TSH or low thyroid levels). Another participant was diagnosed with hypothyroidism but had normal thyroid function whilst another was diagnosed with hypothyroidism but no thyroid tests were done. With regards to renal function, 7 (11%) of those with abnormal LDL values had renal insufficiency evidenced by raised urea or creatinine levels. None of these 7 participants had hypothyroidism. Thus one can conclude that 18% (n=11) of those with elevated LDL levels had comorbidities that could contribute to this phenomenon (refer to table 2.2 and table 3.2 for cut-off values for the various biochemical tests)

Half of the sample (n=52, 50%) had elevated triglyceride levels. Of those with elevated triglyceride levels, seven (11%) had renal insufficiency that could have contributed to the elevated levels.

Just under half of the sample (49%, n=51) had low HDL levels whilst 7 had severely elevated HDL levels. When considering the factors that may have contributed to low levels of HDL, seven (14%) smoked, 92% (n=47) were classified as overweight or obese, 52% (n=27) had hypertrigliceridemia and 12% (n=6) had renal insufficiency.

Table 4.2: Classification of Lipid profile of study sample

	Gender (N, % of gender)		Total sample (N, %)	Ethnic group (N, % of ethnic group)			
	Males	Females		Caucasian	African	Coloured / Mixed ancestry	Asian / Indian
Number (n)	42	61	103	34	12	46	11
TC							
TC, normal	0 (0%)	2 (3.3%)	2 (1.9%)	0 (0%)	2 (16.7%)	0	
TC, Total nu hypercholesterolaemia	42 (100%)	59 (96.7%)	101 (98.1%)	34 (100%)	9 (75%)	45 (100%)	12 (100%)
TC, moderate	29	28	57	20	5	28	4
TC, severe	13	28	41	14	2	17	7
TC, extreme	0	3	3	0	2	0	1
LDLC							
LDLC, normal	18 (42.9%)	23 (37.7%)	41 (39.8%)	17 (50%)	6 (50%)	17 (40%)	1 (9%)
LDLC, total nu elevated	24 (57.1%)	37 (60.7%)	61 (59.2%)	17 (50%)	4 (33.3%)	28 (60%)	11 (91%)
LDLC, elevated >2.5	13	11	24	9	1	9	5
LDLC, mild-mod	11	22	33	5	3	19	5
LDLC, severe	0	4	4	3	0	0	1
HDLC							
HDLC, normal	19 (45.2%)	24 (39.3%)	43 (41.7%)	18 (52.9%)	2 (16.7%)	17 (40%)	7 (58.3%)
HDLC, total nu low	23 (54.8%)	37 (60.7%)	60 (58.3%)	16 (47.1%)	10 (83.3%)	28 (60%)	5 (41.7%)
HDLC, low	20	31	51	14	6	9	3
HDLC, significant	3	4	7	2	1	19	2
HDLC, severe	0	2	2	0	11	0	0
TGL							
TGL, normal	21 (50%)	29 (47.5%)	50 (48.5%)	20 (58.8%)	5 (41.7%)	22 (47.8%)	3 (25%)
TGL, total nu elevated	21 (50%)	31 (50.8%)	51 (49.5%)	14 (41.2%)	6 (50%)	23 (50%)	8 (75%)
TGL, elevated	21	30	50	13	6	23	8
TGL, moderate severe	0	1	1	1	0	0	0

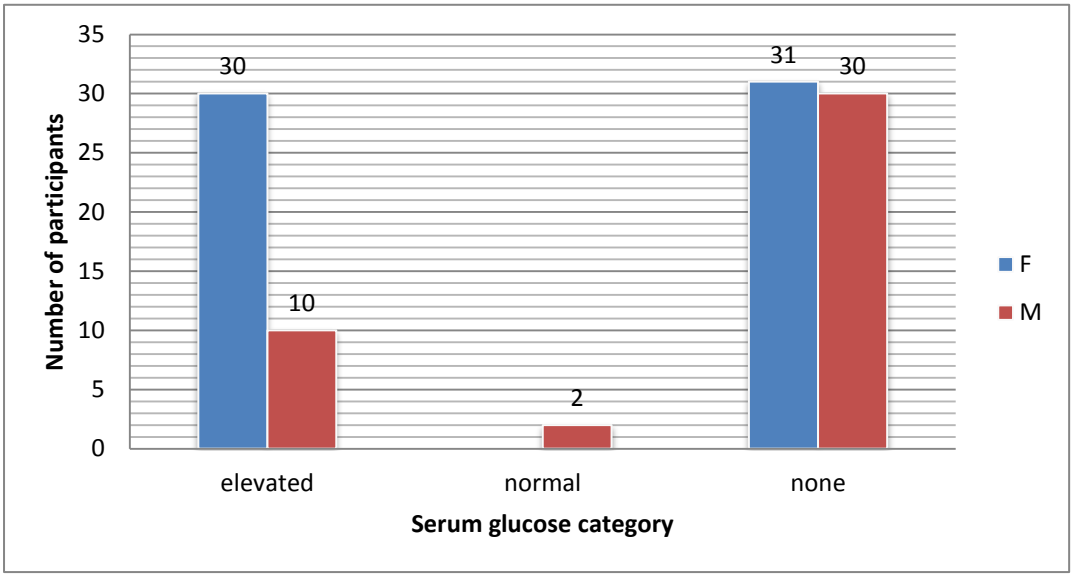
* TC = total cholesterol; LDLC = low density lipoprotein cholesterol, HDLC = high density lipoprotein cholesterol, TGL = triglycerides

4.2.1.2. *Serum glucose*

Serum glucose was tested in only in 41 (41%) whilst in the majority of the sample (N=61; 59%) it was not tested. Hyperglycaemia is defined as a serum glucose value ≥6.1mmol/L or an HbA1c value ≥ 6.5%.

Of those currently diagnosed with DM, all had elevated serum glucose levels (n=37, 100%). In addition, five of those not diagnosed with DM also had elevated serum glucose levels that qualify them as having hyperglycaemia, resulting in a prevalence of 41% for hyperglycaemia for the total sample. Only 2 participants had acceptable glycaemic control (normoglycaemia) as presented in figure 4.1.

The difference in glucose control between genders was found to be significant.



* M = males; F = females

Figure 4.1: Glucose control according to gender [Chi-squared (df=1), p=.02172]

The Coloured ethnic group had the highest prevalence hyperglycaemia followed by the Caucasian group, then the African group and lastly, the Asian group with only 1 participant that was hyperglycaemic. The results of glycaemic control between ethnic groups were insignificant with a probability of 22%.

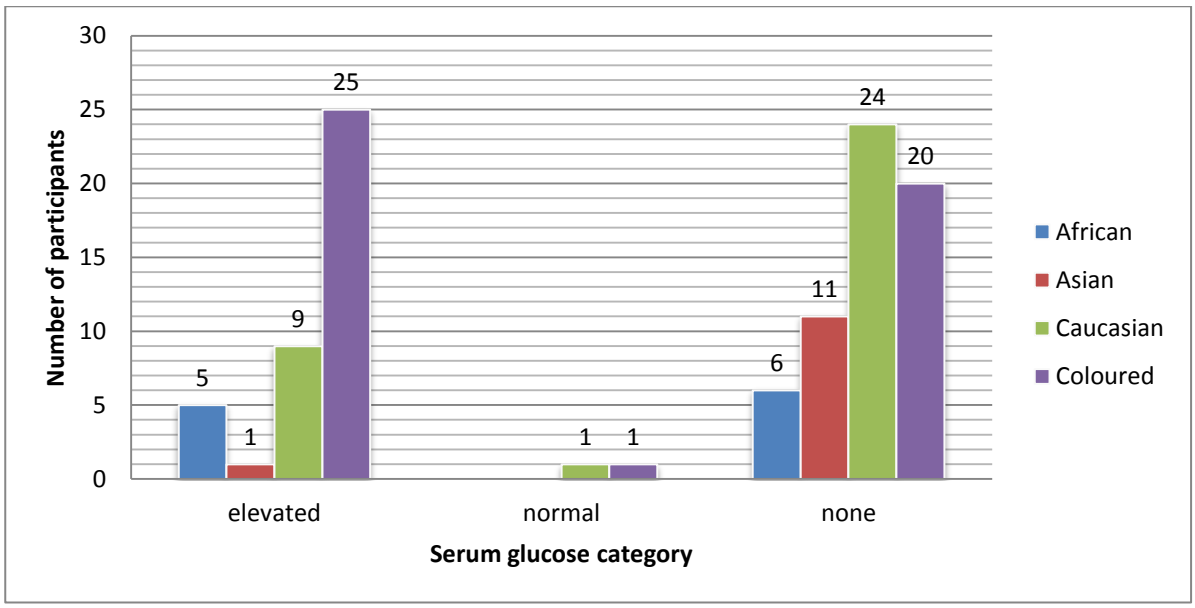


Figure 4.2: Glucose control according to ethnicity [Chi-squared (df=3)=1.08, p=.78102]

4.2.2. Biological Risk Factors

4.2.2.1. *Gender and age*

Of the 103 participants included in the sample, 59% (n=61) were females and 41% (n=42) were males. The mean age along with the minimum age for males was lower than that of the females. Females were much older with a higher maximum age (Table 4.3)

Table 4.3: Age description according to gender

		Age				
	N	**Mean**	**Median**	**Minimum**	**Maximum**	**Std Dev***
Total Sample	103	59.94	60.00	36.00	92.00	10.93
Female	61	61.87	61.00	38.00	92.00	11.57
Male	42	57.14	57.00	36.00	73.00	9.38

Std Dev = Standard deviation

As can be seen in table 4.3 above the mean age for the males was lower than that of the females. This is expected as CVD risk is stratified at lower age for males (45 years) than females (55 years of age).

4.2.2.2. *Ethnicity*

The ethnic distribution of the sample is shown in table 4.4 where it can be observed that Coloured formed the major ethic group (n=46, 45%), followed by the Caucasian group with the Asian and African groups in the minority (n=12, 11% and n=11, 11% respectively). There was no observable age difference between the various ethnic groups however the Coloured ethnic group had a lower mean age than the entire sample as can be seen in Table 4.4 below.

Table 4.4: Age description according to ethnicity

		Age				
	N	**Mean**	**Median**	**Minimum**	**Maximum**	**Std Dev***
Sample	103	59.94	60.00	36.00	92.00	10.93
Caucasian	34	62.70	63.00	45.00	92.00	11.65
Coloured	46	59.73	59.00	40.00	82.00	10.45
African	12	54.33	56.50	36.00	71.00	12.16
Asian	11	58.82	61.00	46.00	74.00	7.73

* Std Dev = Standard deviation

4.2.3. Clinical risk factors

With regards to clinical risk factors, the majority of participants had at least 1 clinical risk factor present. The clinical risk factor that had by far the highest prevalence was HPT.

4.2.3.1. *Hypertension*

The mean and median of SBP are similar whereas that of DBP differs slightly. SBP also has a larger standard deviation than that of DBP (Table 4.5).

Table 4.5: Blood pressure description of sample

		Blood Pressure (mmHg)				
	N	**Mean**	**Median**	**Minimum**	**Maximum**	**Std Dev***
SBP	103	142.15	142.00	98	199	18.85
DBP	103	81.68	83.00	47	125	14.80

Eighty seven (84%) of the study group presented with a diagnosis of HPT whilst only 16 (16%)

presented with normal blood pressure (thus no diagnosis). When looking at the classification of blood pressure according to the different stages, thirty seven (37 of the sample was classified with Stage 1 HPT, 32 with pre-hypertension, 19 with Stage 2 HPT, and 5 with stage 3 hypertension. A mere 10 was classified into the normotensive group (Table 4.6).

Table 4.6: Hypertension classification of sample according to gender and ethnicity

	Blood pressure classification					
	Normal	**pre**	**stage 1**	**stage 2**	**stage 3**	**Total**
Female N; % of females	3 (4.92%)	21 (34.43%)	23 (37.71%)	12 (19.67%)	2 (3.28%)	61 (100%)
African	0	0	4	3	0	7
Asian	1	2	1	0	0	4
Caucasian	1	7	5	5	2	20
Coloured	1	12	13	4	0	30
Males N; % of males	7 (16.67%)	11 (26.19%)	14 (33.33%)	7 (16.67%)	3 (7.14%)	42 (100%)
African	0	3	0	1	0	4
Asian	2	2	2		2	8
Caucasian	1	2	7	3	1	14
Coloured	4	4	5	3	0	16
Grand Total	10 (9.71%)	32 (31.07%)	37 (35.92%)	19 (18.45%)	5 (4.85%)	103

For both genders the majority of participants were classified into stage 1 and stage 2. Of the 61 female participants, 37 (61% of female sample) had blood pressures classifying them as hypertensive whilst 57% (n=24) of the male sample was classified as hypertensive (Table 4.6).

Sixteen of the sample did not have a diagnosis of HPT on contact. Eleven (11; 69%) of the 16 participants undiagnosed with HPT had a blood pressure value classifying them as pre-hypertensive whilst 2 (12.5%) were classified as Stage 1 HPT. Only 3 (19%) had a normal blood pressure classification.

With regards to ethnicity, the Caucasian and mixed ancestry sub samples had higher incidence of pre- and stage 1 hypertension when compared to the African and Indian ancestry. The highest incidence of HPT was found under the African and Indian population groups (73% and

75% respectively) with the lowest incidence found in the Coloured population at 50% (n=25). The Caucasian population had a prevalence of 68% (n=23). It must be noted that the most elevated BP was found under the Caucasians and Indian ethnic groups with 9% (n=3) and 17% (n=2) classified as stage 3 HPT.

4.2.3.2. *Overweight and obesity*

With regards to anthropometric risk factors the mean BMI for the sample was 31.04 kg/m^2 as indicated in Table 4.7. The spread was 17.87 kg/m^2 to 51.11 kg/m^2. When looking at the categorical classification of BMI the majority of participants were classified as overweight (n=32,31%) and obese class I (n=35; 34%). Only one (1) female was classified as underweight. The males of the sample tended to be more overweight (n=19, 45%) whilst the females tended to be more obese (n=41, 67%). The Coloured ethnic group had a lower incidence of overweight and the highest incidence of obesity than the other ethnic groups where the incidence of overweight and obesity was more in line with the total sample characteristics.

Table 4.7: Body mass index according to gender and ethnicity

		Total sample	Gender		Ethnic group			
			Male	Female	Caucasian	Indian	Coloured	African
		N =	N = 42	N = 61	N = 34	N = 11	N = 46	N = 12
BMI * (kg/m^2) (mean ± SD)		31.04 ± 6.19	29.20 ± 4.56	32.29± 6.95	31.71 ± 8.08	29.65 ± 3.93	31.08± 5.26	30.23 ± 5.50
			N, % of gender		N, % ethnic group			
Body mass index (BMI) classification (kg/m^2)	<18.50	1 (1%)	0	1 (1.64%	0	0	1 (2.17%)	0
	18.50 – 24.99	13 (13%)	7 (16.67%)	6 (9.84%	5 (14.71%)	3 (27.27%)	4 (8.69%)	1 (8.33%)
	25 – 29.99	32 (31%)	19 (45.24%)	13 (21.31	13 (38.24%)	4 (36.36%)	12 (26.09%)	3 (25.00%)
	> 30	57 (55%)	16 (38.09%)	41 (67.21%)	16 (47.06%)	6 (54.54%)	29 (63.04%)	6 (50.00%)

More than three quarter of the sample had waist circumferences above the acceptable cut-off values with the majority with waist circumferences above the cut-off for substantially increased NCD risk (table 4.8).

Table 4.8: Waist circumference according to gender and ethnicity

		Total sample	Gender		Ethnic group			
			Male	Female	Caucasian	Indian	Coloured	African
		N = 103	N = 42	N = 61	N = 34	N = 11	N = 46	N = 12
Waist circumference * (cm) (mean ± SD)		102.23 ± 13.41	101.86 ± 11.21	102.50 ± 14.91				
			N, % of gender		N, % ethnic group			
Waist circumference Cut-off (WCC)	WCC, acceptable	17 (16.50%)	12 (28.57%)	5 (8.19%)	6 (17.65%)	3 (27.27%)	7 (15.22%)	1 (8.33%
	WCC, Increased	14 (13.59%)	8 (19.05%)	6 (9.84%)	3 (8.82%)	2 (18.18%)	6 (13.04%)	3 (25%)
	WCC, Substantiall	72 (69.90%)	22 (52.38%)	50 (81.97)	25 (73.53%)	7 (63.64%)	33 (71.74%)	7 (58.33

* Footnote: WCC acceptable: Females < 80cm; Males < 94cm
WCC increased: Females ≥ 80cm; Males ≥ 94cm
WCC substantially increased: Females ≥ 88cm; Males ≥ 102cm

The females had a substantially larger percentage of WC above the ”substantially at risk” category than the males. No noteworthy differences were observed between ethnic groups.

The Caucasian and Coloured ethnic group had a similar distribution than that of the total sample whilst the African ethnic group had a smaller percentage falling in the ”substantially at risk” cut-off..

The Chi square test at a significance level of 95% with 2 degrees of freedom is 10.91 and thus the difference between WC for males and females is significant.

One can observe from table 4.9 that all participants who were classified as obese had a waist circumference above the acceptable cut-off and with the exception of one, they were all above the cut-off classified as substantially increased risk.

Looking at the relationship between WCC and LDL, the Chi square test at a significance level of 95% (significant) with 8 degrees of freedom is 11.91 and thus there is no relationship between LDL and WCC categories.

Table 4.9: BMI classification and Waist circumference classification of sample

	Waist circumference classification n, % of total sample			
BMI classification	**acceptable**	**increased**	**substantially increased**	**Total**
underweight	1	0	0	1
normal	9	3	1	13
overweight	7	10	15	32
obese class I	0	0	35	35
obese class II	0	1	14	15
obese class III	0	0	7	7
Total	17	14	72	103

4.2.3.3. *Clinical manifestation of CHD or atherosclerosis*

When looking at a family history of CVD, 72% (n=74) had a first degree relative with a history of CVD. In the majority of the cases the origin of the CVD was unknown with only 27% (n=28) that were aware of the presence of dyslipidaemia in those relatives affected by CVD.

4.2.3.4. *Diabetes Mellitus*

The clinical risk factor that had the lowest prevalence in the sample, was the diagnosis of DM (n=38; 36%). Forty two percent of the females had a diagnosis of DM whilst only 12 (28%) of the males had a diagnosis of DM (Table 4.10).

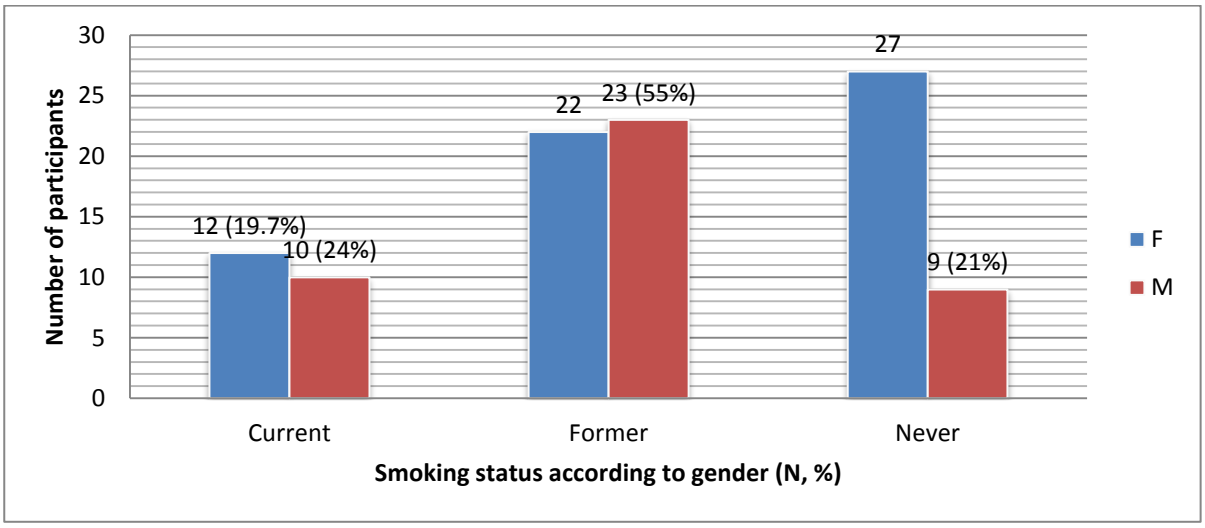
Table 4.10: Prevalence of DM according to gender and ethnicity

	Diagnosis of DM			
	Female (n, % gender group)		**Male (n, % gender group)**	
Ethnicity	**Diagnosis Present**	**Diagnosis not present**	**Diagnosis Present**	**Diagnosis not present**
African	4	3	2	2
Asian	0	4	1	7
Caucasian	6	14	1	13
Coloured	16	14	8	8
Total	26 (42.63%)	35 (57.38%)	12 (28.57%)	30 (71.43%)

4.2.4. Behavioural risk factors

4.2.4.1. *Smoking*

Almost half of the sample was classified as former smokers (n=45, 44%) whilst 21% (n=22) were classified as current smokers. Thirty-six percent (36%) reported to have never smoked. More females than males had never smoked (figure 4.3). For those currently smoking, a similar number of females and males was reported.



* M = males; F = Females

Figure 4.3: Smoking status according to gender

When looking at smoking status according to ethnicity, the majority of the Caucasian and Coloured population used to smoke whilst the African population had the largest number of participants that have never smoked. There were no current smokers in the African ethnic group whilst the Asian and Caucasian had a similar percentage of smokers. The Coloured ethnic group had a slightly higher percentage of current smokers (table 4.11).

Table 4.11: Smoking status according to ethnicity

	Ethnicity (n)				Grand Total
Smoking Status	**African**	**Asian**	**Caucasian**	**Coloured**	
Current	0	2	7	13	22
Former	4	5	14	22	45
Never	7	5	13	11	36
Grand Total	11	12	34	46	103

Considering smoking and HDL levels (as smoking decreases HDL levels), 48% (n=28) of those presenting with low HDL values were former smokers whilst only 16% (n=9) were current smokers (Table 412).

Table 4.12: Smoking status and HDL values

	Smoking status			
HDL level	**Current**	**Former**	**Never**	**Grand Total**
Normal HDL	13	17	13	43
Severe hyper	0	0	2	2
Low HDL	7	26	18	51
Significant hypo	2	2	3	7
Grand Total	22	45	36	103

4.2.4.2. *Physical Activity*

The majority of the sample in this study was categorized as having a low PAL. The section of physical activity at leisure (Addendum A) scored the lowest of the three sections of the Baecke questionnaire.

4.2.4.3. *Step 1 and Step 2 diet*

Forty nine (47%) of the sample followed a Step 1 diet, 23 (22%) followed a step 2 diet and 31 (30%) followed a high fat diet.

The males in the sample had a higher prevalence of high fat intake than the females whilst a larger percentage of females followed a low fat (Step 2) diet (Table 4.13)

Table 4.13: MEDFICTS score according to gender

	Count of Medficts score			
Gender	**High fat**	**Step 1 diet**	**Step 2 diet**	**Grand Total**
Female (n,% of females)	14 (22.22%)	27 (44.26%)	20 (32.79%)	61
Male (n;% of males)	17(40.48%)	22 (52.38%)	3 (7.14%)	42
Grand Total (n,% of total)	31 (30.09%)	49 (47.57%)	23 (22.33%)	103

A greater percentage of Caucasians and Asians followed a high fat diet compared to Africans

as can be observed in figure 4.4 below. The African ethnic group had a percentage of participants following a low fat / Step 2 diet.

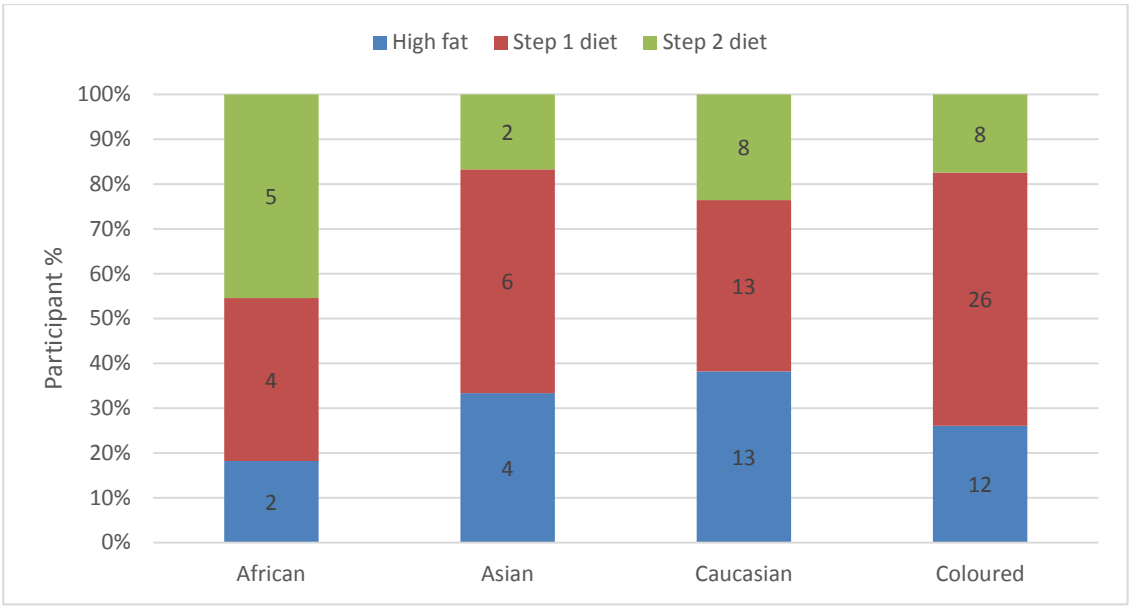


Figure 4.4: MEDFICTS scores according to ethnicity

Half of the sample (51, 49%) recently made dietary changes that included changes influencing fat (and saturated fat) intake. Of those who made dietary changes, the majority received information regarding dietary changes from the dietitians (34%), doctors (17%) and other sources such as magazines, family members (18%).

When observing fat intake and LDLC levels, the majority of those with severe and mild-moderate LDL levels had a high fat or higher fat (Step 1) intake. Those with normal LDLC levels followed mostly a step 1 diet. (table 4.14)

Table 4.14: LDL levels and MEDFICTS scores

LDL levels categories	Count of Medficts score			
	High fat	Step 1 diet	Step 2 diet	Grand Total
normal	10	20	11	41
elevated	8	11	6	25
mild moderate	10	17	6	33
severe	3	1	0	4
Grand Total	**31**	**49**	**23**	**103**

4.2.5. Genetic or familial dyslipidaemia

Only 7 (6.8%) of the sample presented with corneal arcus and all of them female. None of the participants presented with xanthelasmas and xanthomatas.

Of the 7 participants, only one was under the age of 45 years (as stipulated in table 9: The Dutch Lipid Clinics Network Criteria for identifying FH).

Based on the criteria of severe elevated LDLC levels, only 4 participants (3.8%) were identified accordingly. Again all 4 identified participants were female. The one female below 45years of age and identified by the presence of corneal arcus as having possible FH, was identified by both criteria as having possible FH. One of the 4 participants identified had a diagnosis of thyroid disease and was thus excluded from the calculations.

Three (n=3; 2.9%) of the sample possibly had FH.

4.2.6. Referral to Dietetics Department

There was a poor rate of referrals of participants to the Dietetics Department, with only 35% (n=36) of the sample being recently referred to the dietitians.

CHAPTER 5:
DISCUSSION

This chapter presents the discussion on the results of each CVD risk factor as well as the referral to the dietitian.

In this study it was found that the majority of the sample presented with moderate to severe hypercholesterolaemia. More than half of the sample presented with moderate to severely elevated LDLC levels with the same number presenting with low to severely low HDLC levels. Just under half of the sample presented with elevated triglyceride levels.

HPT, obesity and more specifically android obesity were found to be major risk factors for CVD for both genders as well as all ethnic groups.

The Caucasian population had an additional risk factor of high fat intake, whilst smoking was an added risk factor for the Coloured population group. The major risk factor for the African population was android obesity. Interestingly, the African ethnic group presented with the youngest mean age.

When looking at the utilization of the dietitian in managing CVD risk factors, only a third of the sample population was recently referred to a dietitian

With regards to behavioural risk factors, the sample did not have a high saturated fat intake but had a low PAL. A history of smoking is also relevant, more so than current smoking habits.

Factors that could have influenced the findings of this study include the unequal contribution of each ethnic group as well as both genders. Also the population itself as these are patients at risk for CVD. Medication for HPT, DM, and dyslipidaemia were noted but effect on values not taken into account.

5.1. CVD RISK FACTORS

A number of studies has been conducted in South Africa with regards to CVD risk factor descriptions. These include the dYslipidaemia international study – South Africa (dYsis) and the CEntralised pan-South African survey on tHE under-treatment of hypercholesterolaemia (CEpHEus-sa) study.

In the dYsis study over 1000 patients diagnosed with dyslipidaemia and on statin treatment, were evaluated regarding lipid goal attainment. The patients were identified from the private

sector through primary care physicians as well as specialised office-based physicians (e.g. cardiologists).[58]

In the CEntralised pan-South African survey on tHE under-treatment of hypercholesterolaemia (CEpHEus-sa) study, 300 patients were recruited from both the private as well public sector during 2009 and 2010 to monitor the efficacy of statin therapy.[59]

The Africa Middle East Cardiovascular Epidemiology (ACE) study was conducted between July 2011 and August 2012 in 94 general practice primary care clinics across 14 countries, of which RSA was one. The clinics included both urban as well as rural clinics. A total of 4378 adult patients older than 18 years of age were screened for CVD risk factors.[60]

During the discussion reference will be made of these mentioned studies.

5.1.1. Biochemical risk factors

5.1.1.1. *Dyslipidaemia*

For total cholesterol this study had a higher mean and a greater standard deviation than that of the ACE-, dYsis and CEpHEUs-sa studies. (Table 5.1) The same applies for the LDLC levels. This can be due to the higher prevalence of obesity and more specifically android obesity, in this study (the prevalence of android obesity was not reported in the ACE or CEpHEus-sa studies) when compared to the dYsis study. The dietary intake of the study populations could also affect LDLC levels, specifically carbohydrate intake and MUFA intake. Both of these nutrients were not investigated in either of the 4 studies.

The HDLC levels were very similar to that of the dYSis and CEpHEs-sa studies. The ACE study on the other hand, reported a lower mean HDLC. This difference can be due to more people smoking or a greater level of lack of exercise, both unfortunately not reported in the ACE study.[58-60]

The mean triglyceride levels was in line with that of the dYsis study but lower than than of the CEpHEs-sa study. It was also higher than that found in the Ace study.

Just under half of the sample (49%, n=51) had low HDL levels whilst 7 had severely elevated HDL levels. Possible causes of the severely elevated HDL could be a genetic component or estrogen use.

Table 5.1: Lipid profile description for all studies[58-60]

	Values (mmol/L)			
	Total cholesterol	HDLC	LDLC	Triglicerides
This study	5.12 ± 1.8	1.27 ± 0.42	3.02 ± 1.8	1.64 ± 0.09
ACE study*	4.79	1.19	2.89	0.99
dYsis	4.4 ± 1.3	1.3 ± 0.4	2.3 ± 1.1	1.6 ± 1.1-2.3
CEpHEus-sa	4.88 ± 1.24	1.31 ± 0.39	2.73 ± 1.01	1.9 ± 1.71

* Standard deviation not reported

The majority of the participants were on lipid lowering drugs and this could also have resulted in underreporting of the actual prevalence of the various forms of dyslipidaemnias.

5.1.1.2. *Serum glucose*

In this study all those participants who had a diagnosis of DM presented with uncontrolled glycemic levels. In addition, 5 more participants without a diagnosis of DM presented with hyperglycaemia. This resulted in 41% of the sample presenting with hyperglycaemia.

In the ACE study, an additional 5% of the sample was diagnosed with DM based on a single fasting serum glucose of ≥ 7%. This incidence of newly diagnosed DM is line with that found in this study of 4.8%.[54] This is lower than that found in the CEpHEus-sa study where the incidence of newly diagnosed DM was found to be 2.4%. In the CEpHEus-sa study a cut-off value of 5.6mmol/L was used. [59]

5.1.2. Biological risk factors

The gender distribution is similar to that found in the South African part of the dYsis study. In the dYsis, just under 60% of the participants were female.[58] These findings differ from that of the CEpHEus-sa study, where only 47% of the participants were female.[59] This larger percentage of females found in this study could possibly be due to CVD affecting males at a younger age and for every one female mortality there are 2 male mortalities.

The mean age of the sample was 60 ± 10.93 which is similar to that of the dYsis study where the median age was 65.4 ± 10.8 as well as the CEpHEus sa where the mean age was 59.4 years.[58], [59] The higher mean age is expected as the risk of CVD is associated with an aging population.[6] In the dYsis study, the mean ages for the different ethnic groups was similar to that

of the entire sample whilst in this study the African ethnic group was found to have a lower mean age than that of the entire sample.[58] This is surprising as Caucasians have been found to have genetic predisposition and one would thus expect the Caucasian population to present with the lower mean age as genetic dyslipidaemias present at younger ages.

The majority of the sample was from the coloured (mixed ancestry) ethnic group (45%) followed by the Caucasian ethnic group at 33%. These findings differs from the dYsis and CEpHEus sa where the Caucasian ethnic group by far contributed the largest proportion (57% and 46% respectively) and the coloured ethnic group contributed small proportion (12% and 16% respectively). [58,59] A possible reason for this observed difference could be that the dYsis and CEpHEus sa studies were not conducted specifically in the government setting as was the case in this study. In South Africa a large number of the Caucasian population utilizes the private health sector instead of the public health sector and this could have contributed to the smaller number of Caucasian participants in this study.

In this study, the African and Asian ancestry each contributed 11% of the sample where in the dYsis the Africans contributed a larger proportion (22%) and the Asian ancestry a similar proportion (10%). In the CEpHEus sa, Africans contributed a larger proportion (17%) and the Indian population 19% and the Asian 2%.[59] Taking into consideration that in this study the Asian ancestry and Indian ancestry were grouped together, if one combine the Indian and Asian population of the CEpHEus sa study, the Asian population amounts to 21% a far higher proportion than what was found in this study. The Indian/Asian population contributes 2.5% to the total population of South Africa whilst according to the Census 2011 results, the Indian/Asian population only contributed 0.43% of the Eastern Cape population.[59]

This significant lower contribution of Indians and Asians to the total population of the Eastern Cape could explain the differences found in this study to that of the dYsis and CEpHEus-sa that were national studies. Other possible reasons for the different ethnic contribution found in this study compared to either the general population or that of the dYsis and CEpHEus-sa could be the area in which two of the hospitals that form part of the PEHC are situated. The hospitals are situated closely to residential areas that mainly house the Coloured ethnic group and the majority of the participants were recruited from these two hospitals Secondly, one should consider the genetic component that is present in the Caucasian and coloured ethnic groups and not so strongly present in the African ethnic group. This could have resulted in a larger number of coloured and Caucasian participants as they were possibly more inclined to present with dyslipidaemia due to the genetic component.

5.1.3. Clinical risk factors

5.1.3.1. *Hypertension*

Hypertension is a major problem worldwide and is again seen as such in this study where the majority of participants (84%) presented with HPT, a similar finding to the dYsis study where 77% were found to be hypertensive.[58] Of those participants in this study without a diagnosis of HPT the majority were classified with pre- hypertension. This is not surprisingly as the study population of this study were those diagnosed with dyslipidaemia and various studies have shown that HPT and dyslipidaemia frequently coexist (or cluster together). This frequent association has been termed dyslipidemic HPT.[61] Dyslipidaemia causes endothelial damage that can manifest as elevated systemic blood pressure. Limited data exist on the effect of elevated blood pressure on lipid levels.[62]

Two studies that implied the interplay between HPT and dyslipidaemia was the Framingham and MRFIT studies. The Framingham study showed that mild-to-moderately elevated levels of both blood pressure and cholesterol levels had a similar 10-year risk of CHD as that of either one of the two risk factors when alone highly elevated. The MRFIT had similar findings to that of the Framingham showing that mild-to-moderate elevations of both risk factors simultaneously had a risk for CHD similar of even greater than that of either one risk factor when highly elevated alone.[61]

In the CEpHEus sa study, more females than males were found to be hypertensive (75% and 69% respectively), a similar finding to this study with a hypertensive prevalence of 61% in females and 57% in males.[63]

Fifty nine percent (59%) of the sample had elevated blood pressure values. This value could be influenced by the fact that a number of participants were on antihypertensive thus resulting in lower blood pressure values resulting in possible underreporting. Some of the anti-hypertensive medications that the participants were on include hydrochlorathiazide, ridaq and sprinolactone. This study only took into account the blood pressure values on the specific day of contact and did not look at a trend of the blood pressure values when the participant was diagnosed with HPT.

HPT itself has various risk factors such as obesity, African race, smoking, DM, excessive alcohol intake and dyslipidaemia. Of these, obesity, smoking, DM, and dyslipidaemia was found to be prevalent in this study and could indirectly influence the prevalence of elevated blood pressure in this study.

The following increases blood pressure and has not been taken into account: stress and anxiety (the so called white coat phenomenon), alcohol, exercise, smoking and caffeine.

In both the CEpHEus sa study as well as the dYsis study, Africans were also found to have the highest incidence of HPT (as in this study) but the Indian population had a lower incidence of HPT (around 65%) and the mixed ancestry a higher incidence of HPT (80% and 90% respectively compared to 50%) than what was found in this study. The incidence of HPT under the Caucasian ethnic group was found to be similar.[58,59]

A number of participants were on blood pressure lowering drugs and this could also have resulted in underreporting of the actual prevalence of HPT as well as on the description of systolic and diastolic blood pressure values.

5.1.3.2. *Overweight and obesity*

Obesity has become a global burden with negative consequences on health indicators. The Cepheus global data indicated that mean BMI was 30.4 ± 5.6 SD in Africa, this is in line with the mean BMI of 31.04 ± 6.19 SD found in this study.[59] The dYsis study sample had a slightly lower mean BMI at 29.6 ± 6.4 whilst the incidence of obesity was found to be 42.2%. (55) The incidence of obesity in this study was found to be 55% (n=57), higher than the overweight incidence of 31% (n=32). Unfortunately the dYsis study did not report on overweight incidence.[58]

In the CEpHEus sa analysis, the mean BMI for males was found to be 29.2kg/m^2 , the same as in this study (29.20 ± 4.56) and the mean BMI for females was found to be 30.8kg/m^2, slightly lower than this study's female BMI mean of 32.29 ± 6.95.[59] The similarity is most probably due to the target population that is similar.

In South Africa the men were found to be more overweight (incidence: 20.1%) than obese (incidence: 10.6%) where in comparison the females were found to be more obese (incidence: 39.2%) than overweight (incidence: 24.8%).[18] This study had similar findings to the SANHANES results where males had a higher incidence of overweight (45%) than obesity (38%) whilst the females had a higher incidence of obesity (67%) than overweight (21%).[18] The incidence of obesity in females was far higher than that from the SANHANES and again the possible reason for this is the population group investigated (the general population compared to the current study where patient attending PEHC and diagnosed with dyslipidaemia was investigated).

The mean BMI for the various ethnic groups in this study was similar to those from the dYsis

study with the exception of the Asian / Indian group. In the dYsis study the mean BMI for the Asian group was 27.0 ± 4.5 SD compared to this study where it was 31.08 ± 5.26.[58] A possible reason could be the small number of Indian participants in this study. In the SANHANES surveillance, mean BMI for males of African descent was 23.4kg/m^2, for Coloureds it was 24.4kg/m^2 and for Asian/Indian 23.7kg/m^2. For African females it was 29.0 kg/m^2, for Coloured females 28.1kg/m^2, and for Asian/Indian females 26.5kg/m^2.[18] All these values are less than those found in this study. A possible reason could be that the SANHANES analysis included adults 15 years and older where in this study the mean age is 60 years and the youngest 32 years.[18]

When looking at the prevalence of overweight and obesity in this study, the Caucasian population had the highest prevalence of overweight (38%) and the lowest prevalence of obesity (47%) when compared with the other ethnic groups. In all the ethnic groups of the total sample, the prevalence of overweight (25-36%) was lower than that of obesity (50 – 64%). In the dYsis results, the prevalence of obesity in Caucasians was 36.8%, in Africans 61.9%, Asian 22.2 % and Mixed ancestry 47.5%[58] whilst in this study it was in Caucasians 47%, in Africans 55%, Asian 50 % and Mixed ancestry 64%. Thus in this study the prevalence of obesity was found to be higher in Caucasians, Africans and Mixed ancestry. The results could be influenced by the low numbers in each ethnic group.

The major BF distribution pattern associated with increased CVD risk and mortality is abdominal obesity. Indicators of this pattern include elevated waist circumference (WC). When looking at fat distribution based on waist circumference, only 16.5% of the total sample (n=17) had an acceptable waist circumference whilst 84% (n=86) had one above the acceptable cut-off (equal to or more than 102 cm in males and 88 cm in females). It is especially females (92%) that had a high prevalence of waist circumference above the recommended cut-off value compared to the 71% found in males. The SANHANES found the highest prevalence of an increased waist circumference in the general population for females in the age category 55–64 years of age (70.0%) when compared to females of other age categories or males.[18] This is still a lower prevalence than the 92% prevalence found in this study. Again a reason for this can be the target population with this study focusing on those who are at risk for CVD whilst the SANHANES was on the general population.

The Indian population had the lowest prevalence of waist circumferences above the recommended cut-off (75%) followed by Caucasians at 82%, coloured at 87% and Africans with the highest prevalence at 91%. This differs from the SANHANES results where the Asian/Indian populations had the highest prevalence of waist circumference above the recommended cut-

off.[18] The target population could contribute to this difference observed.

5.1.3.3. *Cinical manifestation of CHD or atherosclerosis*

When looking at a family history of CVD, 72% (n=74) had a first degree relative with a history of CVD. This is a far greater prevalence of family history of CHD than that found in the CEpHEus sa study (28.8%) and the dYsis study (26.7%).[58,59]

In this study, the age of the relative was asked but in a number of instances the exact age was unknown. This could have resulted in an overestimation in prevalence.

5.1.3.4. *Diabetes Mellitus*

DM was the risk factor that had the lowest prevalence of all risk factors in the sample at 36%. More females (42%) than males (28%) had a current diagnosis of DM.

The SANHANES determined the prevalence of DM in the general South African population to be 9.5%. Females were found to have a higher prevalence at 11% when compared to males at 7.9%.[18] The difference seen between the total sample prevalence of SANHANES and this study is due to the target population difference. As discussed in the literature study, DM itself is considered a risk factor for CVD and these two conditions are part of a cluster of conditions usually associated together. The risk for CVD is two to three times higher in diabetics than for the general population and the increased risk has been found to be applicable to both genders but it is disproportionately higher in diabetic women.[1,23]

In the ACE study conducted in 2011-2012, 25% of the sample had a diagnosis of DM. The lower prevalence found in the ACE study could be due to the younger mean age of 46 years compared to the mean age of 60 years found in this study. The target populations also differ in that the ACE study population included all attending primary health care clinics and not exclusively those at risk for CVD.[60]

The low prevalence of DM differs from that found in the dYsis study, where the prevalence was 25.6% but DM was also the risk factor with the lowest prevalence in the dYsis study.[58] In the CEpHEus sa study, where the mean age was closer to that of this study, the prevalence of DM was 47.1%.[59] This study's DM prevalence of 25.6% falls between that of the dYsis and CEpHEus-sa studies.

5.1.4. Behavioural risk factors

5.1.4.1. *Smoking*

Almost half of the sample was former smokers (n=45, 44%) whilst 21% (n=22) were current smokers. Thirty-six percent (36%) reported never smoking. More females than males had never smoked. Currently 20% of the females and 24% of the males were smoking. In the CEPHEAS SA study it was found that 11% of the females and 19% of the males were current smokers whilst the prevalence for the total sample was 14.9%.[59] This is lower prevalence of men as current smokers could possibly be due to the higher percentage of men found in the CEpHEus-sa study compared to this study.

The current smokers" statistics is in line with the South African estimates of 18% but when looking at those who never smoked, the percentage is at only 36%, far less than the South African statistics of 79%. The high rate of current/previous smokers are in line with the South African estimates that the Eastern Cape is 5th highest with incidence of smoking in the country.[17]

When looking at the dYsis study results the prevalence of current smokers was only 10% for the study sample. The difference can be attributed to the larger sample size of Africans in the dYsis study (22%) compared to this study where it was 11% (n=11). In both this study as well as the dYsis the lowest prevalence of current smokers was found in Africans, in the dYsis study it was 5.2% and in this study zero. In both studies the coloured ethnic group had the highest prevalence of current smokers [in the dYsis study it was 18% and in this study 28% (n=13)]. In this study the coloured ethnic group contributed 47% to the sample whilst in the dYsis study they only made up 12% of the sample. [58]

5.1.4.2. *Physical activity*

Data on the magnitude and impact of physical inactivity and cardiovascular fitness in sub-Saharan Africa, including South Africa remains sparse, even in light of the contribution of it towards global mortality and morbidity.[18]

According to the Study of Global Ageing and Adult Health (SAGE wave 1) conducted by the WHO, more than 60% of adults in the general population aged 50 years and older do not participate in sufficient daily physical activity. Women more than men had inadequate physical activity.[64] Similarly, the Transition and Health during urbanization of South Africans (THUSA) study using a self-report questionnaire also found low levels of physical activity in a population

sample drawn from North West in 2002.

These findings are also in line with that of the SANHANES of 2010, where 27.9% of males and 45.2% of females were found to be unfit.[18]

Possible reasons for the low PAL could be that the target population is from urban areas and the results from the SANHANES show that those in rural areas tend to be more fit than those in urban areas. This is confirmed by the SAGE wave 1 results from 2008.[64] Additionally, the SANHANES results show that the females from the Coloured ethnic group had the lowest number of fit participants and this study the Coloured ethnic group contributed a large number to the total sample. Another reason could be the older age of the sample as physical fitness has been found to decrease with age.

Care should be taken to compare the SANHANES results to this study, as the SANHANES only tested cardiovascular fitness up to age 40 years in the general population.[18] The SANHANES methodology also went beyond self-reported PA data and cardio fitness was measured directly. Physical activity questionnaires (PAQ) are frequently used due to the low cost and convenience related to their use. Unfortunately there are some limitations associated with PAQ such as PAQs are prone to measurement error and bias due to misreporting, either deliberate (social desirability bias) or because of cognitive limitations related to recall or comprehension. Cognitive immaturity or degeneration can make self-report of physical activity particularly difficult in the young and elderly as can be the case in this study.[65]

5.1.4.3. *Step 1 and Step 2 diet adherence*

The males in the sample had a higher prevalence of high fat intake than the females, whilst a larger percentage of females followed a low fat (Step 2) diet.

The SANHANES found that the mean fat intake nationally was moderate for the population even though caution must be taken when comparing the SANHANES result to that of this study. In the SANHANES a questionnaire and not the MEDFICTS, was used to obtain nutrition information. The scores obtained from the questionnaires was classified into high fat intake (11-20 points), moderate fat intake (6-10 points) and low fat intake (0-5 points).[18]

The SANHANES found that the mean score for fat intake decreased according to age from 7.9 in the age group 15-24 years to 5.5 in the age group 65 years and older. This could explain the higher prevalence of people following the Step 1 and Step 2 diet in this study as the sample had a higher mean age.

No significant difference was found between males and females. In the SANHANES it was also found that participants in rural areas had a low fat intake whilst those in urban areas had a moderate fat intake. The Eastern Cape was also found to have the highest rates of low fat users again supporting the findings of this study.[18]

With regards to ethnicity, the SANHANES results followed a similar trend to that found in this study. The Caucasian population had a higher prevalence of high fat intake whilst highest number of low fat users (Step 2 diet) could be found under the Africans.

In a review conducted in 2015 by Mschiza et al, on nutrition surveys undertaken in South Africa, it was found that the fat contributed 17 – 37% of total energy intake of adults. The majority of the mean % values of fat lie within the Acceptable Minimum Distribution Ranges of the DRIs and is even lower than the maximum of 35% in most of the studies.[66] This supports the findings of this study where the majority of participants followed a Step 1 and Step 2 diet (both indicating fat contributes < 35% of TE).

Unfortunately, neither the SANHANES nor the review conducted by MsCiza focussed on saturated fat and cholesterol intake.[18,66] It should again be emphasized that both the SANHANES and MsCiza review are applicable to the general population and not specifically people at risk for CVD.

Another contributing factor to the results is that half of the sample recently made dietary changes that included changes influencing fat (and saturated fat) intake.

5.2. CLASSIFICATION OF GENETIC OR FAMILIAL DYSLIPIDAEMIA

Three (2.9%) of the sample presented with possible FH. The prevalence of possible FH was 1/34 which is even higher than that found in RSA of 1/70.[46]

Two of the three were female Caucasians, this possibly explaining the high prevalence as the general high prevalence of FH noted in RSA is due to the founder effect found in the White South Africans of Afrikaner descent, Jews of Lithuanian descent- and Indians of Gujerati descent.[46,47]

5.3. REFERRAL TO DIETETICS DEPARTMENT

There was a poor rate of referrals of participants to the Dietetics Department, with only 35% (n=36) of the sample being recently referred to the dietitians. This can be due a number of reasons such as no criteria for referral, lack of insight on the role of Dietitians in CVD risk management. Another reason can be that the dietetics department has a group education session at the lipid clinic itself and since this is where the majority of participants were recruited, it can have an influence on the referral of participants. Since the patients have also been attending the lipid clinic for some time, they could have received dietary counselling from the dietitian at a previous time thus limiting the need for another referral to the dietetics department.

There is a paucity of comparative data in the literature on CVD risk and referral to the dietitian thus this study adds to the value of the work done.

CHAPTER 6:
CONCLUSION

The main aim of the study was to identify and describe the dyslipidaemias as well as the selected risk factors for CVD in patients diagnosed with dyslipidaemia in Port Elizabeth Complex (PEHC). All of the objectives of the study could be answered with limitations on some of the objectives. These limitations will be discussed later.

The sample presented with moderate to severe hypercholesterolaemia. More than half of the sample presented with moderate to severely elevated LDLC levels with the same number presenting with low to severely low HDLC levels. Just under half of the sample presented with elevated triglyceride levels.

Regarding clinical risk factors HPT, obesity and more specifically android obesity were found to be major risk factors for CVD for all sexes and both genders. When looking at the male and female genders for all ethnic groups; the females had a higher prevalence of obesity compared to the males. The males on the other hand, had a higher prevalence of overweight. The major risk factor for the African population was android obesity.

The Caucasian population had an additional risk factor of high fat intake, whilst smoking was an added behavioural risk factor for the coloured population group. .

Only a third of the sample population was referred to the dietitian but some of the participants were recruited at the lipid clinic where group sessions are conducted by the dietetics department. Thus this should be interpreted with caution. So this means that they did not receive individualized counselling, which is also worth noting.

6.1. STRENGTHS AND LIMITATIONS

This is the first study to determine the utilization of dietitians in the management of CVD risk in a public hospital in RSA. This information can contribute to the knowledge regarding the issue with paucity of literature on this matter.

Secondly, the information obtained in this study can assist the personnel of PEHC to focus their treatment options on specific risk factors that have been found to have a high prevalence. The presence of familial dyslipidaemia has been hinted at and this can contribute to the management of patients possibly presenting with this.

The present study has some limitations. Firstly, the findings cannot be extrapolated to the general population as the population of study was focused on those diagnosed with CVD. In

addition, the convenience sampling method could have resulted in selection bias. Similarly, the study population does not reflect the ethnic make-up of the South African population. The study was also conducted in a public sector hospital and cannot be extrapolated to the private sector

It is also possible that some participants did not complete the questionnaire truthfully but rather gave answers that they thought would please the investigators whom were all qualified dietitians.

The diagnosis of the various forms of dyslipidaemia, blood pressure management and serum glucose control was made using treated values and could thus result in underreporting of these results. Untreated values for these variables were not available.

Additionally, underreporting could also have occurred in the reporting of FH as the probability there-off in a participant was not classified.

HPT is often associated with an increased body mass index and more specifically, android obesity, and data from a cohort with a high prevalence of HPT may therefore not be reflective of the general population in terms of risk for CVD.

Measured clinical parameters (such as blood pressure) were from a single visit and, and therefore inaccuracies regarding these indices could have arisen.

Lastly, groups that were compared in the sub-group analyses (e.g. gender and ethnic groups) were not always equal in sample size, thereby reducing the strength of statistical inferences.

However, in spite of these potential limitations, the data obtained during this cross-sectional, observational study of patients attending PEHC has furthered our knowledge of CV risk and the factors that contribute to CVD in these patients.

6.2. RECOMMENDATIONS

A more in depth study should be conducted on those risk factors most prevalent namely HPT and android obesity. Dietary factors contributing to HPT as well as the protection there-off such as sodium intake, wholegrain, fruit and vegetable intake should be investigated as the focus of this study was on fat consumption as stipulated by the MEDFICTS questionnaire and did not focus on any other dietary aspects that could influence CVD risk.

Similar studies with a prospective observational design and with equal numbers of subgroups to be compared (e.g. male vs female) are recommended. Even more so, adequately powered

studies to establish cause-effect relationships between lipid components and various risk factors are highly recommended.

As an outflow of this study, the development and implementation of a referral organogram to aid in the effective multidisciplinary management of patients presenting with CVD is recommended. There is a need for lifestyle intervention which includes the Dietitian with nutrition counselling so as to aid in weight loss and the management of NCD's, specifically HPT and dyslipipdaemia.

Care should also be taken in educating the multidisciplinary team in the dietary management of CVD as a number of patients obtain dietary advice from other members of the multidisciplinary team.

6.3. OVERALL CONCLUSION

CVD is a global as well as national burden of disease. There are numerous CVD risk factors with some having stronger evidence than others on their influence on CVD prevention and development.

Regarding the objective describing the dyslipidaemias in the population, 98% of the sample presented with hypercholesterolaemia and almost a third presented with elevated LDLC. All of the males presented with hypercholesterolaemia. All of the Caucasians as well as the Coloured ethnic groups in the sample presented with hypercholesterolaemia whilst half of the Caucasians presented with decreased HDLC levels and/or elevated LDLC levels. More than 80% of the Africa ethnic group presented with decreased HDLC levels. Ninety-one percent of the Indian ethnic group presented with elevated LDLC levels.

The participants were older whilst two thirds of the sample was female. The Caucasian and Coloured ethnic groups made up the majority of the sample. Hyperglycaemia was found to be prevalent in those where serum glucose levels were tested though the diagnosis of DM was the risk factor with the lowest prevalence in the sample. HPT was prevalent in the sample at more than 60%. More females was obese than overweight whilst the opposite was true for males.

Half of the sample had a history of smoking whilst more than three quarters of the sample followed a diet above the recommended SFA intake of <7%. The majority of the sample had low PA levels.

There was a high prevalence of possible FH even though this should be interpreted with caution due to the small sample size as well as no genetic tests done to confirm a diagnosis

of FH.

Only a third of the sample was referred to the dietitian for assistance in managing dyslipidaemia and CVD risk.

Addressing the risk factors present in this sample, one can decrease CVD risk in patients attending PEHC and presenting with dyslipidaemia.

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ADDENDA

ADDENDUM A: CONSENT FORMS

ADDENDUM B: DATA COLLECTION SHEET

ADDENDUM C: MEDFICTS QUESTIONNAIRE

ADDENDUM D: BAECKE QUESTIONNAIRE

ADDENDUM E: CLINICAL SIGNS ASSOCIATED WITH DYSLIPIDAEMIA

ADDENDUM A

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM

TITLE OF THE RESEARCH PROJECT:

A Description of Dyslipidaemia And Selected Risk Factors For Cardiovascular Disease In Patients Attending Port Elizabeth Hospital Complex

REFERENCE NUMBER: S12/09/251

PRINCIPAL INVESTIGATOR: Ms Vanessa Kotze

ADDRESS: Room 4-8, HW Snyman South, Prinshof campus, University of Pretoria

CONTACT NUMBER: 012 354 1077 / 083 633 3573

You are being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff or dietitian any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the Health Research Ethics Committee (HREC) at Stellenbosch University and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

This study will be conducted at Livingstone Hospital, Dora Nginza Hospital and PE Provincial Hospital in Port Elizabeth. A total of 98 participants will be recruited all together at all 3 sites.

The investigator am interested in finding out what type of cholesterol problems patients at the 3 hospitals present with. There are also certain risk factors for developing cholesterol problems and I would like to see which risk factors people with cholesterol problems in Port Elizabeth have.

To be able to do this The investigator am going to ask you some questions on where you live, with whom you live, smoking habits, exercise habits and what you eat. To help you remember what you eat, the person asking the questions will have some photos and kitchen utensils that you can use to “trigger” your memory.

The investigator also need to take a few measurements. None of these measurements will hurt you. In a private room or if you are being seen in the wards the curtains will be drawn, The investigator will ask you to stand on a scale so that she can take your weight, she will also take your height as well as your waist circumference. She will ask you to do this in as little clothing as possible but you must still feel comfortable. A jacket will be available for you to put on.

Why have you been invited to participate?

You have been asked to take part in the study since you have been diagnosed with cholesterol problems.

What will your responsibilities be?

Your only responsibility is to answer as honestly as possible.

Will you benefit from taking part in this research?

There are no personal benefits for you by participating in this research but by helping us people diagnosed with dyslipidaemia in the future can hopefully be helped more effectively.

Are there in risks involved in your taking part in this research?

There are no risks involved in participating in this research

If you do not agree to take part, what alternatives do you have?

If you do not want to take part in this research you will still be treated as determined by your doctor.

Who will have access to your medical records?

All the information you give us as well as all information we get from your file will be treated with the utmost secrecy and will be kept confidential. Only the person speaking to you and the person responsible for the research study will see your information.

The HREC may decide to check the data collected by the investigators. To enable them to do this, they will have to inspect the research records

Will you be paid to take part in this study and are there any costs involved?

No you will not be paid to take part in the study. There will be no costs involved for you, if you do take part.

Is there anything else that you should know or do?

You can contact Vanessa Kotze at **012 354 1077 / 083 633 3573** if you have any further queries or encounter any problems.

You can contact the **Health Research Ethics Committee** at 021-938 9207 if you have any concerns or complaints that have not been adequately addressed by your study doctor.

You will receive a copy of this information and consent form for your own records.

Declaration by participant

By signing below, I …….…….. agree to take part in a research study entitled: A Description Of Dyslipidaemia And Selected Risk Factors For Cardiovascular Disease In Patients Attending Port Elizabeth Hospital Complex

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (*place*) ……..…….. on (*date*) ……..…….. 2013.

…… ……

Signature of participant **Signature of witness**

Declaration by investigator

I *(name)* ……..…… declare that:

- I explained the information in this document to ……..
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (If an interpreter is used then the interpreter must sign the declaration below.

Signed at (*place*) ……..…….. on (*date*) ……..…….. 2013

…… ……

Signature of investigator **Signature of witness**

Declaration by interpreter

I *(name)* ……..…… declare that:

- I assisted the investigator (*name*) …….. to explain the information in this document to (*name of participant*) ……..…….. using the language medium of Afrikaans/Xhosa.
- We encouraged him/her to ask questions and took adequate time to answer them.
- I conveyed a factually correct version of what was related to me.
- I am satisfied that the participant fully understands the content of this informed consent document and has had all his/her question satisfactorily answered.

Signed at (*place*) .....…….. on (*date*) ……..…….. 2013

…… ……

Signature of investigator **Signature of witness**

DEELNEMERINLIGTINGSBLAD EN -TOESTEMMINGSVORM

TITEL VAN DIE NAVORSINGSPROJEK:

'n Beskrywing van dyslipidemia en gekose risiko faktore vir hartsiekte in pasiënte wat Port Elizabeth Hospitaal Kompleks besoek.

VERWYSINGSNOMMER: S12/09/251

HOOFNAVORSER: Me Vanessa Kotze

ADRES: Room 4-8, HW Snyman South, Prinshof campus, University of Pretoria

KONTAKNOMMER: 083 633 3573 / 012 354 1077

U word genooi om deel te neem aan 'n navorsingsprojek. Lees asseblief hierdie inligtingsblad op u tyd deur aangesien die detail van die navorsingsprojek daarin verduidelik word. Indien daar enige deel van die navorsingsprojek is wat u nie ten volle verstaan nie, is u welkom om die navorsingspersoneel of dokter daaroor uit te vra. Dit is baie belangrik dat u ten volle moet verstaan wat die navorsingsprojek behels en hoe u daarby betrokke kan wees. U deelname is ook **volkome vrywillig** en dit staan u vry om deelname te weier. U sal op geen wyse hoegenaamd negatief beïnvloed word indien u sou weier om deel te neem nie. U mag ook te eniger tyd aan die navorsingsprojek onttrek, selfs al het u ingestem om deel te neem.

Hierdie navorsingsprojek is deur die Gesondheidsnavorsingsetiekkomitee (GNEK) van die Universiteit Stellenbosch goedgekeur en sal uitgevoer word volgens die etiese riglyne en beginsels van die Internasionale Verklaring van Helsinki en die Etiese Riglyne vir Navorsing van die Mediese Navorsingsraad (MNR).

Wat behels hierdie navorsingsprojek?

Hierdie studie sal gedoen word by die Livingstone Hospitaal, die Dora Nginza-hospitaal en PE Provinsiale Hospitaal in Port Elizabeth.'n Totaal van 87 deelnemers sal almal saam by al 3 hospitale gewerf word.

Die ondersoeker is geïnteresseerd daarin om uit te vind watter tipe van cholesterol probleme pasiënte by die 3 hospitale het. Daar is ook sekere risiko faktore vir die ontwikkeling van cholesterol probleme en die ondersoeker sou graag wou sien watter risiko faktore mense met cholesterol probleme in Port Elizabeth het.

Om in staat wees om dit te doen gaan die ondersoeker jou 'n paar vrae vra oor waar jy woon, met wie jy woon, rookgewoontes, oefening gewoontes en wat jy eet. Om jou te help onthou wat jy eet, sal die ondersoeker 'n paar foto&'s en kombuisgereedskap wat jy kan gebruik om jou geheue te help.

Die ondersoeker moet ook 'n paar metings neem. Nie een van hierdie metings sal jou seergemaak nie. Die ondersoeker gaan in 'n privaatet kamer die meetings neem of as jy gesien word in die sale sal die gordyne toe getrek sword. Die ondersoeker sal jou vra om op te staan op 'n skaal te staan sodat sy kan jou gewig kan neem, sy sal ook jou lengte neem sowel as jou middellyf omtrek. Sy sal jou vra om dit te doen in so min as moontlik klere, maar jy moet nog

steeds gemaklik voel. 'n Baadjie sal ook beskikbaar wees vir jou om aan te trek sou jy wou.

Waarom is u genooi om deel te neem?

Jy is gevra om aan die studie deel te neem aangesien jy gediagnoseer is met cholesterol probleme

Wat sal u verantwoordelikhede wees?

Jou enigste verantwoordelikheid is om so eerlik as moontlik te beantwoord

Sal u voordeel trek deur deel te neem aan hierdie navorsingsprojek?

Daar is geen persoonlike voordele vir jou deur deel te neem in hierdie navorsing nie, maar deur te help sal van die mense wat gediagnoseer is met dyslipidemie in die toekoms hopelik meer effektief gehelp word

Is daar enige risiko's verbonde aan u deelname aan hierdie navorsingsprojek?

Daar is geen risikos betrokke in die deelname aan hierdie projek nie.

Watter alternatiewe is daar indien u nie instem om deel te neem nie?

As jy nie wil deel neem aan hierdie navorsingsprojek nie sal jy nog steeds deur jou doctor behandel word soos voorgele deur hom/haar.

Wie sal toegang hê tot u mediese rekords?

Al die inligting wat jy virgee ons sowel as alle inligting wat ons uit jou leer kry sal met die grootste geheimhouding behandel word en sal vertroulik gehou word. Slegs die persoon wat met jou praat en die persoon wat verantwoordelik is vir die navorsing sal jou inligting sien.

Die GNEK mag besluit om na die data wat deur die ondersoekers ingesamel is te kyk. Om dit te kan doen sal hullena die navorsingsdokumente moet kyk.

Sal u betaal word vir deelname aan die navorsingsprojek en is daar enige koste verbonde aan deelname?

Nee, jy sal nie betaal word om deel te neem in die studie nie, Deelname aan die navorsingsprojek sal u niks kos nie.

Is daar enigiets anders wat u moet weet of doen?

U kan Vanessa Kotze by 012 354 1077 indien u enige verdere vrae het of enige probleme ondervind.

U kan die **Gesondheidsnavorsingsetiek administrasie** kontak by 021-938 9207 indien u enige bekommernis of klagte het wat nie bevredigend deur die ondersoeker hanteer is nie.

U sal ’n afskrif van hierdie inligtings- en toestemmingsvorm ontvang vir u eie rekords.

Verklaring deur deelnemer

Met die ondertekening van hierdie dokument onderneem ek, ……..……..……..…., om deel te neem aan ’n navorsingsprojek getiteld: ‘n Beskrywing van dyslipidemia en gekose risiko faktore vir hartsiekte in pasiënte wat Port Elizabeth Hospitaal Kompleks besoek.

Ek verklaar dat:

- Ek hierdie inligtings- en toestemmingsvorm gelees het of aan my laat voorlees het en dat dit in ’n taal geskryf is waarin ek vaardig en gemaklik mee is.
- Ek geleentheid gehad het om vrae te stel en dat al my vrae bevredigend beantwoord is.
- Ek verstaan dat deelname aan hierdie navorsingsprojek **vrywillig** is en dat daar geen druk op my geplaas is om deel te neem nie.
- Ek te eniger tyd aan die navorsingsprojek mag onttrek en dat ek nie op enige wyse daardeur benadeel sal word nie.
- Ek gevra mag word om van die navorsingsprojek te onttrek voordat dit afgehandel is indien die studiedokter of navorser van oordeel is dat dit in my beste belang is, of indien ek nie die ooreengekome navorsingsplan volg nie.

Geteken te (plek) ..... op (datum) ……..…….. 2012

…… ……

Handtekening van deelnemer Handtekening van getuie

Verklaring deur navorser

Ek (naam) ……..…… verklaar dat:

- Ek die inligting in hierdie dokument verduidelik het aan …….....
- Ek hom/haar aangemoedig het om vrae te vra en voldoende tyd gebruik het om dit te beantwoord.
- Ek tevrede is dat hy/sy al die aspekte van die navorsingsprojek soos hierbo bespreek, voldoende verstaan.
- Ek ’n tolk gebruik het/nie ’n tolk gebruik het nie. (Indien ’n tolk gebruik is, moet die tolk die onderstaande verklaring teken.)

Geteken te (plek) ..... op (datum) ……..…….. 2012.

…… ……

Handtekening van deelnemer Handtekening van getuie

Verklaring deur tolk

Ek (naam) ……..…… verklaar dat:

- Ek die navorser (naam) …….....……. bygestaan het om die inligting in hierdie dokument in Afrikaans/Xhosa aan (naam van deelnemer) ……..... te verduidelik.
- Ons hom/haar aangemoedig het om vrae te vra en voldoende tyd gebruik het om dit te beantwoord.
- Ek ’n feitelik korrekte weergawe oorgedra het van wat aan my vertel is.
- Ek tevrede is dat die deelnemer die inhoud van hierdie dokument ten volle verstaan en dat al sy/haar vrae bevredigend beantwoord is.

Geteken te (plek) .....…….. op (datum) ……..……. 2012.

…… ……

Handtekening van deelnemer Handtekening van getuie

ADDENDUM B

DATA COLLECTION SHEET

Date DD / MM /

Please tick the following where applicable to the patient:					
• < 18 years	Y	N	• Pregnant	Y	N
If answered yes to any of the above, do not continue					

Gender: M - 1 / F - 2 Gende

Date of Birth: _____ Age

Ethnicity: African - Caucasian - Coloured - Asian - Indian - Etn

Diagnosis: IHD - 1 CHF - 2 : _____ Diseas

Medical history /medication: _____

_____

Biochemical

Total cholesterol_____ n Modera Severe Extrem TC

HDL_____ n < 1.2 Signicant < Severe > HDL

LDL_____ n >2.5 Mild-mod 3- Severe LDL

Tgl_____ n > 1.7 Hypertgl > 5 Severe Tgl

s-glucose _____ or HbA1c_____ < 6 / 6.5 - > 6 / 6.5 s-

TSH _____ n - 1 > 4.2- < 0.27- TS

T4_____ n ↑- ↓- low T4

LFT – ALT _____ AST_____ ALP_____ GGT_____ n - ↑- LFT

Kidney - urea_____ N or ↓ - ↑- Ure

Creatinine_____ N or ↓ - ↑- Crea

Referred to dietetics department: Yes –No Ref

Level of education: Primary school (< Grade 7) | High school (Grade 8 - 12) | Tertiary (Degree / diploma) | Edu

Income level H2 | H1 | Pension/disability | Irratic | Inc

Primary Diagnosis _____ | DM

Additional Diagnosis DM _____ HPT_____ Other:_____ | HPT

Medical (family) history: Heart disease YES | NO Who in family_____ | CHD

Cholesterol YES | NO Who in family_____ | Ath

Stress YES | NO What_____ | Stres

Anthropometry

Height _____m Weight 1) _____ kg 2)_____kg (ave)_____ | Wt

BMI _____ | < 18 | 19 - 25 | 25 - 30 | 30 - 35 | 35 - 40 | > 40 | BMI

Waist circumference 1 _____cm 2_____cm ave_____cm | WC

Classification | < 80 ♀ / < 95 ♂ | < 88 ♀ / < 102 ♂ | > 88 ♀ / > 102 ♂ | WCC

Clinical

Last BP _____ Date _____

SBP	< 120	120 – 139	140 - 159	160 – 170	> 180	SP
DBP	< 80	80 – 89	90 – 99	100 – 109	> 110	DP
Xanthomata	elbows	hands -	knees -	ankles -	none –	Xan
Eyes	Xanthelasmas	Corneal Arcus –	none -			Eves

Behavioural - smoking

Smoking status | never | former | current | SS

If former, please indicate when quit_____

If answered never, please skip to demographic section

Duration | 0 - | 1 – 20 | >21 | Dur

What | cigarettes - | hand-rolled- | pipe- | Typ

How much a day | 1 – 20 - | 21 – 30 - | > 31- | SA

Demographic

Housing | Brick - 1 | Informal settlement - 2 | DH

What facilities do you have? | DF

Fridge | YES - NO - | DF

Freezer | YES - NO - | DO

Oven | YES - NO - | DM

Microwave | YES - NO - | DS

Stove | YES - NO - | Other

Other_____

How many people live with you?_____ | peopl

Do you take any supplements? | YES – 1 | NO – 2 | Suppl

If yes, please specify_____

Have you made any changes to your diet? | YES – 1 | NO – 2 | Diet

If yes, please specify_____

Who gave you the information? | Nurse - 1 | Doctor - 2 | Dietitian – 3 | Other - 4 | Advic

If other, please specify_____

ADDENDUM C

MEDFICTS

Complete for usual (typical) dietary intake by filling in a number.

1. First ask if patient eat the specific food or not. Go through list of foods in food group.
2. Next ask about the frequency of consumption for the food **group**
   a. If a food category is eaten rarely, continue to next food category.
   b. If consumed regularly, complete consumption by indicating frequency during week or day e.g. twice a week
3. Next, complete serving size.
   a. The **average** serving size is indicated at heading of food group.
   b. A **small** serving size indicated half of an ave serving size and
   c. **large** means 1.5 time an ave serving size.

Food category	Eat – yes / no	Weekly consumption			Serving size			Score
		Rarely	Daily – write down a number	Weekly - write down a number	Small	Ave	Large	
Meats – ave serving size: 90g or ½ cup								
≥ 10 g fat per ave cooked serving								
Beef, ground, ribs, steak					1	2	3	
Chicken with skin								
Lamb – chops, ribs								
Pork – loin chops, roast, ribs								
Seafood - mackerel								
Meat loaf with minced meat								
Organ meats								
Processed meat								
≤ 10 g fat per ave cooked serving								
Beef – lean, lean minced							6	
Processed meat – low fat								
Chicken without skin								
Seafood - calamari								
Seafood - prawns								
Seafood – other fish								
Veal & venison								
Lamb – loin, shank,								

Food category	Eat – yes / no	Weekly consumption			Serving size			Score
		Rarely	Daily – write down a number	Weekly - write down a number	Small	Ave	Large	
Eggs – nu of eggs								
Whole eggs, yolks					≤1 - 1	2-2	≥3-3	
Egg whites, substitutes								
Dairy – ave serving size 1 cup								
1. Whole milk: FC, 2% fresh, long life, powder,					1	2	3	
condensed,								
evaporated								
creamers,								
fc yoghurt: plain/ flavour,								
buttermilk / amasi								
2. Low fat milk: skimmed/ 1% milk (fresh, long life, powder)								
yoghurt (plain/flavoured)								
Cheese – 30g or matchbox size								
1. Full cream: Cream cheese, cheddar, gouda, tussers, cheese spread & wedges, blue cheese, regular cottage cheese					1	2	3	
2. Low fat:hard cheese, LF cheese spread, wedges low fat/fat free cottage che								
Frozen desserts – ave serving size ½ cup								
1. Full cream: Ice cream, milk shakes, custard					1	2	3	
2. Low fat: Low fat milk drinks, frozen desserts								

Food category	Eat – yes / no	Weekly consumption			Serving size			Score
		Rarely	Daily – write down a number	Weekly - write down a number	Small	Ave	Large	
Frying foods – ½ cup or 90g								
This section refers to the manner in which the meat and vegetables were preparared								
Fried								
French fries								
fried vegetables					1	2	3	
Fried seafood (fish, calamari), chicken, meat								
Other : baked, broil, grill, poach, roast, stew								
Vegetables,								
seafood,								
poultry,								
meat,								
Baked goods- Ave serving size: 1 unit								
Doughnuts, biscuits, cake, sweet and savoury tarts, pastries, rusks, muffins, scones, pies					1	2	3	
Fruit bars, low fat biscuits, cake, Homebaked goods with vegetable oils, breads, bagels								
Convenience foods								
Canned (e.g. meat, soup), ready to eat sachets or frozen meals and dishes (e.g. pizza, pasta) Soup made with cream Ave serving: 1 cup or 1 slice Potato, pasta and rice dishes with cream / cheese sauce Ave serving size : 1/2 cup					1	2	3	

Food category	Eat – yes / no	Weekly consumption			Serving size			Score
		Rarely	Daily – write down a number	Weekly - write down a number	Small	Ave	Large	
Potato, pasta and rice dishes without cream / cheese sauce Ave serving size : 1/2 cup								
Spreads and sauces - Ave serving: 1 tsp								
Butter, brick (paper wrapped) margarine, mayonnaise, regular salad dressing, peanut butter					1	2	3	
Tub margarine(regular, medium or low fat), low fat salad dressing, vinegar, low fat mayonaisse								
Snacks								
High fat - Chocolate, peanuts, crisp chips, regular salty biscuits, caramel, toffee,fudge, coconut candy. Ave serving size: 50g chocolate, 30g (small) chips, 6 biscuits					1	2	3	
Low fat - dried fruit rolls or bars, dry crackers, Hard/jelly/ marshmallow type sweets, air popped popcorn (3 cups) licorice, Ave: 10 sweets, 1 fruit bar, 3 provitas								

Score from pg 1 = _____

Score from pg 2 = _____

Score from pg 3 = _____

TOTAL SCORE = _____

≥ 70 High fat diet

40 – (‹70) Step 2 diet

‹ 40 Step 1 diet

ADDENDUM D

PHYSICAL ACTIVITY QUESTIONNAIRE (BAECKE QUESTIONNAIRE)

(Please encircle the choice made by the patient)

1. What is your mainoccupation?..... Q1

2. At work I sit…….... … Never - Seldom - Sometimes - Often Q2

3. At work I stand…… Never - Seldom - Sometimes - Often Q3

4. At work I walk…… Never - Seldom - Sometimes - Often Q4

5. At work I lift heavy loads…… Never - Seldom - Sometimes - Often Q5

6. After working I am tired…… Very often - Often - Sometimes - Seldom Q6

7. At work I sweat…… Very often - Often - Sometimes - Seldom Q7

8. In comparison with other of my own age I think my work is physically

Much heavier - heavier - as heavy - Slighter - Much lighter Q8

A1

9. Do you play sport? Yes / No

If yes

- Which sport do you play, most frequently?..... Intensity Q9b
- How many hours a week?..... Hours: (< 1) - (1 – 2) - (2 – 3) Q9c
- How many months a year?..... Months: (< 1) - (1 – 3) - (4 – 6) Q9d

If you play a second sport,

Which sport is it?..... Intensity Q9e

- How many hours a week?..... Hours: (< 1) - (1 – 2) - (2 – 3) Q9f
- How many months a year?..... Months: (< 1) - (1 – 3) - (4 – 6)

A2

10. In comparison with others of my own age Much more more - the same - less Q1

I think my physical activity during leisure time is…… Q1

11. During leisure time I sweat……. Very often - Often - Sometimes - Seldom Q1

12. During leisure time I play sport…. Never - Seldom - Sometimes - Often Q1

13. During leisure time I watch televis Never - Seldom - Sometimes - Often Q1

14. During leisure time I walk…… Never - Seldom - Sometimes - Often Q1

15. During leisure time I cycle…… Never - Seldom - Sometimes - Often Q1

16. How many minutes do you walk and/or cycle per day to and from work, school and shopping?.....

A3

ADDENDUM E

CLINICAL SIGNS ASSOCIATED WITH DYSLIPIDAEMIA

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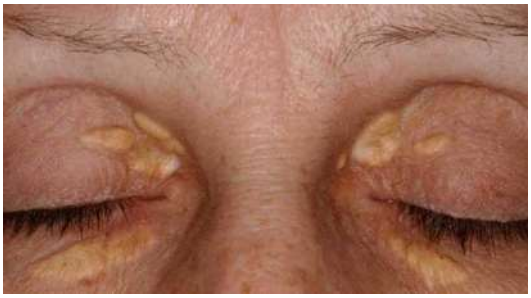
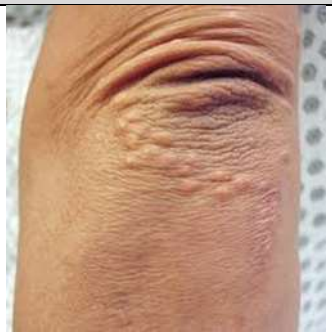
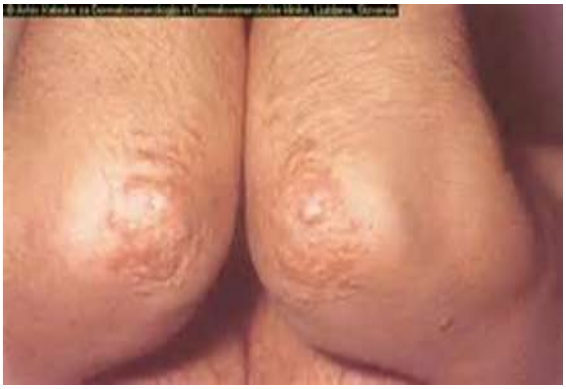
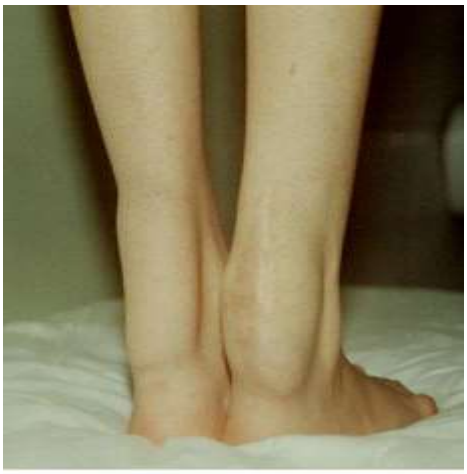
<tr><th colspan="2">Eyes</th></tr>
<tr><td> 
Corneal arcus</td><td> 
Xantholasmata</td></tr>
<tr><th>Hands</th><th>Knees</th></tr>
<tr><td>  </td><td>  </td></tr>
<tr><th>Elbows</th><th>Tendons</th></tr>
<tr><td>  </td><td> 
re1: Bilateral Achilles Tendon Xanthomas</td></tr>
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