CARDIOVASCULAR DISEASE RISK FACTORS IN THE URBAN BLACK POPULATION OF CAPE TOWN

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Thesis Presented for the Degree of

DOCTOR OF PHILOSOPHY

in the Department of Medicine

UNIVERSITY OF CAPE TOWN

February 2013

ACKNOWLEDGEMENTS

I would like to express my gratitude to the following people whose contributions have made this dissertation possible:

Professors Krisela Steyn and Dinky Levitt, my supervisors at the University of Cape Town, for their invaluable insights and guidance

Statisticians Carl Lombard, Nomonde Gwebushe, Rebecca Shanmugam and Ria Laubscher for their statistical support

The study team including Serena van Haght, Erica April, Debbie Jonathan and Theresa Gogela, as well as Jean Fourie (editing), Whadi-ah Parker and Anniza de Villiers for their technical support

The funders of the study: Servier Laboratories (South Africa), the Medical Research Council of South Africa, the Initiative for Cardiovascular Health Research in Developing Countries (IC Health) Foundation Council, and Brigham Hospital and Harvard University

The City of Cape Town for the provision of the aerial maps used in the selection of the study sample

ABSTRACT

Background

There is a dearth of recent surveillance data on the prevalence of cardiovascular disease (CVD) risk factors, which are highly prevalent and significant contributors to morbidity and mortality, in the South African population. Previous studies in Cape Town were conducted approximately two decades ago.

Aims

To determine the prevalence of CVD risk factors in 2008/09, changes in these risk factors between 1990 and 2008/09 and the association between psychosocial stress and other CVD risk factors in a random sample of the 25-74-year-old urban black population of Cape Town.

Methodology

A randomly selected representative cross-sectional study, stratified for age and gender, was conducted in the same communities sampled in 1990. Data were collected by administered questionnaires, clinical measurements and biochemical assessments. The prevalence of CVD risk factors and psychosocial measures, including sense of coherence (SOC), locus of control and adverse life events, was determined.

Results

There were 1099 participants, 392 men and 707 women (response rate 86%). Age-standardised (SEGI) prevalence (95% confidence interval) was: diabetes: 11.3% (8.0-14.6) and 14.7% (12.1-17.3), hypertension: 39.3% (33.4-45.2) and 39.4% (35.5-43.4), and raised low-density lipoprotein cholesterol (LDL-C): 37.9% (32.6-43.4) and 48.3% (44.5-52.2) in men and women, respectively. These rates were higher than in 1990 and management was poor with suboptimal rates of awareness, treatment and control. Overweight/obesity in women (82.9%) was higher than in men (28.9%) but daily smoking (49.4%) and problem drinking (49.7%) were higher than in women (7.9% and 18.1%, respectively). Between 1990 and 2008/09, overweight/obesity increased in women and decreased in men, smoking in men, but not women, decreased, and alcohol consumption increased in both sexes. In the multiple logistic regression models, age, body mass index (BMI) and waist circumference were significantly associated with diabetes in both men and women, but psychosocial stress (SOC) was only relevant in women. Age, BMI, positive family history, physical inactivity and urbanisation were independently related to hypertension, and age, BMI and high fat intake were independently associated with raised LDL-C.

Conclusions

The prevalence of many CVD risk factors was high in 2008/09 and substantially higher than in 1990, highlighting the urgent need for prevention and control measures.

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ART	antiretroviral therapy
BMI	body mass index
BP	blood pressure
CHW	community health worker
CVD	cardiovascular disease
DOH	Department of Health
FCAC	Framework Convention on Alcohol Control
FCTC	Framework Convention on Tobacco Control
GDP	gross domestic product
GPAQ	global physical activity questionnaire
HDL-C	high-density lipoprotein cholesterol
HIV/ AIDS	human immunodeficiency virus/acquired immune deficiency syndrome
IDF	International Diabetes Federation
IFG	impaired fasting glucose
IGT	impaired glucose tolerance
IHD	ischaemic heart disease
JIS	Joint Interim Statement
LDL-C	low-density lipoprotein cholesterol
LOC	locus of control
MDG	Millennium Development Goals
MI	myocardial infarction
MS	metabolic syndrome
NCD	non-communicable disease
NGO	non-governmental organisations
OGTT	oral glucose tolerance test
PHC	primary healthcare
PVD	peripheral vascular disease
SADHS	South African Demographic Health Survey
SOC	sense of coherence
SSA	Sub-Saharan Africa
TB	tuberculosis
TC	total cholesterol
UN	United Nations
US	United States
WC	waist circumference
WHO	World Health Organization
WHR	waist-to-hip ratio

CHAPTER ONE: LITERATURE REVIEW

The literature review focuses on the global cardiovascular disease (CVD) epidemic including type II diabetes (henceforth referred to as diabetes), and highlights their trends as well as those of the individual risk factors in developed and developing regions. The literature relating specifically to the CVD risk factor burden in Sub-Saharan Africa (SSA) and South Africa is summarised towards the end of this chapter while the details are presented in Chapter Four so as to avoid repetition.

1.1. GLOBAL OVERVIEW OF CARDIOVASCULAR DISEASE

1.1.1. INTRODUCTION

The dawn of the third millennium has seen chronic non-communicable diseases (NCDs) sweeping the entire globe following the major health transitions observed in the second half of the 20th century (1, 2). Reddy emphasised that the most pervasive change among these health transitions has been the rising burden of NCDs, and in particular CVD (2). CVD has grown from a relatively minor condition over the last century to a leading cause of morbidity and mortality worldwide (3). This is the foremost cause of death in all regions except SSA, responsible for over one in four deaths in developed nations, and over one in five deaths in developing nations (4). Here it causes nearly twice as many deaths as tuberculosis (TB), human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS) and malaria combined.

1.1.2. DRIVERS OF THE CARDIOVASCULAR DISEASE EPIDEMIC

The rapid rise in CVD over a fairly short period is attributable mainly to the following factors: 1) the projected 60% rise in population between 1990 and 2020, 2) the increasing average life expectancy on account of improvements in public health and medical care, and 3) the economic, technological, social and cultural changes, and the subsequent profound changes in diet and lifestyles that enable CVD risk factors to flourish (1-3, 5-8).

1.1.3. PREVALENCE AND MORTALITY TRENDS

At the beginning of the 20th century CVD accounted for less than 10% of all global deaths. A century later it has shifted from being a minor cause of death and disability to a major contributor to the global burden of disease, responsible for ≥30% of mortality worldwide (3, 9-16). CVD accounted for approximately 17 million deaths worldwide in 2008 (17). The predominant causes attributable to atherosclerotic

disease were from ischaemic heart disease (IHD) and cerebrovascular accidents (stroke) (18). By 2030, the number of CVD deaths is predicted to increase to 25 million annually (17).

The global CVD epidemic has evolved with the burden shifting to developing countries because of the large populations residing in these regions. This is now endemic worldwide and no longer confined primarily to developed nations as once believed (14, 19-21). About 80% of the global CVD burden currently occurs in developing nations and CVD mortality is already twice as high as in developed countries (9, 13, 22, 23). As the phenomenon of the epidemiological transition gathers momentum, the CVD epidemic will continue to accelerate worldwide and involve all social classes (2, 24).

Furthermore, according to Yusuf and colleagues, IHD mortality was predicted to increase by 137% for men and 120% for women in developing countries compared with 48% and 29%, respectively, in developed countries between 1990 and 2020. The predicted increase in mortality attributable to stroke among men and women was similarly higher in developing (124% and 107%, respectively) compared to developed nations (78% and 56%, respectively) (6).

Not only are the absolute numbers greater in developing countries but so too are the age-specific morbidity and mortality associated with CVD compared to developed regions. Whereas almost 80% of CVD mortality in developed countries occurred in those older than 60 years old; in developing countries, only 42% of CVD deaths occurred in this age group (5). CVD morbidity and mortality disproportionately affects the working-age population in developing countries in their prime and at younger ages rather than the older retired members of society commonly found in developed nations (16, 18, 25-27).

In addition to the suffering and loss of life, there are far-reaching social and financial repercussions as breadwinners succumb to CVD and other NCDs thereby perpetuating the vicious cycle of poverty (5, 7, 22, 24). In low-resource settings, healthcare costs for these conditions, including often prolonged and expensive treatment, together with the loss of breadwinners rapidly drain household incomes and force 100 million people into poverty each year (28, 29).

CVD mortality accounted for the largest proportion of NCD deaths (48%) in 2008; the other main causes were cancers (21%), chronic respiratory disease (12%) and diabetes (3.5%) (17). The World Health Organization (WHO) reported that 36 million of the estimated 57 million deaths in 2008, i.e. about 63%, were attributable to NCDs,

with about 80% of the NCD mortality occurring in developing regions. Further, 48% of these deaths occurred in those <70 years in developing countries compared to 26% in developed nations. Mortality attributable to NCDs in 30-70-year-olds was highest in SSA, Eastern Europe and parts of Asia, highlighting the greater adverse impact in poorer regions (17).

1.1.4. MANAGEMENT

Since the risk factors for CVD and other NCDs are known, and many have the potential for control and modification, means that about 80% of premature heart disease and stroke, 80% of diabetes and 40% of cancers are preventable (1, 12). Measures directed at high-risk individuals cover those with acknowledged risk factors for the disease (1, 5) and have been shown to substantially reduce the absolute risk for CVD and to avoid unnecessary costs (30).

In developed countries, CVD prevention programmes have probably averted much premature disease over the past few decades (31) such that the age-standardised morbidity and mortality rates are lowest in high-income compared with middle- and low-income countries (32). Concerted measures to prevent, diagnose and treat IHD and stroke have succeeded in delaying these CVDs to more advanced ages and deferring death (5, 6, 33). Therefore, despite the overall increase in burden, the age-standardised CVD mortality has been halved (5, 34) with only 10% of cardiac mortality occurring in populations younger than 65 years in North America, New Zealand, Australia and parts of Europe (35). According to the WHO, CVD and other NCDs occur among both the wealthy and the poor; however, wealthier individuals are able to access services and products to protect them from the greatest risks, while the poor often cannot afford this (28).

Most low-income countries are not geared to respond to the growing problem of CVD and other NCDs (24, 36); they lack national policies for the control of these conditions and primary healthcare (PHC) systems have not adapted to cope with the new additional challenges (37). In keeping with these findings, Alwan and colleagues found that 23 low- and middle-income countries with a high burden of NCDs lacked the capacity to effectively deal with the existing and projected burden of these conditions (38). With prevention not a priority and effective treatments not widely available (39), it is not surprising that NCD mortality occurs at earlier ages in developing countries with the increased incidence of these conditions compounding the continuing health burden (6, 40).

Nevertheless, countries in resource-poor settings with already burdened healthcare budgets cannot afford to ignore the opportunity to address this major problem (7) by implementing cost-effective primary and secondary prevention programmes, as has been shown in developed nations (24). Although a challenge, prevention and control of CVD and other NCDs need to be a priority even in resource-limited settings (41) since existing healthcare systems do not have the capacity to cope with this burden (1). PHC systems in developing regions are currently oriented towards management of acute problems and need to evolve rapidly to deliver care, which is fundamentally different, for common chronic diseases both infectious and non-communicable (42). Innovative solutions are required to overcome the enormous difficulties of deficient health systems in these settings (37).

Vitally important is to use the limited resources that are available as efficiently as possible by prioritising cost-effective strategies and by targeting those most likely to benefit from evidence-based interventions (43). High impact essential interventions to strengthen early detection and timely treatment need to be delivered through a PHC approach (28) with cost-effective measures implemented to achieve these goals (37). Mendis and colleagues have shown the total cardiovascular risk approach to be more cost-effective, enabling more accurate targeting of high-risk individuals, than using the single risk factor approach (44). Even in resource-scarce setting such as SSA, Gaziano recommends the total cardiovascular risk assessment approach as a cost-effective strategy for the effective prevention, treatment, and management of CVDs (45).

The emphasis on treating and preventing CVD and other NCDs are excellent economic investments because, if applied early, can reduce the need for more expensive treatment with significant cost savings (28, 46). Simple, inexpensive and cost-effective measures with high impact have been proven to produce rapid health gains (13, 47, 48). Individual-based strategies with the greatest cost-effectiveness include BP-lowering drugs, lipid-lowering agents and aspirin. According to Lim and colleagues, an opportunistic screening-based multidrug regimen for CVD prevention in high-risk individuals could potentially avert many deaths. Over ten years, this would amount to almost 18 million deaths, equivalent to almost a fifth of CVD mortality, in 23 low- and middle-income countries, including the SSA region (49). Investing in such intervention measures, particularly those related to primary prevention, will have the maximum impact health wise and economically (48). Therefore, despite severe resource constraints in developing regions, a strong PHC

system is required as part of an integrated health system to respond to the burdens of communicable and cardiovascular and other NCDs (13).

For the successful prevention and control of the CVD epidemic, in combination with the individual high-risk approach, the equally important population-based strategies are essential to shift the current distribution of cardiovascular risk in a population to a more optimum distribution in the long term (16, 43, 50-53). Small improvements in the overall distribution of risk in a population have the potential to yield greater gains in disease reduction when the underlying conditions that confer risk are pervasive in the population (53). Such interventions, which encompass low-cost solutions to reduce the common modifiable risk factors of tobacco and harmful alcohol use, unhealthy diets and physical inactivity (28), if implemented, could more than half the burden of CVD (5). The population-based approach includes prevention of the emergence of risk factors from the outset by targeting the social, economic and cultural determinants that contribute to the development of CVD risk factors (30, 48, 54). These interventions require actions outside the health system to realise the maximum impact (47). For example, Asaria and colleagues found that salt reduction and tobacco control initiatives could avert 13.8 million deaths in 23 developing countries over ten years with most of the deaths averted (75.6%) being from CVDs (55).

To lessen the impact of these diseases on individuals and society, a comprehensive population-based approach attempts to modify the prevalence of risk factors across an entire population by national economic and environmental policies (1, 5, 18, 48, 52, 56, 57). A holistic government approach that includes not only health but all sectors such as health, finance, foreign affairs, education, agriculture, trade, food security, planning, need to cooperate to reduce the risks associated with CVDs and to promote interventions for the prevention and control of these conditions (28, 29, 58). Alwan and MacLean state that comprehensive strategies will encompass laws and regulations, tax and price interventions, improving the built environment, advocacy, mass media, community-based interventions, school- and workplace-based interventions, screening and clinical prevention (48).

Such strategies create an enabling environment that facilitates healthy behaviour and thereby avert the development of CVD risk factors in the population as a whole (54, 58). Healthy individual choices are easier to practice if supported by enabling environments such as tobacco-free public and work spaces, easy access to healthy foods, and opportunities for physical activity (59). Without such government intervention, it will be difficult to create an enabling environment for many lifestyle

changes at the individual level, particularly for the disadvantaged in all societies (60). Therefore, governments have a pivotal role in the fight against rising CVD and other NCDs by developing appropriate policies and implementing strategies that influence the uptake of healthy lifestyles (27, 48, 56).

The success in materialising such policies depends on factors such as political commitment and the involvement of political leaders and the mass media (54, 61). Sustained national leadership is, however, missing and governments, predominantly in developing regions, have up to now largely abdicated the responsibility for tackling the CVD and other NCDs epidemic (48, 61). Although health policymakers are now increasingly recognising these conditions as a major health priority, unfortunately, this has generally not been translated into serious policies or plans (48).

1.1.5. INTERNATIONAL STAKEHOLDERS AND GLOBAL INITIATIVES

In addition to government action within countries, Beaglehole and colleagues emphasise that international leadership is essential because of the part played by multinational companies and trade agreements in exacerbating the CVD epidemic (47). For nations to successfully address the transnational factors influencing smoking rates, and dietary, nutrition, and physical activity patterns through effective national and international regulation of products, activities, and conditions that adversely affect health or lead to health inequities, collective action at a global level is necessary (4, 62).

The key international stakeholders

Among the first to accentuate the need to ensure that NCDs are urgently accorded greater priority in the health and development policies of poor nations and on global aid agendas has been the WHO (56). In 2000, WHO introduced the Global Strategy for the Prevention and Control of NCDs (63) and is recognised as the principal organisation with the capacity to shape global health policies. This has been possible through its strong knowledge base, convening powers and ability to identify and disseminate best practices (4).

The World Bank is another important stakeholder in NCD prevention and control, with extensive resources and experience in developing regions, which have the greatest need for development assistance in this area. The World Bank has also acknowledged the ‘formidable challenge’ of NCDs caused by tobacco and obesity, and stressed their comparative advantages in the health sector in their recent health, nutrition and population (HNP) strategy. Strengthening healthcare systems remains their core priority as well as assisting countries to integrate policies for chronic

disease prevention within their health and development strategies, through a multiple sectorial approach (4).

Other agencies that have embraced the NCD challenge include action oriented groups such as the Oxford Health Alliance, which is a network of institutional and individual collaborators aimed at preventing and controlling NCDs; and collaborative global priority-setting groups such as the Global Alliance for Chronic Diseases which is a consortium of six influential health agencies (27). Similarly, the NCD Alliance is a partnership of four international non-governmental organisations (NGOs), the World Heart Federation (WHF), International Diabetes Federation (IDF), Union for International Cancer Control, and International Union Against TB and Lung Disease, which aims to stimulate and support action for NCD intervention (47). Other professional societies including the European Society of Hypertension (ESH), the International Society of Hypertension (ISH) and the American Heart Association (AHA) also contribute to setting the NCD agenda. In addition, the world's largest philanthropic organisations have recognised the need for developing nations to implement interventions to reduce tobacco use and the associated mortality (48).

The Institutes of Medicine (IOM) in the USA advocated action on the prevention and control of NCDs as a global health priority, particularly in developing regions (27, 48, 64). The IOM highlighted intensifying existing interventions, generating and sharing knowledge, investing in institutional and human capacity, increasing financial commitments, and engaging in respectful partnerships (27).

WHO Framework Convention on Tobacco Control and Global Strategy for Diet, Physical Activity and Health

As recently as 2005, the lack of global control efforts resulted in NCDs being regarded as 'the neglected development goal' in a series on chronic diseases published in The Lancet (65). The global framework for action on chronic diseases had, until recently, been mainly exemplified in two WHO initiatives (4). These included the WHO Framework Convention on Tobacco Control (FCTC) and the Global Strategy for Diet, Physical Activity and Health.

In recognition of the threat that tobacco use posed to global public health and the need for comprehensive tobacco-control policies, the FCTC was adopted in May 2003 (66, 67), marking a critical achievement in the efforts to stem the global tobacco epidemic (66, 68, 69). The FCTC was the first-ever international treaty devoted to health and remains the only example of the WHO using its treaty making right (70). This treaty is a legal instrument to focus on tobacco-related issues such as tobacco

promotion and sponsorship, illicit trade of tobacco products, tobacco taxes and agricultural diversification (8). The FCTC is an important mechanism to tackle tobacco-control and provides a basis for multi-lateral commitment, cooperation and action (71, 72). Furthermore, it offers governments, health professionals and many others with suggested policies and programmes for reducing tobacco use.

The 2004 WHO's Global Strategy for Diet, Physical Activity and Health emphasised that comprehensive and coordinated public health efforts were required by all stakeholders, particularly governments (58, 73). This would address the problem of CVD and other NCDs in developing regions, a consequence of changing lifestyles related to diet and physical activity. Detailed guidelines were provided on strategies to improve diets and encourage physical activity. However, few governments have made progress in the implementation of these strategies (74). Moreover, products such as processed foods and alcohol urgently require stronger global, regional, and national regulatory controls (62).

Millennium Development Goals

The WHO's support for the NCD agenda was the impetus for the new global goal for the prevention and control of NCDs proposed to supplement the Millennium Development Goals (MDG) (4, 56, 65). The most ambitious example of a global health partnership (4), these are a set of development outcomes that government leaders have committed to achieve, collectively, over the period 2000–2015 (4, 75). The WHO's new free-standing goal is a reduction in mortality attributable to the main NCDs (heart disease, stroke, cancer, diabetes, and chronic respiratory diseases) by an additional 2% per annum between 2005 and 2015 (39). Achieving this global target would prevent 36 million deaths between 2005 and 2015, of which half would be attributable to CVD (4, 13, 56, 61, 76). Most of these averted deaths will be in developing countries (28 million), and approximately half will be in people younger than 70 years old (13, 39, 61, 76).

WHO Non-communicable Disease Action Plan

According to Strong and colleagues, there has been a major shift in the emphasis from a few years ago where the gap between the reality of the chronic disease burden worldwide and the response of national governments, civil society, and international agencies remained wide (39). This occurred despite increasing awareness of the rising global burden of NCDs. The new global initiative by the WHO for NCDs is based on the 2000 Global Strategy for the Prevention and Control of NCDs and the corresponding 2008-2013 Action Plan. This initiative provides Member

States and international partners with steps on how to address NCDs (28, 48). This action plan advocates a comprehensive approach for the prevention and control of CVD and other NCDs that can be achieved through a combination of complementary and synergistic strategies, targeting the whole population and those with disease or at high risk of developing disease (18, 48). These encompass the development of national policy frameworks, establishment of programmes, capacity building for effective national responses, monitoring and evaluation at different levels, and research promotion (10, 56, 77).

These efforts, across almost 20 years, have led to very limited, if any, policy change at the country level. Mamudu and colleagues suggest that this may essentially be on account of the complexity and cross-cutting nature of CVD and other NCDs, but may also be because of inadequate political leadership at the global level. Despite providing technical leadership for NCDs, the WHO lacks the political authority and governance to mobilise intensive action by the wide range of global stakeholders (63).

United Nations High-Level Meeting

International political support can be garnered through the United Nations (UN) which is uniquely placed to assume a strong political leadership role to complement the WHO's technical lead in the fight against NCDs. The UN, by convening the recent High-level meeting on NCDs in New York in September 2011, elevated the NCD issue on the domestic policy agendas of Member States (63, 78) securing recognition of NCD prevention and control as a global priority. This represents a major breakthrough in the global struggle to garner recognition, support and action for the threat posed by NCDs (17). This was only the second occasion in its history that the UN has met on a health issue, the previous one a decade earlier related to the HIV/AIDS epidemic (79-81).

The UN raised international awareness on the magnitude, and socioeconomic and developmental impacts of CVD and other NCDs (82). The need for governments to recognise their primary role and responsibility to respond to the challenges of NCDs was also stressed (81, 83). A Political Declaration on the threats posed by the growing burdens of NCDs and calls for national plans by 2013 were adopted at the meeting (78, 81, 84). Also emphasised was the responsibility of the international community in assisting developing countries to generate effective responses (83) with NCDs positioned resolutely as a development, and not only a health, issue (84).

However, the inclusion of time-bound goals and targets as originally called for by the Secretary General would have been ideal (81, 84).

Notwithstanding, this marks a major turning point in the attitude and attention allocated to CVD and other NCDs globally. Hopefully, the focus and momentum garnered at the UN High-level meeting will translate into concrete action in the form of strategies, policies and programmes in member states, especially in developing regions and particularly in SSA.

1.1.6. SUMMARY

The worldwide spread of CVD and other NCDs presents an opportunity for all countries, developed and developing, to jointly confront the major global challenge that threatens health and economies alike (27). There needs to be a sustained response and political commitment to the prevention and control of these epidemics. If the battle against NCDs is to succeed these conditions need to be a global public health priority (10, 56). Population-based strategies to address tobacco and excessive alcohol use, unhealthy diets, physical inactivity and overweight/obesity are imperative. Simultaneously, high-risk individuals must be identified and targeted through PHC systems using cost-effective and integrated approaches (43, 44). A concerted effort is required to change the course of the CVD and other NCD epidemics; the price of inaction will otherwise be potentially devastating (7).

The general consensus, as stated by Labarthe and Dunbar, is that there is now reason for cautious optimism as the pandemics of CVD and other NCDs have moved from initial neglect in the MDGs to prominence at the highest levels of the UN in a decade. The momentum garnered should allow for meaningful progress globally in cardiovascular health promotion and CVD prevention (79).

1.2. CARDIOVASCULAR DISEASE RISK FACTORS

1.2.1. INTRODUCTION

The WHO reported that eight preventable risk factors, tobacco use, physical inactivity, raised blood pressure (BP), raised blood glucose, raised blood cholesterol, alcohol use, high body mass index (BMI), and low fruit and vegetable intake accounted for 61% of total CVD deaths (10, 85). Of note, is that over 84% of the total global burden of disease caused by these risk factors occurs in developing regions (85). Global life expectancy would increase by almost five years if exposure to these eight risk factors were reduced.

The INTERHEART and INTERSTROKE studies, large international multi-centre standardised case-control studies of acute myocardial infarction (MI) and acute stroke, respectively, showed that approximately 90% or more of the risk were attributable to most following risk factors. These include smoking, hypertension, abnormal lipids, diabetes, abdominal obesity, unhealthy diets, alcohol consumption, physical inactivity and psychosocial factors such as stress (86, 87).

Furthermore, Lopez and colleagues determined that high BP, smoking and high cholesterol were the three leading risk factors responsible for global mortality in 2001. Overweight/obesity, physical inactivity and alcohol use were also among the ten leading causes of global mortality. Apart from physical inactivity, these risk factors were also among the ten major causes of the global burden of disease (88). The CVD risk factors may be described as those that are related to behaviour and the environment and which are modifiable, and those that are physiological.

1.2.2. ENVIRONMENTAL AND BEHAVIOURAL RISK FACTORS

1.2.2.1. Psychosocial Stress

Introduction

Stress is defined as the process whereby environmental demands strain an individual's adaptive capacity causing both psychological burdens and biological changes that could place the individual at risk for illness (89). The concept of psychosocial stress incorporates several factors, from external stressors such as work stress, adverse life events and financial problems, to possible reactions to stress such as depression, anxiety, psychological distress and sleeping difficulties (90, 91). However, compared with many other biological and lifestyle risk factors, there is no universally accepted definition or measurement of psychosocial stress.

Psychosocial stress and cardiovascular disease

Nonetheless, multiple studies, using different study designs and approaches, have examined the relationship between psychosocial stress and CVD and its risk factors (90, 92, 93). During the past few decades, evidence has emerged on the association of markers of psychosocial stress with: 1) CVD, such as acute MI and stroke (87, 90, 94), 2) the increased likelihood of developing hypertension (93, 95-102), 3) adiposity, including general obesity (103, 104), raised waist circumference (WC) (103, 104) and raised waist-to-hip ratio (WHR) (105-107), and 4) the metabolic syndrome (MS) (103, 104, 108-114).

Psychosocial stress and diabetes

Regarding psychosocial stress and diabetes, which shares many of the risk factors for IHD and stroke and is simulaneously a risk factor for CVD, many studies have found an association between depression and diabetes (115, 116). There is also growing evidence that other forms of psychosocial stress contribute to the development of diabetes (115). A cross-sectional study found an association between adverse life events and chronic stress with reported diabetes in two American Indian communities (117). The Copenhagen City Heart Study, defining stress as 'tension, nervousness, impatience, anxiety or sleeplessness', demonstrated that stressed men, but not women, were more than twice as likely to develop diabetes during follow-up (118). In the Whitehall II study psychosocial work stress was an independent predictor of diabetes in middle-aged women, but not in middle-aged men, after 15-years of follow-up (119). Job strain was also found to be associated with an increased likelihood for diabetes in women in two case-control studies in Sweden and one cross-sectional study in Belgium (120-122).

In contrast, in the Nurses' Health Study II, work strain was unrelated to newly diagnosed diabetes (123). Furthermore, in a meta-analysis of longitudinal studies no association between stressful life events, stress-prone personality or coping style and poor social support, and incident diabetes was found. However, the authors stated that the findings should be interpreted with caution on account of the limited number of studies that were included (116). These studies underscore the lack of conclusive evidence on the association of psychosocial stress with diabetes.

Psychosocial stress and hypertension

Numerous studies have evaluated psychosocial stress as a possible risk factor for hypertension with the intensity and duration of the exposure reputed to be important determinants of risk. In a meta-analysis of cohort studies, Gasperin and colleagues found that individuals who had stronger responses to stressors (reactivity) and high BP in the recovery period were more likely to develop BP increases or hypertension (124). Nonetheless, although acute stressors have been shown to affect BP, on-going exposure to stress may more likely be related to sustained BP elevations and hypertension incidence. Chronic psychosocial stress related to various spheres such as occupation, finance, relationships, personality traits, low socioeconomic status and, recently, race discrimination have been examined and linked to BP outcomes (125-127).

In a cohort of young adults in the Coronary Artery Risk Development in Young Adults (CARDIA) study, job strain, defined as high job demands and low decision latitude,

was associated with incident hypertension after eight years (128). Also in the CARDIA study, the psychosocial factors of time urgency/impatience behaviour and hostility were associated with an increased risk of developing hypertension at the 15-year follow-up; however, achievement striving/competitiveness, depression and anxiety were not related (129). On the other hand, in the Healthy Women Study (HWS), the likelihood of hypertension increased in women who experienced consistently high anxiety levels, increasing feelings of anger, and decreasing social support over nine years. However, baseline levels of these variables were not predictive of subsequent hypertension (97). Psychosocial stress associated with high levels of anger traits, compared with low/moderate levels, were significantly related to progression from prehypertension to hypertension in the Atherosclerosis Risk in Communities (ARIC) cohort study (130). Changes in financial strain, another measure of chronic psychosocial stress, were associated with ambulatory BP in a 3-year follow-up in a sub-study of the Whitehall II participants; however, there were no cross-sectional associations between financial strain and ambulatory BP (131).

The variability in evidence of the association between psychosocial stress and BP is suggested to be, among others, related to the limitations of clinical BP measurements, such as using office-based rather than ambulatory BP, and consequently the failure to exclude individuals with isolated hypertension (126). Also, the different indicators used to define psychosocial stress invariably result in varied outcomes (127).

Pathogenesis

There are several pathways postulated by which psychosocial stress can lead to CVD and its risk factors. These include behavioural mechanisms because of the association between emotional stress and unhealthy lifestyle behaviours, such as poor diet, decreased physical activity, smoking and excessive alcohol consumption. These, in turn, would lead to BP increases, obesity and predispose to diabetes and CVD (115, 116, 118, 124). Physiological mechanisms have also been postulated whereby chronic stress activates the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system resulting in increased cortisol levels and sympathetic predominance, respectively (91, 110, 111, 115, 132-134). Chronic stress adversely affects BP, blood glucose and lipid levels; additionally, it increases atherosclerotic progression and inflammation, and promotes endothelial dysfunction and central obesity (110, 115, 124, 134). Pouwer and colleagues postulated that another pathway for the association of stress with diabetes is that of stress-induced alterations in immune system activity that increase cortisol and pro-inflammatory

cytokines (115). Interestingly, low sense of coherence (SOC), an indicator of stress, has been shown to be associated with higher cortisol levels in normal controls (135). Nonetheless, an individual's unique combination of genetics, personality and coping mechanisms determine the perception of an event and its attached meaning (91).

Psychosocial measures

There is a dearth of standardised tools to measure psychosocial stress. Three of those available included the SOC, locus of control (LOC) and the Brugha life events questionnaires.

Antonovsky's SOC or orientation to life questionnaire is a theoretical construct to study stress and health (136, 137). The SOC questionnaire assesses a personality and related 'stress-resistance resource' that comprises the belief that life is comprehensible, manageable and meaningful, and has been suggested to be important in coping with stressors and for maintenance of health (120). For example, individuals with the same adverse life experience but dissimilar SOC will perceive the event differently, with the higher SOC individual coping more successfully with the stressor than the low SOC individual (136, 137).

Low SOC, i.e., a low ability to cope with stressors, was associated with diabetes in middle-aged Swedish women (120). In a Finnish cohort study of male employees it was demonstrated that low SOC was associated with a higher risk of diabetes in participants who had been younger than 50 years old on entry into the study (136). In the EPIC-Norfolk study in the United Kingdom, no association was found between a three-item SOC questionnaire and systolic BP. However, high SOC was associated with a reduced rate of stroke incidence, a frequent complication of high BP (138) and also with a reduction of all-cause, cardiovascular and cancer mortality (139).The SOC questionnaire has been validated cross culturally, including in South Africa where it has previously been used in Tswana and Afrikaans (140).

The concept of LOC, developed by Rotter, refers to the belief that individuals have in the amount of control they exert over their lives (141, 142). LOC, therefore, determines an individual's perceived sense of control over his/her environment and life (90). Individuals with high scores or internal LOC are more likely than those with low scores or external LOC to exert efforts to control their environment and to take responsibility for their actions (141, 142). High LOC individuals believe in their ability to cope with anything that might happen to them (143) and subsequently experience lower psychosocial stress.

Low LOC was associated with IHD in the INTERHEART study (90) and in Swedish men (144), as well as with total mortality in Norwegian men (145). The LOC scale has been used widely in studies in Eastern Europe and was reported to predict cardiovascular events in longitudinal studies (90). A British cohort study demonstrated an association between poor LOC at age 10 years and the development of hypertension in 30-year-old women (146). In a French study, using a single LOC question, hypertension was found to be associated with low LOC in hypercholesterolaemic participants (147).

The Brugha Life Events questionnaire assesses the perceived impact of different life stressors (148). In addition to ascertaining the number of adverse life events, it is relevant to assess the intensity of the stress experience. Stressful life events may pose different experiences in various individuals, thus examining the perceived severity of adverse events is important (104). Previous studies have demonstrated the association of various stressors, both work and non-work related, with diabetes (107, 120, 149). In a Dutch study, researchers reported the association of stressful life events, for example, death of a partner, with diabetes. The prevalence of previously undetected diabetes increased significantly with the number of stressful life events experienced (107). Chronic stress as a result of work-related problems, financial difficulties or marital conflict was associated with hypertension in reviews by Spruill (125) and Sparrenberger and colleagues (127).

1.2.2.2. Tobacco Use

Introduction

Mass-manufactured cigarettes first appeared in the 19th century and since then cigarette smoking has spread worldwide on a massive scale (150). Industrialisation, urbanisation and other processes of modernisation including globalisation have enabled the rapid uptake of cigarette smoking (150, 151), with the tobacco industry driving the development of the tobacco pandemic in the 20th century (151, 152). The tobacco conglomerates have expanded and are now targeting new markets. Initially men were targeted, then women and youth in the developed world, and now the developing world (152, 153). The globalisation of tobacco use has imposed a huge and growing public health burden worldwide with the threat to global health greater today than ever before (153-155).

Current smokers are estimated to consume approximately six trillion cigarettes every year (156). In addition to cigarettes, other forms of tobacco are smoked, particularly in Asia (such as the 'bidis' in India), Africa and the Middle East, and to a lesser extent

in Europe and the Americas (156, 157). Also, smokeless tobacco through chewing or sniffing is used worldwide.

Prevalence and trends

The worldwide number of smokers is staggering despite the risks of tobacco smoking being known for decades (71, 151, 158, 159). Approximately 20% of the global population smoked tobacco in 2010, comprising 800 million men and 200 million women (160). The overall prevalence of tobacco smoking was highest in the WHO European Region (almost 29%) and lowest in SSA (8%) (156). There was a male preponderance for smoking globally with the highest rate of male smokers in the WHO Western Pacific Region (46%). Smoking in women was much lower than in men with the highest prevalence in the European Region (20%).

Worldwide, men smoke more than women with a smaller gender difference in developed regions (154, 157). Nonetheless, rates are increasing in women, particularly young women (160). Disturbingly, the age of smoking initiation in women appear to be approaching the young ages at which men begin (157). Marketing efforts of tobacco companies that especially target young women (153, 157, 161), in conjunction with increased social and economic independence and changes in women's roles particularly in developing regions, have contributed to the rise in their smoking uptake (151, 161).

While cigarette consumption has historically been highest in developed regions, according to the Tobacco Atlas, targeted marketing, increased social acceptability, continued economic development and population increases have seen consumption rise in developing nations (160). About 80% of current smokers resides in developing countries; the enormous expansion in tobacco use in these regions is the predominant contributor to the global rise in smoking (71, 150, 154, 155, 159, 162-164). The number of smokers are predicted to reach 1.5 billion by 2025 (153). The increased consumption of manufactured cigarettes in developing countries seems to follow the patterns found in developed regions. Initially occurring among men then among women, first in older people and then passing to younger individuals, among the more affluent at the outset and then spreading and concentrating in the less affluent (164).

Among developed nations, by contrast, while smoking continues to increase in some groups, there has been a decline in the overall smoking prevalence for decades, particularly in men (150, 154). For example, cigarette consumption in Western Europe decreased by 26% between 1990 and 2009 (160). These declines in tobacco

use have occurred in developed countries as individuals increasingly understand the dangers of smoking and governments continue to implement tobacco-control policy and legislation. In contrast, in developing regions tobacco marketing relates male smoking with masculinity, happiness, wealth, virility and power. In reality, however, smoking kills nearly four million men every year and leads to infertility, health disparities, illness and premature mortality (160).

Consequences

The health consequences of smoking are well documented, with tobacco use known to cause or probably contribute to more than 25 diseases (71, 150, 165). The predominant tobacco-related morbidity and mortality is on account of lung and other cancers, CVDs including IHD, stroke and peripheral vascular disease (PVD), and respiratory diseases such as chronic obstructive airway disease and TB (71, 150, 156, 163, 166, 167). The use of smokeless tobacco is also hazardous and has been related to oral cancer, hypertension, heart disease and other conditions (156).

Tobacco smoking was found to be second only to dyslipidaemia in importance for determining the attributable risk of acute MI in the INTERHEART study, underscoring the strong adverse influence of this risky behaviour (90). Furthermore, over and above its independent effect on CVD, smoking interacts synergistically with the other major CVD risk factors such as hypercholesterolaemia, hypertension and diabetes to substantially increase the risk of CVD (71, 167).

Morbidity and mortality

Tobacco use was the second leading cause of mortality, after elevated BP, responsible for almost six million deaths in 2011, and accounting for 12% and 6% of global mortality in all men and women, respectively. Of note is that of the global mortality just over 600 000 deaths were attributable to second-hand smoke exposure among non-smokers (156).

Smoking causes about 71% of lung cancer, 42% of chronic respiratory disease and nearly 10% of CVD (156). The risk of death from smoking is extremely high with about one-half to two-thirds of long-term smokers killed by their addiction (154). Compared with other risky behaviours, tobacco smoking is associated with an extremely high risk of premature death (150). Mortality in 50% of long-term smokers is attributable to tobacco use, and of these deaths, half will be during the productive middle age, thereby losing 20-25 years of life compared with the life expectancy of non-smokers (150, 154). Tobacco use is mounting in importance as a leading preventable cause of CVD (166). IHD is the tobacco-related disease in which excess

mortality is apparent earliest in life: below the age of 45, IHD is the main cause of increased mortality owing to cigarette smoking (167).

Nearly 80% of mortality occurred in low- and middle-income countries, indicating the high burden in poorer regions. As consumption rates in developing regions continue to increase, these countries will experience a disproportionately greater burden of tobacco-related morbidity and mortality (160). Mortality related to tobacco consumption is projected to soar in coming decades, particularly in developing regions, as the adverse effects accrue among those who began smoking over the past few decades, along with population growth and ageing (71, 165). This will exacerbate the health disparities between developed and developing regions (153). By 2020, the number of deaths attributable to tobacco use is predicted to increase to 7.5 million, accounting for 10% of all mortality (156).

Developed nations have begun to hold tobacco companies responsible for the high burden of disease inflicted by cigarette smoking and have introduced measures to deter smoking. This has led to declines in the use of cigarette and other tobacco products in developed regions. Consequently, tobacco multinationals have turned their focus to expanding smoking uptake in developing regions (153). Unfortunately, their marketing efforts have been remarkably successful because of limited awareness of the hazards of tobacco use and minimal tobacco-control policies in many developing countries (151). The implementation of effective interventions and policies are urgently required to halt the outreach of the tobacco industry to reduce smoking among men and prevent increases among women in developing countries (165).

Tobacco control

Seeing that smoking is a powerful CVD risk factor and smoking cessation is probably the single most effective lifestyle measure to prevent CVD (168), reducing tobacco use and deterring uptake is of paramount importance. A window of opportunity currently exists, particularly in developing regions, to reverse these trends and decrease the epidemic of tobacco-related morbidity and mortality given the long delay between smoking uptake and the development of disease (71, 154). Substantial evidence shows that smoking cessation reduces mortality from tobacco-related diseases and improves health (154). Within 12-18 months of smoking cessation, most of the increased cardiovascular risk disappears and by 3-5 years the risk is similar to that of a non-smoker (134).

Governments have the main responsibility to control tobacco consumption with effective and strong action; adopting and implementing comprehensive tobacco control policies have the greatest potential to stem the tobacco epidemic (72). The FCTC provides a template for developing and sustaining comprehensive tobacco control programmes at the national level (72, 159). Measures proven to be effective in reducing tobacco use include increased tobacco tax, dissemination of information about health risks from smoking, restrictions on smoking in public and work places, comprehensive legislation prohibiting tobacco advertising and promotion, and increased access to smoking cessation therapies (7, 71, 154, 169).

By investing in such tobacco control strategies, governments have a unique opportunity to improve the health of their citizens (71). Tobacco-control legislation is essential as this influences the social acceptability of smoking by shifting attitudes and changing individual rights. Previously, the right to smoke-free air was contested but legislation unambiguously prioritises the right of non-smokers to smoke-free air (170).

While extensive knowledge about effective tobacco control measures exist, dissemination of best practices and the adoption and implementation of recommended policies are fragmentary (154, 159). By 2008, 1.1 billion individuals were covered by the adoption of the most effective tobacco-control policies (157). These include advertising bans (9%), health warnings and access to cessation programmes (8%), optimal tobacco taxation levels (6%) and smoke-free environments (5%) (70). However, 83% of the global population are not covered by two or more of these policies (157).

That many nations, particularly in developing regions, have not implemented tobacco control measures as advocated in the FCTC is disquieting. The economic power and financial clout of the tobacco conglomerates, as well as to the social acceptability of smoking contribute to the low implementation of tobacco-control initiatives (164).The limited implementation of effective tobacco-control initiatives in developing countries is because of political constraints along with a lack of awareness of the unprecedented effectiveness and cost-effectiveness of these interventions (154). Additionally, the lack of financial resources and capacity to develop and sustain tobacco-control programmes may be a key barrier to the implementation of the FCTC in developing countries (68, 72).

In 2011, tobacco control was identified as the ‘most urgent and immediate priority’ intervention to reduce NCDs, with this tenet echoed at the UN High-level meeting on

NCDs. To reduce the global smoking prevalence by 30% by 2025, countries were urged to fully implement the FCTC (157).

Conclusion

Despite its central role in morbidity and mortality, it is of grave concern that smoking prevalence has been shown to be increasing globally (171). Cigarette smoking represents the most important cause of preventable morbidity and premature mortality globally and concerted measures for prevention are essential (160, 172). While aggressive tobacco-control policies can and will diminish the toll of tobacco, the prospects for the foreseeable future seem bleak (69). Unless there is a rigorous attempt to reduce tobacco use by effective interventions and policies, the number of deaths attributable to this health hazard will increase dramatically (71, 165).

1.2.2.3. Alcohol Use

Introduction

Alcohol has been a part of human culture since the beginning of recorded history and today approximately two billion people globally consume alcohol (173, 174). There was a high level of variation in alcohol consumption around the world with global adult per capita intake estimated, on average, at 6.0 litres of pure alcohol per year in 2008. This was highest in Europe (12.2 litres) and lowest in the Eastern Mediterranean (0.6 litres) (156). Almost all societies that use alcohol demonstrate related health and social problems to the extent that there are about 76.3 million individuals worldwide diagnosed with alcohol use disorders (173, 174).

Consequences of alcohol misuse

Problematic alcohol consumption constitutes a serious public health problem; nonetheless, it is generally an underappreciated risk factor for many conditions (175, 176). Alcohol use is strongly related to many CVDs, including hypertensive disease, haemorrhagic stroke and atrial fibrillation (83, 174, 177). Regarding other NCDs, alcohol has been linked to eight different cancers, various liver diseases and pancreatitis (83, 174, 177, 178). Consumption of alcohol, together with smoking, diet and physical inactivity, are among the four most important risk factors for NCDs (83, 178).

The relationship between alcohol consumption and IHD and strokes is complex depending on the amount and the pattern of alcohol consumption (156). While alcohol has been reported to have beneficial effects on IHD, by increasing the high-density lipoprotein cholesterol (HDL-C) in the blood, these beneficial effects are restricted to middle-aged and older adults in countries with high CVD rates and is

closely dose-dependent (176, 179, 180). The protective effects tend to disappear if the pattern of drinking is characterised by heavy episodic drinking (156). On the whole, the literature suggests that the detrimental effects of alcohol far exceed the health benefits and arguments must not be undermined by considerations of cardiovascular benefit (175, 178, 181, 182). For public health purposes, it is essential that the harmful alcohol-related health effects are emphasised (173, 180).

The average volume of alcohol consumed and the pattern of use, especially heavy drinking occasions, contribute to disease burden (174). The impact of average volume of consumption on morbidity and mortality is partially moderated by the pattern of alcohol consumption, which in turn is influenced by the cultural context (183).

Determining alcohol misuse

The two dimensions of alcohol consumption include the average volume of alcohol consumed and pattern of drinking (184). Patterns of drinking extend from light regular drinking to drinking to intoxication, heavy drinking occasions and other more detrimental drinking patterns. Questions identifying adverse drinking patterns include the number of heavy drinking occasions (often termed binge drinking), high usual quantity of alcohol per occasion, drinking daily or almost daily and proportion of drinking occasions when drinkers got drunk.

Considering the disapproval associated with heavy drinking in many societies, direct questioning may not always result in truthful answers. This has led to the development of various tools for detecting alcohol misuse and dependence such as the CAGE (cut down, annoyed, guilty, eye-opener), MAST (Michigan Alcoholism Screening Test) and AUDIT (Alcohol Use Disorders Identification Test) questionnaires (185). The initial approach was pioneered by Ewing with the development of the CAGE set of four questions (186, 187), a brief and commonly used screening instrument that is a valid and reliable tool for detecting lifetime alcohol abuse and/or dependence (185, 188). In contrast to the CAGE, the MAST and AUDIT questionnaires preclude their use in setting where brevity is essential (185).

Burden of disease

The global burden related to alcohol consumption in terms of morbidity and mortality is considerable (174). Alcohol consumption was responsible for 3.8% of mortality worldwide in 2008, which is about half the number attributable to tobacco use (156, 174, 176). NCDs, including CVD, cancers and liver cirrhosis account for over 50% of these deaths (156). The mortality rate was higher in men (6.3%) than in women

(1.1%), a reflection of the difference in consumption, with respect to overall volume and pattern of heavy drinking (174). Nevertheless, the increase in mortality rate from 3.2% in 2000 (173) to 3.8% in 2008 was mainly on account of increases in the number of women consuming alcohol.

An estimated 4.5% of the global burden of disease, in terms of morbidity, was attributable to the harmful use of alcohol (156). This was approximately the same as that caused by tobacco (174, 176). CVD, cancers and liver cirrhosis were responsible for a quarter of the alcohol-related disease burden (156). Poor populations and developing countries have a higher relative burden compared to high-income populations and developed countries (174, 176). In addition to high healthcare costs, the mostly unmeasured social costs of alcohol misuse are also substantial (176).

Rising pattern of alcohol use

Without measures to curb alcohol abuse, traditionally low alcohol-consuming cultures may be transformed into high alcohol-consuming countries, for example, as has transpired in Thailand (181, 189). The transition occurred because of permissive, industry-friendly, governmental policies on production, marketing, and availability of alcohol (181). Global, regional, and national policies are supporting the expansion of alcohol corporations in developing regions (189). A strong connection between purchasing power and per-capita alcohol intake prevails. With aggressive and sophisticated marketing techniques by the alcohol industry, consumption and associated harm are, therefore, likely to increase in most societies in the future (176, 189). Alcohol use and alcohol-related harm is expected to rise particularly in developing regions and in young individuals in developed nations (189).

Despite the evidence of rising alcohol consumption, the high global burden of disease and the substantial economic costs attributable to alcohol misuse, the focus on alcohol control is disconcertingly inadequate in most countries (189). The fact that the alcohol-attributable burden is increasing at a time when available strategies can efficiently and cost-effectively control alcohol-related harm, is unacceptable (174). This is occurring because the alcohol industry is well organised and effectively lobby for industry-friendly policies both internationally and nationally (178, 189). There is an imbalance of power between the alcohol industry and health groups which results in the continuing neglect of alcohol as a global health issue (176).

Strategies to reduce alcohol use

Cost-effective and efficient evidence-based measures to address the harmful use of alcohol involve focusing on regulation of affordability, availability, marketing, and

drink-driving legislation (83, 156, 189). Ideally these would encompass implementing a full ban on alcohol advertising, augmented with other policy interventions. These would include raised alcohol excise taxes, addressing alcohol availability through tighter control on the hours of sale and strengthening measures to counter driving while under the influence of alcohol (175-177, 189, 190).

Strategies that make alcohol more expensive, less available and less acceptable can curb the problematic use of alcohol consumption (176) and reduce the alcohol-related burden by up to 25% (175). Decreasing the alcohol-related health burden has the potential to be one of the most cost-effective population-based health programmes in developing countries (175).

Implementation of alcohol control strategies

Seeing that effective regulatory control, including cost-effective and affordable interventions to restrict alcohol harm, exist (189), the need now is to move beyond strategy development and encourage nations to approve and implement alcohol policies (191). As demonstrated in North America, Europe and Australia, this is a considerably more difficult process (191). Factors hampering progress include a lack of political will, obstruction by the alcohol industry in the policy process, and globalisation with its free-trade environments that prevents an adequate response at a national level (189). Therefore, taking action on alcohol requires strong political will, both internationally and nationally, with governmental action being essential (176, 189).

Alcohol control needs to be given political priority as a global health issue with calls for international, national and local sustained efforts to prevent and control alcohol-related harm (176, 189). Until 2009, in contrast to tobacco and illicit drugs, alcohol lacked a coherent framework for global control within the UN system, despite the clear need and importance relative to these substances (189). Unfortunately, in the past, neither the WHO, the policy holder for alcohol within the UN system, nor other UN agencies with potential interests, had paid much attention to alcohol.

Recently however, alcohol has been receiving increasing recognition, particularly within the WHO which approved the Global Strategy to Reduce the Harmful Use of Alcohol in 2010 (83, 156, 178). Alcohol, together with tobacco, diet and lack of exercise, was named as one of the four major common risk factors for NCDs in the recent status report of the WHO, in addition to the Lancet NCD action group (83). Other international agencies such as the World Bank, which once facilitated the establishment of breweries as part of economic development, has called for countries

to strengthen their alcohol policies, particularly for tax, availability control and advertising bans (189). Regional and international NGO networks have also been established in the past decade in response to the perceived need for a global response to the aggressive promotion of alcohol.

Framework Convention on Alcohol Control

Furthermore, in light of the strong parallels between tobacco and alcohol, and the precedent established by the WHO FCTC, there have been calls for a Framework Convention on Alcohol Control (FCAC). The utilisation of international law, in the form of the FCAC, to achieve a medium for cooperation and negotiation is essential. While the initial steps have been undertaken to this end, these need to be urgently accelerated (189). However, despite the success of the FCTC, and the need for measures to counterbalance the pressures from globalised industries, and free trade treaties and settlements, there seems to be little immediate chance of the WHO or member states supporting the complex process of developing a FCAC (176, 178, 189).

1.2.2.4. Insufficient Physical Activity

Introduction

The physical, economic and social environments in which individuals reside today have been changing rapidly and more so since the middle of the last century (192). The changes include revolutions in transportation, communication, workplace and domestic-entertainment technologies, which are occurring predominantly in urban settings. The consequences of urban living and employment, coupled with easier access to public transport and a lack of basic infrastructure for exercising, have been associated with significantly reduced physical activity (26, 192-194).

Of note is that even rural locations far from cities are increasingly becoming urbanised and mechanised (195). Even in developing regions, the physical activity patterns over the past few decades have shifted from labour-intensive lifestyles to more sedentary and less physically demanding activities (196). Technology and economic incentives tend to discourage activity; technology by decreasing the energy requirements for routine daily activities, and economics by greater reimbursements for sedentary than active work (197).

Prevalence

Adults aged 18–64 years are recommended to participate in at least 150 minutes of moderate-intensity aerobic physical activity or 75 minutes of vigorous-intensity aerobic physical activity per week, or an equivalent combination of moderate- and

vigorous-intensity activity (198). However, 31% of adults (men: 28%, women: 34%), age ≥15 years globally, were insufficiently active and did not meet these minimum requirements in 2008. Inactivity was higher in women compared to men in all WHO regions with the highest rates in the Americas and the Eastern Mediterranean regions. Almost 50% of women were insufficiently active in both regions, while 40% and 36% of men, respectively, were inactive. The least inactive men (15%) and women (19%) were in the South-East Asia region. Insufficient activity rose in accordance with increasing country income level, with the prevalence in high-income countries more than double that of low-income countries. Increased work and transport-related physical activities in developing compared to developed regions may explain the differences in activity levels (156).

Consequences

The declining environmental needs for physical activity are associated with shifts in health-related behaviours and a rise in the risk of related conditions (192). Strong evidence demonstrates that insufficient physical activity increases the risk of many adverse health conditions including CVD, thromboembolic stroke, hypertension, diabetes, obesity, dyslipidaemia, osteoporosis, colon and breast cancers, anxiety and depression, and shortens life expectancy (73, 197, 199-204). Insufficient physical activity increases the risk of all-cause mortality by 20-30% compared to individuals meeting the minimum requirement of participating in at least 30 minutes of moderate intensity physical activity on most days of the week (156).

Therefore, it is not surprising that physical inactivity has been identified as the fourth leading risk factor for global mortality responsible for 6% (3.2 million) of deaths globally in 2008; only high BP, tobacco use and high blood glucose contributed to more deaths (156, 198). The Lancet Physical Activity Series Working Group attributed 9% of premature mortality and 6-10% of the NCD burden in 2008 to physical inactivity. Insufficient activity caused 6% of the disease burden from IHD and 7% from diabetes globally demonstrating the major impact of this unhealthy behaviour (203).

Physical activity is beneficial for physical, mental and social health as well as being fundamental to maintaining energy balance and weight control (73, 205). The cardiovascular benefits of physical activity are mediated through several mechanisms including improved glucose metabolism, reduced body fat and lowered BP, resulting in a reduced risk of CVD and diabetes (73, 168, 200). Engaging in 150 minutes of moderate physical activity each week (or equivalent) is estimated to reduce the risk of IHD by about 30% and the risk of diabetes by 27% (85, 156, 198). This also lowers

the risk of stroke and hypertension (156), and is associated with improved low-density lipoprotein cholesterol (LDL-C) particle size, lower triglycerides and higher HDL-C levels (73, 204, 206).

Measuring physical activity

Physical activity is a complex multi-dimensional behaviour, including different dimensions (type, intensity, duration, frequency) and domains where activity takes place (196). This makes it difficult to quantify physical activity and various methodologies, instruments and analyses have been used (200). Nonetheless, subjective self-reported questionnaires are routinely used to measure physical activity levels. Some self-reported tools developed to measure physical activity in the past decade include the International Physical Activity Questionnaire (IPAQ) and the Global Physical Activity Questionnaire (GPAQ) (200, 207). The accuracy of questionnaires, however, is limited by recall bias and the difficulty in assessing all dimensions and domains of physical activity when using self-reported instruments (196).

The gold standard method for measuring free-living total energy expenditure is doubly labelled water but this is not appropriate for large population studies. Objective methods such as accelerometry, heart rate monitoring, and combined movement and heart rate monitoring are considered to be more accurate than self-report methods (196). The development of these sophisticated device-based instruments to measure physical activity has enabled the accurate accounting of an entire range of activity, from sedentary through to highly vigorous activities in free-living participants over a number of days. The most frequently used device-based tool in population-based studies thus far has been the accelerometer (199). Although device-based measures are being used more frequently for measuring physical activity in epidemiological studies in developed regions, their uptake in developing nations has been limited (196) and is likely to be delayed by high cost factors.

Sedentary behaviour

In addition to insufficient physical activity, an added concern is that of sedentary behaviour in the form of excessive sitting. In contemporary society this is a common occurrence that extends across many settings including transportation, the workplace and the home. Of note, is that even if the recommended levels of activity are achieved, sitting for prolonged periods can compromise cardio-metabolic health as reported by Owen and colleagues and Dunstan and colleagues in their reviews (192, 199).

Strategies to increase physical activity

Physical inactivity remains an urgent public health issue globally (197) and seeing that it has major health consequences, decreasing or removing this unhealthy behaviour would greatly improve health. Therefore, all avenues and all efforts should be explored to reduce physical inactivity worldwide (203). Complex variables, including personal, programmatic, social, environmental and related factors, facilitate a physically active lifestyle and need to be maximised (29, 197). The WHO recommendations for promoting physical activity target policy-makers at the national level and support population-based strategies (198). These have been incorporated in its Global Strategy on Diet and Physical Activity with suggested strategies highlighting the need for national physical activity plans and their integration with diet and obesity control programmes (207).

Environmental influences on physical activity patterns

Information and awareness have increased on the role that the environment plays in influencing physical activity, and efforts to promote physical activity need to consider the manner in which individuals interact with the environment (29, 197). Environments that facilitate physical activity need to be encouraged with easier access to such facilities (29, 73). The creation of these environments requires government involvement to implement policies that promote population-based approaches for enhanced physical activity. For example, there needs to be dedicated safe and accessible spaces to encourage walking, cycling and other forms of physical activity (29, 73, 208). Public policies and legislation that can potentially impact on opportunities for physical activity are multi-sectoral and include those relating to transport, urban planning, education, labour, social inclusion, sport and recreation, and healthcare funding connected to physical activity (73, 195). Additionally, constraints to physical activity such as crime and air pollution also need to be addressed (208).

Socio-cultural influences on physical activity patterns

Equally important, it must be noted that societal, cultural and personal influences affect the uptake or continuation of physical activity patterns, and need to be identified and incorporated into strategies of exercise promotion (209). Strategies need to overcome social norms that prevent activity and improve community understanding and acceptance of integrating physical activity into everyday life (73). National strategies must therefore be culturally appropriate and capable of challenging cultural influences and responding to changes over time.

In summary, efforts to improve physical activity need to take cognisance of increasing urbanisation and various aspects of city planning, transportation, safety and access to physical activity during leisure, and socio-cultural attitudes to exercising (73). The implementation of such a strategy requires sustained political commitment and the collaboration of numerous stakeholders. The benefits of promoting a population-based physical activity strategy will contribute to the effective prevention of CVDs and other NCDs.

1.2.2.5. Unhealthy Diets

High fat intake

Introduction

Over the past century, with rising industrialisation, urbanisation and mechanisation evident in most countries worldwide, diet and nutritional status have undergone major changes (8, 210). The changing dietary patterns are a product of the modern trade systems and the effect of the global food industry on food-supply chains (211). Consequently, there has been a shift away from traditional diets toward the higher fat and higher refined carbohydrate western diet (212), with dietary fat intake increasing steadily over the last four decades (156).

Patterns of fat intake

There are large variations globally in the amounts of total fats consumed. The highest proportions of energy derived from total fat intake are in parts of North America and Europe (>30%), while the lowest quantities consumed are in Africa and South-East Asia (<20%) (8, 156). The proportion of energy from dietary fats is over 30% in developed regions and in most other regions this share is increasing (8). The pace of dietary change is occurring at varying degrees in different regions of the world (210). While the proportion of fat intake has increased with growing country level income, unhealthy diets have been rising quickly in lower-resource settings with particularly rapid increases in fat intake in lower-middle-income countries since the 1980s (156). Growing incomes in developing regions have led to increases in the accessibility and intake of energy-dense high-fat diets, especially among the poor (8).

Consequences

The WHO recommendation is that fat intake should not exceed 30% of daily energy intake (94), as an unrestricted fat intake is associated with potential excess energy consumption and unhealthy weight gain (213). Intake of unhealthy diets that are richer in high-fat, high-energy foods contributes directly to increased energy

imbalances, and the rapidly rising global levels of obesity and subsequent CVDs (208).

In addition to affecting body weight, dietary fat intake, specifically the qualitative composition of dietary fats of high saturated and trans-fatty acid intake, influences the risk of CVDs such as IHD and stroke. This occurs through effects on blood lipids, thrombosis, BP, arterial (endothelial) function, arrhythmogenesis and inflammation (8, 205, 213-215). However, not all fats are categorised as unhealthy; while saturated and industrially produced trans-fats contribute to CVDs, polyunsaturated and monounsaturated fats are cardio-protective (94). High total fat intake has also been associated with a higher risk of impaired glucose intolerance (IGT) and higher fasting glucose and insulin levels (8).

Other dietary influences on cardiovascular health

In addition to high fat intake, other diet and nutrition factors also play a key role in the causation of CVDs by influencing the biological variables that mediate the risk for these conditions. The quantities of fruit and vegetables, and salt consumed daily are likewise key influences on cardiovascular health. Although other food items also contribute to greater or reduced CVD risk, these are the main determinants of diet-related risk for CVD (213).

Adequate quantities of fruit and vegetable intake (400–500 grams/day) are recommended by the WHO to lower the risk of IHD, stroke and high BP, as well as stomach and colorectal cancers (94, 156, 213). These contribute to cardiovascular health through numerous phyto-nutrients, potassium and fibre (213). Salt or sodium intake has been directly correlated with BP and the prevalence of hypertension (55, 156, 213). Likewise, high intakes have a direct effect on stroke, left ventricular hypertrophy, progression of renal disease, and proteinuria, independent of but additive to the impact of salt on BP (55, 216). Consequently, a daily intake of less than 5 grams/day has been recommended to reduce the risk of IHD and stroke (217).

Strategies to improve diets

Considering that dietary changes can substantially alter the risk of CVD, opportunities exist to modify the direction and dimensions of the global CVD epidemic through policy interventions at the local, national and global levels. As stated by Reddy, policies and intervention strategies that promote the availability, affordability and acceptability of health enhancing diets, and restrain the marketing and consumption of unhealthy foods are urgently required (213). National food and

agricultural policies ought to be consistent with the protection and promotion of public health (73).

Globalisation presents a major challenge to implementing nutritional policies at national levels because of the ubiquitous presence of the fast-food industry. This global industry, with its rapid penetration of high-salt, high-fat, high-energy processed foods into developing country markets, promotes the consumption of foods detrimental to cardiovascular health (213). Therefore, global and national agriculture and trade policies need to urgently address these concerns and find sustainable solutions.

Effective interventions include the development of food-based dietary guidelines deduced from the recommendations of specific amounts of nutrient intakes and the appropriate dissemination of these to consumers. However, these has not been introduced yet at a national level in most countries (156). Equally important is to ensure effective product labelling practices, whereby adequate nutritional information with respect to fat and sodium content is provided (156, 195, 213). To promote cardiovascular health, dietary intake of trans-fats should be <1%. This is particularly important in developing regions where this low-cost fat is frequently consumed (218). Industrially produced trans-fatty acids (hydrogenated fats) are harmful and need to be reduced through mandatory regulation of food standards; the most effective action is a total ban (156). Another important strategy is to lower the sodium content of manufactured foods and meals (156), particularly of regularly consumed foods like breads and cereals (213). Also, subsidising or lowering prices of more healthful foods was associated with greater intake of these foods. For example, in observational studies in the United States (US), fruit and vegetable intake increased and BMI dropped with lower prices of these foods (51).

1.2.3. PHYSIOLOGICAL RISK FACTORS

1.2.3.1. Overweight and Obesity

Drivers of the obesity epidemic

Before 1980, global obesity levels were generally much lower than 10% (219). However, there has been a rapid rise in the prevalence of overweight and obesity with the emergence of an ‘obesogenic’ environment (220, 221). Globalisation and urbanisation have over the past few decades contributed to environmental and societal changes with subsequent alterations in dietary and physical activity patterns. These processes have resulted in an abundant supply of processed, energy-dense foods high in fat, salt and sugars, which are convenient, affordable and effectively

marketed (74, 77, 219, 220, 222). Reduced physical activity promoted by the built environment, particularly in urban settings, is attributable to increasing sedentary occupations and changing modes of transportation (77, 220-222). In addition, the complex interplay between biological factors operating during foetal development and infancy, and the related energy imbalances aggravate many health problems (222).

The overconsumption of food, decreased physical activity, or both have contributed to the energy imbalance between calories consumed and calories expended. The energy imbalance, with greater calories consumed than expended, leads to the accumulation of abnormal or excessive fat that presents a risk to health and is the hallmark of overweight/obesity (77, 220, 223). The obesity epidemic seems to be related to increased energy consumption in developed regions and to increased consumption and decreased energy expenditure in some developing countries (223).

The obesogenic environment is exacerbated by the absence of supportive policies in sectors such as health, agriculture, transport, urban planning, environment, food processing, distribution, marketing and education (77). As a result, overweight/obesity has become a major and serious, yet neglected, public health problem that threatens to overwhelm developed and developing regions (205, 220, 224). Overweight/obesity has reached epidemic proportions (224), overtaking tobacco as the largest preventable cause of disease burden in some regions (74).

Prevalence and trends

In 2008, 34% men and 35% of women ≥20 years old, comprising 1.46 billion adults globally, were overweight/obese suggesting that one in three adults were affected (50, 156, 225). The prevalence of overweight/obesity was highest in the WHO Region of the Americas (overweight: 62%, obesity: 26%) and lowest in South-East Asia (overweight: 14%, obesity: 3%) (17, 156) .

Worldwide, women were more likely to be obese than men, with the rates in women in Africa, South-East Asia and the Eastern Mediterranean approximately twice those of men in 2008 (156). Women, for biological reasons, usually have a higher mean BMI and thus higher rates of obesity at all ages worldwide, compared to men (205). The obesity prevalence almost doubled between 1980 and 2008 from 5% to 10% for men and from 8% to 14% for women (17, 156, 225). During this period, the mean global BMI increased by 0.4 kg/m² for men and 0.5 kg/m² for women per decade (225).

The prevalence of overweight/obesity by country income level, was higher in high-income and upper-middle-income countries compared to low- and lower-middle-

income countries (156). Nonetheless, overweight/obesity cannot be considered a problem only of developed regions as it is becoming more prevalent in low- and middle-income countries, particularly in urban settings (77, 224). Furthermore, although more prevalent in developed regions, substantially larger absolute number of individuals are affected by overweight/obesity in developing regions because of the considerably larger population in the latter (226). Also, in several developing countries in Asia and SSA the prevalence of obesity is comparable to that found in the US and other high-income nations (224). Developing regions are now facing a double burden of disease, with infectious disease and under-nutrition continuing to be a problem. They are experiencing a rapid rise in CVD risk factors such as overweight/obesity, and as mentioned earlier, particularly in urban areas (77, 224).

The prevalence of overweight/obesity worldwide differs by socio-economic status. An inverse relationship exists between socioeconomic status and obesity in women in developed nations, yet in developing nations the relationship is positive in women and men (156). However, trends indicate that while overweight/obesity initially affects wealthier individuals in urban areas in developing regions, this is followed by a reversal of the socioeconomic gradient as overweight/obesity becomes a disease of the poor (221). This is particularly true when a country's gross domestic product (GDP) exceeds about US$5000 per year (205).

Of added concern is that not only have the global overweight/obesity rates risen steadily over the past few decades in developed and developing regions but there is little indication of this trend slowing down (220, 227). The prevalence of overweight/obesity is predicted to rise to about 58% (overweight: 38%, obesity: 20%) by 2030, with 3.3 billion adults either overweight or obese if recent secular trends of obesity continue. The proportional increase in the number of overweight/obese individuals will be larger in developing regions because of factors including growth in population size, population ageing, urbanisation and changes in lifestyle related to higher total calorie intake and decreased physical activity (226).

Consequences

The risk attributable to excess body weight is exceedingly high with no other modifiable effect having such an impact on health (228). Consequently, obesity has also been identified by the International Statistical Classification of Diseases as a chronic disease in its own right (224, 229). Excess body weight is associated with an increased risk of many diseases, notably diabetes, hypertension, dyslipidaemia, IHD, stroke, musculoskeletal diseases, several cancers including endometrial, breast and colon, and premature death (74, 77, 85, 156, 182, 205, 215, 220, 227, 229-233). The

WHO Comparative Risk Assessment Study (Global CRA) estimated that in ≥30-year-old adults, BMI >21 kg/m^2 was associated with approximately 58% of diabetes, 39% of hypertensive disease, 21% of IHD and 23% of ischaemic stroke, among other conditions (234). In addition to reduced life expectancy and the health-related risks and costs, excess adiposity has other substantial implications for the individual and society in terms of lost productivity and economic liabilities (205, 220).

Mortality

Overweight/obesity is the fifth leading risk for global mortality, responsible for about 4.8% of global mortality or at least 2.8 million deaths annually (77, 85). The excess mortality is mainly attributable to CVD. Using BMI as the measure of adiposity, each five units above the overweight category is associated with about 30% higher overall mortality and 40% higher cardiovascular mortality (220).

Depending on the severity of obesity, the life expectancy of overweight/obese adults may be shortened by 4-10 years (205, 220). On account of the high obesity prevalence in young individuals, it has been projected that for the first time in this century their expected lifespan will decrease in the near future. This is because of the earlier onset of diabetes and its complications, mainly CVD and end-stage renal disease, compared to previous generations (228).

Strategies to reduce overweight/obesity

The obesity epidemic requires urgent action, particularly by policy makers and international stakeholders, such as the UN, so as to provide global leadership to dismantle the obesogenic environment (74, 220).

The WHO responded to the global obesity pandemic by adopting the Global Strategy on Diet, Physical Activity and Health in 2004. This document, as discussed previously in Section 1.1.5., describes the actions needed to support healthy diets and regular physical activity and advocates stakeholders at global, regional and local levels to act to improve diets and physical activity patterns at the population level (77).

Nonetheless, public health interventions have been limited, especially in developing regions. In these regions, where healthcare resources are scarce, primary prevention of overweight/obesity through population-based initiatives is particularly important, and more feasible and cost-effective than the challenge of weight reduction. A reduction in the global burden of overweight/obesity will translate into declines in diabetes, CVD, cancers, all-cause mortality and other accompanying complications (226).

In order to create such supportive environments the key determinants of the obesogenic environment need to be targeted (220, 235). Governments at all levels need to enact policies that facilitate greater physical activity and healthy food consumption in a manner which makes these the easy choices (220). Structural, regulatory, and economic interventions have the potential to bring about these changes (225). Seeing that supportive environments and communities are key to shaping individual choices, by making a healthier dietary choice and regular physical activity the easiest one, overweight/obesity can be prevented (77, 220, 228, 231).

At individual level, it is vital to encourage weight loss in those who are overweight or obese. Modest weight loss of, for example, 5% to 10% is associated with improvements in cardio-metabolic risk factors (236), with significant improvements in BP in those with and without hypertension, in lipid profiles by lowering triglycerides and raising HDL-C, and in glucose tolerance or insulin resistance with a reduction in the progression to diabetes (232, 236).

Nonetheless, it must be emphasised that although health behaviour modification remains the cornerstone for the treatment of overweight/obesity (220), simple advice and exercise alone have not been found to be effective (225), with a lack of motivation a massive barrier to change (205). Weight-management is a long-term process and the proportion of people who are adequately motivated to accept treatment is estimated to be less than 20% (205). Therefore, obesity is virtually impossible to treat by conventional methods (235), particularly as the range of options within which individuals make their choices is skewed in favour of weight gain rather than weight loss (237). Changing the environment within which these decisions are made to help support behaviour change is likely to be far more effective than merely encouraging individuals to make better choices (235, 237) since overweight/obesity cannot be managed solely at the individual level (238).

1.2.3.2. Diabetes Mellitus

Introduction

Diabetes mellitus, a metabolic disorder characterised by chronic hyperglycaemia that occurs because of defects in insulin secretion, insulin action, or both (239), is escalating and poses a threat to health and socioeconomic development in the 21st century (240). The number of individuals with diabetes worldwide has more than doubled over the last three decades; a remarkable increase that is occurring in all corners of the globe (241, 242). Diabetes today poses a global public health crisis that threatens the economies of all countries, particularly those of developing nations (194, 228, 243).

Classification

The predominant form of diabetes is type II diabetes, which accounts for approximately 90% of cases, and is the type of diabetes investigated in this thesis. Another important class of diabetes is type I diabetes, which is attributable to an autoimmune process or beta–cell destruction for which neither an aetiology nor a pathogenesis is known (idiopathic) (239). Diabetes may also occur during pregnancy and is classified as gestational diabetes. Less common secondary causes of diabetes include diseases of the exocrine pancreas, such as tumours or pancreatitis, endocrinopathies like Cushing's syndrome or phaeochromocytomas, drug-induced diabetes and infections.

There are intermediate metabolic states between normal glucose homeostasis and diabetes that are too high to be considered normal. These consist of IGT and impaired fasting glycaemia (IFG) (244). These forms of impaired glucose regulation, while not clinical entities in their own right, are transitional stages in the development of diabetes (244, 245); almost half of those with these pre-diabetes states progress to diabetes. Individuals with pre-diabetes are also at increased risk for CVD: IGT increases the risk of CVD by approximately 60% and IFG by about 30% (246).

Predisposing factors

Driven by rapid globalisation and urbanisation, with subsequent changes in diet and increasingly sedentary lifestyles, the diabetes epidemic has expanded in line with the worldwide rise in overweight/obesity. The rapid rise of obesity is the single most important predictor of diabetes that has contributed to the worldwide spread of this condition (242, 247). In addition, diabetes is rising on a global level on account of population ageing and rapid urbanisation (242, 243, 248-253).

A complex gene-environment interaction of non-modifiable (genetics, age, sex, ethnicity and family history) and modifiable risk factors predisposes to the development of diabetes (194, 247, 254). The significant modifiable risk factors include overweight, abdominal obesity, physical inactivity and sedentary behaviour, and increased total dietary fat and carbohydrate intake (249, 254, 255). In addition, intra-uterine and early childhood influences as well as stress may also play a role (194, 242, 254, 255).

Although genes that predispose to diabetes are considered an essential factor in the development of the disease, the activation of a genetic predisposition necessitates the presence of environmental and behavioural factors that are usually associated with lifestyle (254). As a result about 80% of diabetes, according to Bruno and Landi,

may be prevented by only avoiding being overweight/obese (228). Overweight/obesity has the most potent effect on diabetes with every unit increase in BMI producing a 12-% rise in the risk of diabetes (249, 254).

Prevalence and trends

The rise of obesity, driven by rapid globalisation and urbanisation with subsequent changes in diet and increasingly sedentary lifestyles, has been central to the expansion of the diabetic epidemic (194, 242, 247, 254). Diabetes has escalated to become a global epidemic that is expected to worsen in the coming decades (256).

In accordance with rising levels of dysglycaemia, mean fasting glucose levels have been increasing globally between 1980 and 2008 (241). According to the fifth edition of the IDF Atlas, the global diabetes prevalence was 8.3% among 20-79-year-old adults, equating to approximately 366 million individuals (253). This is estimated to reach pandemic levels by affecting 552 million individuals or 9.9% of the adult population by 2030 (228, 253). In addition, the global prevalence of IGT in adults in 2011 was 6.4% (280 million individuals) and is predicted to rise to 7.1% (398 million individuals) by 2030.

The dynamics of the diabetes epidemic are shifting rapidly; once a disease of developed regions and the affluent, diabetes has now spread to every country in the world and is becoming increasingly common among the poor (194). The major burden of diabetes today occurs in developing, compared to developed, regions with approximately 80% of diabetic individuals residing here. According to the IDF Diabetes Atlas, China and India had the greatest numbers of affected individuals but diabetes was most prevalent in the Middle East and North Africa Region in 2011 (11.0%) (253). Furthermore, the proportion of young to middle-aged individuals with diabetes was higher in developing than in developed countries (242, 252). In developed regions, most diabetic individuals were above 60 years old (252).

Consequences

Hyperglycaemia and diabetes contribute significantly to morbidity and premature mortality worldwide (241, 253). Chronic hyperglycaemia leads to micro- and macro-vascular complications. The micro-vascular complications include retinopathy with the potential for blindness, nephropathy which may lead to renal failure, and/or neuropathy with risk of foot ulcers and subsequent amputation (239). The macro-vascular complications make diabetes a significant contributor to CVD: it affects the heart (IHD), the central nervous system (cerebrovascular disease) and the lower limbs (PVD) (239, 257). Diabetes is believed to confer an equivalent risk to having an MI.

Mortality

Among 20-79-year-old adults, 8.2% of the global all-cause mortality (4.6 million) was attributable to diabetes in 2011 (253). CVD is usually the leading cause of mortality among diabetic individuals accounting for over 50% of deaths in some populations (249, 253). Globally, 22% of IHD and 16% of stroke mortality was attributable to raised blood glucose (85).

Mortality attributable to diabetes was highest in the Western Pacific Region (>15%) and lowest in SSA (6.1%). However, the Western Pacific Region and developed countries had the lowest age-specific risk of mortality from high blood glucose (85). In SSA, the majority (72.8%) of diabetes mortality occurred in people younger than 60 years old compared to the global proportion of 48% (253).

Management

Diabetes is associated with a heavy health burden and to slow the progression to micro-vascular and macro-vascular complications, it is vital for healthcare systems to develop programmes that improve the detection and management of diabetes (241). This is particularly true for developing regions like SSA where early detection of established diabetes will improve outcomes and decrease costs (247). Equally important for successful management, is the need for health education and increased public awareness of diabetes (245, 256).

The rising number of individuals with diabetes has important implications for healthcare provision aimed at diabetes control (245). Feasible and cost-effective interventions in diabetic individuals that improve health include tight glucose and BP control, and foot care for individuals with a high risk of ulcers. BP control in diabetic individuals is very effective in reducing the risk of cardiovascular complications as well as retinopathy and nephropathy. In resource-poor regions, BP control is estimated to be one of the most feasible and cost-effective interventions in individuals with diabetes (156).

Nonetheless, diabetes management remains suboptimal, even in developed countries, with a major gap between recommended care and that actually received. Reports from Asia found that 32-50% of diabetic individuals had poor glycaemic control, defined as >2% above the upper limit of the normal range of HbA_{1C} (258). Among diabetic adults aged 60 years or older in an urban slum in Delhi, awareness, treatment and control among were 36.0%, 22.5% and 16.9%, respectively (259). Although suboptimal, population-based surveys conducted in the US showed that the

proportion of diabetic adults with HbA_{1C} <7.0% improved from 44.3% in 1999-2002 to 52.2% in 2007-2010 (260).

Prevention strategies

In addition to optimal detection and management of diabetes, prevention is of paramount importance. Seeing that approximately 90% of individuals who developed diabetes had BMI higher than 23.0 kg/m^2 (205), intensive lifestyle interventions in high-risk individuals specifically aimed at weight loss and increased physical activity can prevent or at least delay the progression to overt diabetes by 50%(261).

However, sustained shifts in diet and lifestyle require not only individual behavioural changes, but also fundamental shifts in public policies. Public health strategies that alter the obesogenic environment by promoting healthy diets and lifestyles are paramount to curtail the diabetes epidemic (194). Despite the difficulties in implementing such population-based interventions, these strategies are vital since diabetes has become one of the most important public health challenges following the dramatic rise in the global prevalence (241, 242, 256).

1.2.3.3. Dyslipidaemia

Introduction

The value of abnormal blood lipid levels to predict IHD has been studied for decades (262), with the importance of total cholesterol (TC) as a risk factor for the development of IHD originally demonstrated in the Framingham Heart Study (263). However, the initial focus has shifted from examining the relationship with TC to that of the individual components associated with TC. TC is a composite measure of the cholesterol content of lipoprotein particles including LDL-C and HDL-C (262).

Consequences

Dyslipidaemia is defined as the clinically significant alteration in circulating lipids and lipoproteins that predisposes to IHD and related disorders, with the key lipid abnormalities including those related to TC, HDL-C, LDL-C and triglyceride levels (264, 265). Furthermore, it is a determinant for the development of atherosclerosis and a major independent risk factor for heart disease, stroke and other vascular diseases (85, 156, 264, 266).

In the INTERHEART study, dyslipidaemia was found to be the single most powerful cardiovascular risk factor for IHD (86). A 10-% reduction in TC in 40-year-old men can reportedly reduce heart disease by 50% within five years (156). Worldwide, a third of IHD was attributable to raised TC (85, 156), with the highest risk found in

middle-income European countries, and lowest in low- and middle-income Asian countries (85).

The most common and clinically significant lipid abnormality is hypercholesterolaemia, i.e. elevated serum TC (265). LDL-C is the most atherogenic of the lipoprotein particles, with raised levels required for the initiation and progression of atherosclerosis (267). Hypertriglyceridaemia is also an independent predictor of IHD (268) with this association more robust in those with than without diabetes (269). In addition to excess lipids or hyperlipidaemia, such as raised TC, LDL-C and triglyceride levels which lead to adverse consequences (265), a low HDL-C is independently atherogenic (270). This is recognised as a major risk factor for IHD, with high levels usually protective against atherosclerosis and subsequent CVD (265). Compared to Caucasians, HDL-C levels are usually much higher in individuals of African descent (271, 272). Consequently, TC may not be as important a proxy measure for CVD risk in the latter compared to other populations where it may be an accurate substitute for high LDL-C levels. However, emerging data on HDL-C-raising agents and Mendelian randomisation studies have lately questioned the causal relationship between HDL-C and atherosclerosis. Further research is required to clarify the role of HDL-C in the development of CVD risk (273).

Predisposing factors

TC levels are affected by diet and physical activity patterns as well as genetics, with dietary saturated fat the main determinant of TC and LDL-C levels (85, 233, 274). Conditions such as hypothyroidism, nephrotic syndrome and pregnancy, and the use of some drugs may also predispose to dyslipidaemia (265).

Prevalence and trends

While the dyslipidaemic patterns of high levels of LDL-C and/or low HDL-C have been found to impart high risk for developing IHD, globally, there is more information available on TC levels in populations than on LDL-C and HDL-C levels (85, 262). The global prevalence of TC ≥5.0 mmol/l among ≥25-year-old adults in 2008 was 39% (men: 37%, women: 40%). The highest prevalence was in Europe (54%) and the Americas region (48%), while the lowest was in SSA (23%). The prevalence of raised TC increased according to the income level of the country from about a quarter of adults in low-income countries to a third in lower-middle income countries and over 50% in high-income countries (156).

Although mean TC levels were highest in developed nations, these were decreasing; in contrast, in developing countries, particularly in Asia, mean TC levels were on the

rise (275). The likely drivers of these polarised global trends are dietary fats and adiposity, and probably statin use in high-income countries. Globally, mean TC has remained reasonably stable between 1980 and 2008, falling by <0.1 mmol/l per decade in men and women worldwide (156). The modest decline in TC predates the widespread use of statins in most parts of the world with their use remaining extremely low, even for secondary prevention in most countries (50).

Mortality

Approximately 4.5% of global mortality (2.6 million deaths) was attributable to TC ≥5.0 mmol/l in 2008, making it the sixth leading cause of death (85, 156). The proportion of mortality attributable to raised TC was higher in high-income (5.8%) compared to low-income countries (3.4%); however, the numbers were higher in low- compared to high-income countries (0.9 million vs. 0.5 million) (85), emphasising the problem in poor regions.

Management

Population-based interventions that promote healthier lifestyles, including dietary modification, weight loss, smoking cessation and increased exercise, are important to prevent or improve lipid abnormalities (276, 277). TC levels are influenced favourably by improved dietary changes as well as increases in physical activity (233), while low HDL-C levels may be raised predominantly by smoking cessation, weight loss and aerobic exercise (270). Physical activity is associated with lower levels of LDL-C and triglycerides, and higher levels of HDL-C (204). Replacing 60% of saturated fat intake with other fats and reducing dietary cholesterol intake could reduce TC levels by about 0.8 mmol/l, that is, 10 to 15%. About 80% of this reduction will be in LDL-C (274).

The treatment of dyslipidaemia is central to cardiovascular prevention (278), with high LDL-C levels being the primary target for cholesterol-lowering therapy (270). Lipid-lowering agents, statins in particular, have been shown to greatly improve cardiovascular morbidity and mortality (204, 266). Studies have demonstrated that each 1-% reduction in TC level was associated with approximately 1-% reduction in the risk of cardiovascular events (279).

Although the use of lipid-lowering drugs, such as statins, is increasingly common in high-income countries, there is lower coverage of screening and treatment in low- and middle-income regions (275). The WHO MONICA study, conducted in 19 countries, also showed better management in wealthier compared to poorer countries (280). The data from the 19 countries overall reported low rates of

cholesterol testing in the previous year (men: 37%, women: 30%). Awareness of hypercholesterolaemia was 19% in men and 17% in women. Among men and women, 45% and 44%, respectively, with raised TC were receiving treatment while 61% and 65%, respectively, of those on treatment had desired levels <6.5 mmol/l. Other studies have reported suboptimal control of hypercholesterolaemia even in high-risk individuals. In Asia, TC >5.2 mmol/l among diabetic individuals was high in Singapore (67%), India (46%) and Taiwan (47%) (258). Notably, a multidisciplinary approach is required for the management of dyslipidaemia; in addition to lifestyle and diet interventions and pharmacological treatment of dyslipidaemia, treatment of concomitant CVD risk factors such as hypertension and diabetes is needed (266).

1.2.3.4. Hypertension

Prevalence and trends

The high prevalence of hypertension has gained global importance and is recognised as a key contributor to the present pandemic of CVD (11, 281). Worldwide, the hypertension prevalence in ≥25-year-old adults was about 40% in 2008 amounting to almost one billion individuals, with most residing in developing countries (156). Hypertension was higher in low-income (40%) compared to high-income countries (35%), demonstrating the greater burden in poorer regions.

Hypertension has been on the rise over the last few decades, with the numbers increasing from 600 million in 1980 to nearly one billion in 2008 (282), and by 2025 the total number is estimated to increase to 1.56 billion (11, 283). The major rise is expected to occur in developing countries with an 80% increase in the number of hypertensive individuals as compared to a 24-% increase in developed nations (11).

Predisposing factors

The development of hypertension is a complex combination of genetic and environmental influences and cannot easily be simplified. In any given individual, although one factor may be more important than others, hypertension is often multifactorial (284). The key risk factors for essential hypertension, also referred to as primary or idiopathic hypertension are excess body fat, a salt-rich diet with processed and fatty foods, a low consumption of fruit and vegetables (that is, low potassium intake), physical inactivity, excessive alcohol consumption and psychosocial stress (37, 85, 168, 216, 285-288). These changing lifestyles associated with globalisation and urbanisation (233) as well as population growth and ageing, seeing that these effects accumulate with age (85), have contributed to and will lead to increases in hypertension.

A specific cause of BP elevation can be identified in a small proportion of individuals with hypertension. Secondary causes of hypertension include polycystic kidney disease, renovascular hypertension, phaeochromocytoma, primary aldosteronism, Cushing's syndrome, coarctation of the aorta and drug-induced hypertension (168).

Consequences

Raised BP has serious and life-threatening consequences; it is a major risk factor for IHD, stroke, heart failure and chronic renal failure, and a predominant contributor to CVD morbidity and mortality (11, 53, 94, 156, 281, 289, 290). Other common target organ damage includes left ventricular hypertrophy, arrhythmias, sudden death, retinopathy and PVD (156, 291, 292). Hypertension also contributes to diabetic nephropathy, with the coexistence of overt diabetes and hypertension doubling the risk for CVD, as well as for nephropathy (267).

Cardiovascular morbidity and mortality demonstrate a continuous relationship with BP levels which is positively and progressively related to the risk (156, 168). Of note is that cardiovascular risk occurs even at systolic and diastolic levels of 110–115 mmHg and 70–75 mmHg, respectively. The relationship has been reported to be less steep for coronary events than for stroke; stroke is recognised as the most important hypertension-related complication (168). Globally, approximately two-thirds of strokes and almost half of all IHD cases were attributable to systolic BP ≥115 mmHg (293). About 4-6% of global disease burden was attributable to high BP (19, 85, 293).

High BP was the foremost cause of death worldwide responsible for 13-14% of global mortality or about 7.5 million deaths (19, 85). This is not surprising bearing in mind the high global prevalence of hypertension and that high BP is a powerful independent risk factor for deaths attributable to stroke and IHD (281). Worldwide, 51% of stroke and 45% of IHD deaths were attributable to high systolic BP (85), making raised BP the leading risk factor for CVD mortality (282).

The hypertension burden is already imparting a profound effect on populations in low- to middle-income countries (36). Approximately 80% of the hypertensive disease burden occurs in developing regions and over half in those aged 45–69 years (19).

The number of deaths was higher in low- (2.0 million) and middle-income (4.2 million) compared to high-income countries (1.4 million) (85), reinforcing the higher burden in poorer regions. Furthermore, a greater proportion of the burden occurred in younger individuals in developing regions (19) because, at any given age, the risk of dying from high BP was more than double in low- and middle-income countries compared to high-income countries (85).

Management

Despite the gravity of complications, significant numbers of hypertensive individuals are unaware of their condition and diagnosed hypertensive treatment is often inadequate (294). If the march of hypertension-related morbidity and mortality is to be contained, prevention, detection, treatment, and control of hypertension should receive high priority (11), particularly in developing regions.

In developed regions, levels of hypertension awareness and treatment were relatively high with approximately one-half to two-thirds of hypertensive individuals aware of their diagnosis and one-third to one-half receiving treatment. The rates of hypertension control among treated individuals were 30-50% (294). The lower mortality burden attributable to high BP in high-income countries is likely related to their better hypertension management compared to poorer regions. Although hypertension prevalence increased in high-income countries (295), there was a marked decline in mean BP in this region (50, 282), likely because of the active management of hypertensive individuals through the widespread use of drug treatment (295).

In contrast, while mean BP in high-income countries dropped between 1980 and 2008, in low-income countries, the mean BP increased during the same period (50, 282). The rising BP levels in developing regions are suggestive of a lack of effective measures to optimise hypertension management, despite the availability of effective treatment. The levels of hypertension awareness, treatment and control in most developing countries tended to be lower than those reported in economically developed countries, with approximately one-quarter to one-half of hypertensive individuals aware of their diagnosis, 10-50% receiving treatment, and 20-50% of treated individuals being controlled (294).

A systematic review by Pereira and colleagues (2009), however, found no significant differences between developed and developing regions (281). Among men, the highest prevalence of hypertension awareness, treatment and control was reported in North America (66.1%, 46.3% and 24.9%, respectively). The lowest rates among men were in Southern Asia (awareness: 35.3%), Southern Europe (treatment: 23.6%) and Northern and Central Asia (control: 5.7%). Among women, the highest prevalence of hypertension awareness, treatment and control was observed in South and Central America (73.6, 62.5 and 33.2%, respectively). The lowest rates among women were in Southern Asia (awareness: 46.4%) and Northern Europe (treatment: 29.9%, control: 10.0%).

Although the overall prevalence of controlled hypertension was higher in more affluent countries, hypertension control among treated individuals was not so different in developing compared to developed regions (37). This suggests that the large difference in hypertension control between these regions is likely attributable to the extent that hypertension was diagnosed, which is much lower in low-income regions. The difference in levels of awareness may be related to a lack of resources characteristic of less affluent settings (37).

Considering that hypertension accounts for more deaths globally than any other CVD risk factor, including cholesterol, tobacco, BMI, and physical activity (296), antihypertensive therapy, when optimally prescribed, is among the most efficient means for disease prevention (297). Lowering BP is associated with a reduction in cardiovascular morbidity and mortality associated with stroke, IHD and heart failure, as well as chronic kidney disease (156, 281, 282, 289). Effective treatment could prevent 250 000 deaths per annum (298), with antihypertensive therapy reducing the incidence of stroke by 35-40% and of MI by 20-25% (297, 299).

Therefore, the early detection, treatment and control of hypertension are central to the integrated management of cardiovascular risk (300). Even in developing regions a substantial commitment of scarce resources must be considered for the management of hypertension using the total CVD risk assessment approach (289, 297).

Although hypertension management may be better in developed than in developing regions, there still remains a large ‘care gap’ worldwide among those who would benefit from treatment but are not detected, treated or adequately controlled (43). Hypertension care and control remains difficult, even in developed countries, for several reasons (283). Barriers to optimal hypertension management include the healthcare service, the healthcare provider and the patient indicating that a multilevel approach is required to improve outcome (168, 301). The WHO has identified poor adherence as the most important cause of uncontrolled hypertension worldwide, with an estimated 50–70% of patients not taking their antihypertensive drugs as prescribed (289).

Considering the asymptomatic and chronic nature of the condition, hypertension poses the challenge of daily vigilance and continuing commitment to treatment (302, 303). This can understandably be difficult.

Lifestyle modification strategies

Along with pharmacological interventions, and irrespective of the level of hypertension, BP reduction by non-pharmacological means is equally important and always preferable (289). Interventions that have proven effective include weight loss, modification of eating habits with increased fruit and vegetable and decreased saturated and total fat intake, reductions in salt and alcohol consumption, and increases in physical activity (11, 168, 281, 289, 294, 304, 305). However, adherence to such lifestyle interventions is known to be extremely poor (289).

Lifestyle modifications are likely to be more sustainable when instituted in supportive environments (306). Therefore, population-based approaches targeting diet and lifestyle, for example, a reduction in salt intake, a key contributor to raised BP, can achieve a downward shift in the distribution of BP in the whole population (307). Currently, unfavourably high salt consumption is prevalent, with the average daily salt intake of 9-12 gram/day approximately twice the recommended level of <5-6 grams daily (216, 285, 308-310). Beaglehole and colleagues recommend reducing salt consumption as one of five immediate priority interventions that are considered highly cost-effective in low-resourced settings (80). Indeed, the available data suggest that reducing salt consumption is more or at least just as cost-effective as tobacco control in terms of reducing CVD per se (55, 285).

Numerous salt-reducing initiatives at the population level have proven to be effective and to potentially reduce BP and CVD risk (37, 94, 216, 307-309, 311). The evidence suggests that modest, long-term reductions in population salt intake would immediately reduce mortality from stroke and IHD by approximately 14% and 9%, respectively, in hypertensive individuals, and by about 6% and 4% in those with normal BP (94). Nonetheless, public health efforts to reduce salt intake remain limited to a few countries (19, 308, 309).

Policymakers need to introduce legislative measures that create a congenial environment and facilitate the adoption of healthy lifestyles (305, 306). Such population-based strategies that promote healthier lifestyle choices will contribute to lower BP levels in the whole population as well as reduce the hypertension prevalence (305). In economically developing regions where healthcare resources are particularly scarce, investment in prevention strategies are likely to yield the greatest benefit (11) and should be a public health priority in these countries (36). Moreover, many lifestyle modifications also have a positive effect on other cardiovascular risk factors, in particular obesity and diabetes (11).

Conclusion

Hypertension is thus a major public health challenge and an acknowledgement of the global nature of the problem is needed to effect optimal management via pharmacological and non-pharmacological interventions (281, 294). Currently, this silent epidemic is not matched with comparable levels of awareness among policy makers or the general population or with optimal interventions by healthcare systems.

1.3. METABOLIC SYNDROME

1.3.1. INTRODUCTION

The associations among diabetes, hypertension and dyslipidaemia have been known for many decades but the seminal paper by Reaven in 1988 that ascribed much of the aetiology of these risk factors to insulin resistance ushered in a new era of awareness and research focus with a better appreciation of the impact of obesity on CVD (232, 312). The concept that these metabolic abnormalities cluster commonly resulted in the emergence of the term 'metabolic syndrome' (232) and refers to a cluster of risk factors for CVD and diabetes, which occur together more often than by chance alone (313-315). The MS is characterised by variable combination of central obesity and alterations in BP, glucose and lipid metabolisms (168, 313).

1.3.2. PATHOGENESIS

The pathogenesis of the MS and each of its components is complex and not well understood; nonetheless central obesity and insulin resistance are considered the primary underlying risk factors (315-318). Genetics, physical inactivity, ageing, a proinflammatory state and hormonal changes are also proposed to have a causal effect, but the role of these may vary depending on ethnic group (315, 316).

1.3.3. CONSEQUENCES

The MS is associated with an increased added risk of diabetes, CVD morbidity and mortality, and total mortality compared to those without the syndrome (168, 249, 304, 314-321). The risk of CVD is approximately doubled (315, 322) while the risk of developing diabetes in those without diabetes is about 3-6-fold higher (168, 315, 316, 319, 323, 324) and the risk of new onset hypertension is also greater in those with the MS (168). Individuals with both diabetes and the MS are at an even greater risk for CVD with the risk greater than the sum of the measured risk factors (314-316, 318, 325). The MS is frequently associated with subclinical organ damage such as microalbuminuria and reduced glomerular filtration rate, arterial stiffening, left

ventricular hypertrophy, diastolic dysfunction and atrial enlargement (168). The risk for CVD and diabetes is greater in the presence of more components of the MS (315, 317, 319) and worsened by concomitant elevations in LDL-C (319).

1.3.4. RELEVANCE

While accepted by many, the clinical utility of the MS has been questioned by some (232, 324). The claim made is that aggregating the metabolic risk factors adds little to clinical management. Even so, most experts agree that the clustering of metabolic risk factors is a real and relatively common phenomenon (324). Of relevance is that a combination of even modest elevations in BP, plasma lipids, and blood glucose confer substantial excess risk for diabetes, CVD and death, and a diagnosis of MS warns of extremely adverse metabolic states (326, 327). Diagnosing the MS extends the concept of cardiovascular risk; the importance of the syndrome is the identification of individuals at high risk of developing diabetes, hypertension and premature CVD (289, 319, 321).

The increased risk associated with the presence of the MS makes it a valuable tool to alert healthcare providers that early diagnosis is essential and that comprehensive care with optimal control of multiple CVD risk factors is required (304, 328). The presence of the MS also underpins the need to emphasise earlier intervention with lifestyle therapies to reduce risk factors and disease incidence (289, 321, 324, 328). Although the MS is not a robust risk assessment tool for estimating absolute 10-year risk, its presence indicates the need for more extensive short-term risk assessment (316) and warrants aggressive intervention to reduce levels of individual risk factors (326, 327). The MS represents that part of global risk which is attributable to underlying metabolic causes such as obesity and abnormal body fat distribution (324) and may be useful in predicting risk among individuals classified as low or intermediate risk by the Framingham or other risk scores (329).

1.3.5. DEFINITION

Over the past few decades there have been several definitions of the MS using various diagnostic criteria; the most commonly cited include those proposed initially by the WHO (1998, 1999), European Group for the Study of Insulin Resistance (1999) and the American Association of Clinical Endocrinologists (AACE) (2000), then by the National Cholesterol Education Program Third Adult Treatment Panel (ATPIII) (2001,2004) and more recently, the International Diabetes Federation (IDF) (2005) (304, 323, 330). Notwithstanding the various definitions, central obesity, dyslipidaemia, hyperglycaemia and elevated BP are the key characteristics (315,

317, 320).The main difference between the two major sets of criteria that were commonly used, i.e. the ATPIII and IDF criteria, was that central obesity, as measured by WC, was a prerequisite in the IDF definition with WC cut-points being ethnic specific and lower than in the ATPIII definition (313, 315, 316, 318, 331, 332). In 2009, in an attempt to unify the criteria, an additional definition was proposed as a joint interim statement (JIS) by several organisations (313). For a diagnosis of MS, three out of five abnormal findings were required with WC not an obligatory component. Notably, the WC criteria for Africans is the same as Caucasians but likely require modification as shown by Motala and colleagues (331).

1.3.6. PREVALENCE

The numerous definitions of the MS have resulted in widely differing prevalence estimates depending on the definition used (304, 331). Nonetheless, the MS is highly prevalent worldwide and presents a serious public health challenge (312, 324, 333). In most countries, approximately 20-30% of adults can be characterised as having the MS (324). Current lifestyle trends and increasing obesity are contributing to the global rise in the MS (324, 331, 333). The likelihood of a further increase in the MS can be expected on account of the predicted higher obesity prevalence in the future (324, 326).

1.3.7. MANAGEMENT

The objective of treatment in the MS is to reduce the high risk of a cardiovascular event and to prevent the much greater likelihood of developing diabetes or hypertension (334). Concurrent with pharmacological management of the individual, MS components of hyperglycaemia, raised BP and dyslipidaemia, therapeutic lifestyle changes, especially weight reduction, increased physical activity and an anti-atherogenic diet are the cornerstone of management in the MS to improve the metabolic profile (168, 249, 304, 313, 316, 317, 319, 322, 326, 333, 335). Additionally, smoking cessation is mandatory (316, 319).

Important to note is a wide spectrum of total cardiovascular risk that is present in individuals with the MS, which compels careful assessment (304), and the use of drug therapy guided by the level of risk (249). After an initial risk assessment with the Framingham or other risk algorithms, utilising novel risk markers and screening for subclinical atherosclerosis may improve the risk stratification and identify those at greatest risk for future CVD events and mortality (304).

1.4. TOTAL CARDIOVASCULAR DISEASE RISK ASSESSMENT

1.4.1. INTRODUCTION

Treatment of CVD risk factors have traditionally been based on the presence or absence of a single cardiovascular risk factor, such as hypertension, hyperlipidaemia or diabetes without considering the continuous relationship between BP, blood glucose, blood cholesterol and cardiovascular risk (5, 43, 336). While this approach appears straightforward, it may result in committing some individuals with only a small cardiovascular risk to years of unnecessary treatment or, conversely, neglecting to treat individuals with an overall higher risk (10, 43, 336). This is because a combination of several slightly elevated risk factors may result in a much higher total risk than a single, more strikingly raised factor (30, 34, 168).

The goal of primary prevention is the avoidance of all atherosclerotic CVD, which encompasses IHD, stroke and PVD (30, 337). Since all atherosclerotic diseases of the vascular tree share the same risk factors, the most appropriate outcome for risk-estimation systems is considered to be total CVD where combined risk factor effects are evaluated (30). Consequently, clinical guideline recommendations on assessing risk and preventing CVD have undergone a substantial change over the past two decades with the recent focus on total cardiovascular risk a cost-effective strategy to assess individual risk (9, 34). Risk prediction has now assumed a key role in the field of CVD prevention (338), with primary preventive treatment targeted at asymptomatic individuals with an elevated absolute 10-year CVD risk (339). CVD management has shifted from an era of single risk factor intervention to multiple risk factor approach in high-risk individuals (182).

1.4.2. RELEVANCE

Moreover, single risk factor approaches are neither cost-effective nor affordable for poorer individuals and in developing regions with limited resources (10, 43). Given the enormous burden of CVD and the high costs of management, it is therefore essential to prioritise cost-effective approaches that target high-risk individuals (43). The use of the multifactorial cardiovascular risk-assessment approach to identify high-risk individuals who need interventions is being widely advocated with the initiation of therapy based on the predicted absolute cardiovascular risk of the individual (336). Total cardiovascular risk assessment is the most cost-effective approach with targeting treatments at high-risk individuals leading to the greatest absolute reduction in disease (5, 36). The total CVD risk assessment approach is particularly recommended as a cost-effective strategy in low-income regions with

scarce resources. A higher cut-point of >30% risk of having a CVD event in the next 10 years may be used as the guideline for treatment compared with the standard >20% risk for a cardiovascular event that is recommended for less resource constrained settings (44).

1.4.3. RISK-ESTIMATION SYSTEMS

That CVD risk factors cluster and interact multiplicatively to promote vascular risk led to the development of multivariable risk prediction algorithms (337). Several computerised methods for estimating total cardiovascular risk have been developed (168). The first risk-estimation system was developed by the Framingham Heart Study researchers in the US and is the best known internationally and the most frequently used (30, 34). This is also the score that has been best validated across different populations, modified for use in several countries and recommended by numerous international guideline committees for CVD prevention. European investigators, in addition, have developed various risk prediction scores and these numerous risk-estimation systems have been the foundation for guidelines and prevention strategies in developed countries (34).

Most scoring systems require expensive laboratory tests; however, recent advances include the development of models that used simple office-based predictors easily obtained in primary care and did not require laboratory testing. BMI replaced TC and HDL-C in these models. The unchanged variables included age, systolic BP, antihypertensive medication use, current smoking and diabetes status (337). This is highly relevant in the developing world with its increasing burden of CVD and the need for cost-effective use of limited resources. The use of non-laboratory-based total CVD risk assessment has the potential to improve worldwide utility of the risk scores and enhance targeted CVD prevention efforts, particularly in low-resource settings where widespread laboratory availability is problematic (30, 34).

1.4.4. LIMITATIONS

Despite the utility of the risk assessment tools, all total cardiovascular risk models have limitations and these need to be noted (168, 329). These models do not incorporate all CVD risk factors, particularly physical activity and stress. They also do not consider the duration of exposure to a risk factor nor do they include relevant family history (168, 340).

One of the most relevant criticisms is that the risk estimation models strongly favour treatment of elderly versus young individuals on account of age being a powerful determinant of short-term risk, i.e. the 10-year absolute risk estimate (168, 289). In

younger individuals treatment decisions would be better guided by quantification of the relative risk, i.e. the increase in risk in relation to average risk in the population (168). The absence of adequate treatment in younger individuals may lead to the earlier development of organ damage or to partly irreversible high risk conditions in later years.

In women, while high scores identify those at high risk, lower scores do not sufficiently ensure that individual women are at low risk. It is difficult for women <75 years, even with several markedly elevated risk factors, to be classified as high risk. For cardiovascular risk management in women, factors beyond the risk scores including medical and lifestyle history, family history of CVD, markers of preclinical disease, and other conditions need to be considered when determining the intensity of preventive therapy. Recommendations also include a lower cut-point for defining high risk in women as ≥10% 10-year risk for all CVD compared to the traditionally ≥20% 10-year risk estimate utilised (340).

The international applicability of these guidelines is a critical issue, because these risk assessment tools are applicable primarily to populations of European origin in developed regions. Additionally, important differences prevail in the incidence of coronary and stroke events between developed and developing regions. Therefore, further assessments are necessary to determine the optimal methods for identifying high-risk individuals in developing regions, where 80% of the global CVD burden occurs (34). The development of accurate ethnic- and region-specific risk tools for developing regions thus need to be prioritised (36).

1.4.5. CONCLUSION

The strategy for CVD prevention now advocates multivariable assessment rather than management of individual risk factors with the adoption of a total cardiovascular risk approach as the strategy to inform decisions for initiating drug treatment (37). Appropriate action according to the level of risk must guide treatment (337, 341). The weaknesses of the CVD risk prediction models should not defer the control of the major risk factors through this cost-effective approach (10, 339). Total CVD risk assessment is likely to remain an important therapeutic component for individuals and populations (342).

1.5. OVERVIEW OF CARDIOVASCULAR DISEASE IN SUB-SAHARAN AFRICA

Countries in Africa are among the poorest in the world with per capita GDP as low as US$200 (343). Expenditure by governments on health is low with most spending <2% on healthcare services (343) or about US$10 per person annually (54). The limited resources available are allocated to combat communicable diseases such as HIV/AIDS, TB and malaria which have an impact on economic development that are much more noticeable than NCDs (343). Consequently, PHC services often lack the most basic equipment to manage NCDs, such as a calibrated and functioning sphygmomanometer or a glucometer (37).

Although SSA is the only world region where infectious diseases (798 per 100 000) outnumber NCDs (779 000 per 100 000) as the predominant cause of mortality in 2008 according to the WHO (17), it is a misperception that they are not important contributors to the burden of disease in the region (344). The proportion of deaths attributable to NCDs is below that of developed nations because of the very high mortality from infectious diseases (17, 345). SSA has the unenviable challenge of dealing with a double burden of disease: rapidly rising CVDs and other NCDs which occur alongside continuing high rates of infectious diseases in SSA (7, 344, 346, 347). In 2008, the age-standardised mortality among 30-70-year-old adults for CVD and diabetes was 382 per 100 000 in Africa, the highest in the world and more than double that of the lowest WHO region (Region of the Americas: 169 per 100 000) (17). Even though HIV/AIDS is the main overall cause of death in this region, CVD is the second-leading contributor and the major cause in those >30 years old (14). Furthermore, CVD is anticipated to soon overtake communicable and poverty-related diseases as the predominant cause of morbidity and mortality in the region (348) and the greatest proportionate increase in NCDs over the next 10 years globally is predicted to occur in Africa (81).

Along with the poor nations of Asia and Latin America, Africa bears a significant proportion of the global burden of CVD and other NCDs (344). The WHO has projected that the largest increase in mortality rates (27%) from CVD and other NCDs will be in Africa with 28 million deaths over the next 10 years. Most markedly, mortality from diabetes is projected to increase by 42% (32). Although these figures highlight the impending dire consequences of NCDs, these are highly avoidable. The WHO emphasises that if measures were introduced to curb the CVD and other NCD epidemic with the aim of a 2% reduction in NCD mortality over and above the current trends, these would prevent 3 million deaths over the next 10 years with almost 2

million of these averted in individuals younger than 70 years old (32). However, without concerted measures this is unlikely to happen; the high burden of disease in SSA is compounded by the weakest health systems and workforces as well as the lowest per capita income globally (7, 58, 349, 350).

Similar to other developing regions of the world, SSA's NCD burden is attributable to numerous factors including increasing life expectancy, changing lifestyle behaviours, poverty, urbanisation and globalisation (7, 32, 348, 351). SSA, in particular, is currently experiencing one of the most rapid increases in urbanisation and changes in lifestyle behaviours (348). With the urban population in SSA currently growing at an average annual rate of 4.5% (346, 352), CVD and its risk factors have the potential to rise exponentially. Exacerbating the CVD and other NCD burden is a lack of comprehensive government programmes for the prevention of these conditions (7, 344, 348).

Regarding the prevalence of the individual CVD risk factors in SSA countries, these will be discussed in detail in Chapter Four. Suffice to say, the rates of these risk factors are on the rise as reported in several SSA countries including Tanzania (diabetes, hypertension, obesity and hypercholesterolaemia) (345, 351, 353, 354), Cameroon (diabetes, hypertension, obesity and physical inactivity) (351, 355), Nigeria (diabetes and hypertension) (356), and South Africa (diabetes and hypertension) (345). Furthermore, many CVD risk factors are highly prevalent in SSA (351) as demonstrated in recent reports from Kenya (357), Tanzania (358), Nigeria (356, 359) and South Africa (351, 360, 361).

There is considerable variance in the prevalence of the CVD risk factors among countries in SSA as well as by urban-rural location and sub-populations which is likely a reflection of the varying rapidity at which communities are undergoing transition. For example, population-based studies demonstrate a wide range in the prevalence of obesity in SSA from 0.4% reported in rural Tanzania to 34% in black South African women (351). The evidence indicates that overweight/obesity is rising in Africa especially among women with increases in the intake of fat and sugar as well as sedentary lifestyles linked to the development of the epidemic (7, 240). Processed foods have become easily available in SSA as a result of foreign direct investment from transnational food companies. In addition to weight gain, the adoption of physically inactive lifestyles in SSA is high (362) and increasing, and can be ascribed to rapid urbanisation and socio-economic transitions (240, 363). The estimated doubling of the urban population in SSA to 487 million by 2020 (352) is likely to witness a marked increase in the rates of these CVD risk factors.

Besides the impact of an obesogenic environment, a complex set of cultural, psychosocial and biological factors influence the maintenance of a healthy weight (197, 210, 364). Particularly in SSA, where access to food remains a daily challenge, overweight/obesity is perceived as a sign of affluence and good living, and is a deeply rooted status symbol conferring respect and influence (221, 243, 248). Another important influence on the positive attitude to overweight/obesity is the association of thinness with HIV/AIDS, with overweight/obesity perceived as an absence of the disease and with being healthy (205, 221)

Although tobacco use is lower in SSA compared to other world regions (153, 156) with a prevalence in men of ≤10% in countries like Ethiopia, Nigeria and DRC (38), tobacco-related conditions are emerging as an increasingly important public health problem in the region (7). Among developing nations, the greatest rise in the rate of tobacco use is occurring in Africa (7); the prevalence has increased by over 40% over the last few decades (365). However, the prevalence of smoking varies across countries; population-based studies in SSA reported rates in the last decade ranging from 3% and 6% in urban Ghanaian men and women, respectively, to 57% in South Africa (351). The rising tobacco use can be attributed to urbanisation, acculturation and globalisation together with aggressive marketing by tobacco conglomerates (7, 153, 365).

These influences are also likely to have a similar impact on the lower rates of alcohol consumption in SSA. Currently, the prevalence of non-drinkers is higher in SSA compared to Europe (men: 32% vs. 8%, women: 45% vs. 14%, respectively). Nevertheless, 19% of SSA men could be classified as binge drinkers (366). Some CVD risk factors display gender disparities in SSA with smoking (344, 351, 354, 367) and alcohol consumption (351, 354, 367) much more common in men than women while the opposite holds true for overweight/obesity (344, 347-349, 351, 354, 356, 362, 367, 368), and lower activity levels (354, 362).

Diabetes, once rare in SSA, is now responsible for a considerable amount of morbidity, mainly attributable to micro-vascular complications, and mortality, primarily due to infection and acute metabolic complications, in the region (240, 243, 248, 250, 352, 369, 370). Even in this region with the lowest diabetes prevalence (253), and one of the lowest mean fasting glucose levels in 2008 (241), diabetes was not only no longer rare but had risen markedly over the last few decades. The IDF Diabetes Atlas reported that in 2011, the diabetes and IGT rates in SSA were 4.5% and 9.7%, respectively, and expected to rise to 4.9% and 10.7%, respectively, by 2030 (253). Of note is that almost half of the diabetic individuals in SSA were between 40 and 59

years old and over a quarter were between 20 and 39 years old. Considering that diabetes affects mainly the economically active population in SSA, it is disconcerting that the region has the highest proportion of undiagnosed diabetes worldwide; 78% compared to the global prevalence of 50% (253), which is nonetheless also unacceptably high. The number of individuals with diabetes in SSA is projected to increase by 90% from 14.7 million in 2011 to 28.0 million in 2030; markedly higher than the 51% rise predicted globally. This highlights the rapid epidemiologic transition occurring in SSA with diabetes emerging as a significant NCD in the region (243, 371). Factors underwriting the rise in diabetes here include a change in demography with an ageing population, urbanisation, and the increasing prevalence of obesity and physical inactivity (249-251, 369, 372).

Although historically, African populations have tended to have relatively favourable lipid profiles, with lower TC, higher HDL-C and lower triglyceride levels (54, 344, 365, 366), the data available indicate that dyslipidaemia is no longer rare and is emerging as an important CVD risk factor in SSA (347, 348, 356). Recently, for example MI, the main consequence of dyslipidaemia, was found to be the leading cause of CVD mortality in Kenya, contributing nearly 20% of the 134 autopsy cases of cardiovascular related deaths examined (373). These findings were in contrast to previous reports from SSA, including Kenya, where IHD was once considered to be rare (365, 373, 374).

Despite the high burden imposed by HIV/AIDS, TB and malaria (375), hypertension has emerged as a significant medical and public health problem in SSA (348, 366). In contrast to the other CVD risk factors, the highest prevalence of hypertension globally was in SSA (46%) (156); a far cry from the early 20th century when hypertension was rare in the region (54, 365). Furthermore, unlike high-income countries where mean BP has decreased over the last three decades, in Africa this has remained stable or increased in most countries (17) with hypertension emerging as the most prevalent CVD risk factor in the latter half of the 20th century (365). Hypertension constitutes the foundation for the CVD epidemic in the region (298, 306, 376) and is regarded as one of the continent's greatest health challenges after HIV/AIDS (377). Remains the primary cause of significant financial burden, which includes the cost of caring for stroke, IHD and congestive cardiac failure related to hypertensive heart disease and systolic dysfunction (45). Notably, mortality attributable to hypertension in under 60-year-old individuals was 25% in SSA compared to only 7% in high-income countries (85). Notwithstanding, the high and growing prevalence of hypertension as well as increasing CVD morbidity and

mortality, hypertension awareness, treatment, and control are unacceptably low in the region (300, 378).

Worryingly, two of the most common infectious diseases seen in Africa, TB and HIV/AIDS, not only co-exist but interact with CVDs, with the one exacerbating the other (344, 346, 352, 375). Diabetes increases the risk of developing TB three-fold (352, 375) and it seems that TB may predispose to diabetes (352). The co-morbid presentation of diabetes and TB is associated with poorer outcomes (344, 352). Antiretroviral therapy (ART) for HIV/AIDS is associated with an increased risk of diabetes and the MS (350, 375) as well as worsening lipid profiles (344, 346, 352, 375). HIV has also been linked with an increased risk of developing CVD (352).

The progress made in combating infectious disease is being undermined by CVD and other NCDs (379). Therefore, despite the challenges faced by healthcare systems in SSA it is imperative that NCDs be prioritised with greater attention given to primary prevention of these conditions. If left unattended, CVDs and their risk factors will impose an increasingly significant socio-economic burden including a decreased quality and length of life across the continent; the price of inaction will be devastating (7).

1.6. OVERVIEW OF CARDIOVASCULAR DISEASE IN SOUTH AFRICA

According to Census 2011, the Republic of South Africa, a country occupying the southernmost tip of Africa, has a population of almost 52 million, most of whom are black Africans (79%) (380). This country is in the midst of a health transition characterised by a high burden communicable diseases, in particular HIV/AIDS and TB, rising NCDs including CVDs, a heavy burden of perinatal and maternal disorders, and injury and violence (381, 382). Consequently, until recently, inadequate attention had been paid to the rising burden of NCDs despite the high mortality attributable to these conditions: 40% in women and 36% in men (381). CVD and the related risk factors are highly prevalent and significant contributors to morbidity and mortality in the general South African population. At 16.6%, CVD was the second leading cause of death after HIV/AIDS with ischaemic heart disease, stroke, hypertensive heart disease and diabetes among the principal ten causes of death in 2000 (381). In addition, the years of life lost for CVD and other NCDs (25%) approached that for infectious diseases (28%) (25).

The high prevalence of many CVD risk factors in the country were reported in the South African Demographic and Health Surveys (SADHS) conducted in 1998 and 2003. These included daily smoking (men: 32-37%, women: 9%), problematic alcohol

consumption (men: 21%, women: 7%), physical inactivity (men: 48%, women: 63%), overweight/obesity (men: 29-30%, women: 55-56%) and hypertension (men: 23%, women: 25%) in ≥15-year-old South Africans (360, 361).

Diabetes and dyslipidaemia were not ascertained in these national studies, but smaller regional epidemiological studies conducted approximately 15-20 years ago reported moderate prevalence of diabetes (383-385) and favourable lipid profiles in black populations (385-387). The most recent diabetes prevalence data for the black population in Cape Town, obtained in 1990 using the 1985 WHO criteria, reported a crude prevalence of 6.3% (age-standardised prevalence 8.0%) in >30-year-old men and women (383); higher than that found in other SSA countries and in black populations from other urban (5.3-6.0%) and rural (3.9-4.8%) centres in South Africa (384, 385, 388). The national prevalence of hypercholesterolaemia (TC >5 mmol/l) in ≥30-year-old black African men and women, estimated from a few regional studies, was 19.7% and 29.2%, respectively (389). Further details on the prevalence of CVD risk factors, as pertaining to this thesis, will be discussed in detail in Chapter Four.

The patterns and trends described above strongly suggest that the CVD risk profile may be deteriorating in South Africa and that the black population, in particular, because of rapid urbanisation, might be experiencing these trends most forcefully. This highlights the need for current CVD risk factor studies in the black South African population to identify the trends and patterns that need to be addressed in effective NCD policies for the country.

CHAPTER TWO: STUDY RATIONALE, AIMS, HYPOTHESES AND OBJECTIVES

2.1. STUDY RATIONALE

In order to appropriately allocate resources and develop cost-effective therapeutic strategies and programmes, the prevalence, distribution and trends of CVD risk factors need to be established. However, in South Africa, there is a dearth of recent national and regional surveillance data; for example, the prevalence of diabetes, dyslipidaemia, hypertension and other CVD risk factors have not been ascertained in approximately 1-2 decades in the urban black population of Cape Town. Using these historical prevalence data for current and future health service planning can result in inappropriate resource allocation for CVD management and a lack of understanding of the size of the problem in South Africa if the risk factor prevalence has changed. The suggestions that the prevalence of CVD risk factors are rising in SSA as described in Chapter One, the high rates of obesity, physical inactivity and urbanisation, and the changes in demography with ageing populations in South Africa (250, 390), provide reasonable evidence that the prevalence of CVD risk factors have also increased in the local urban black population.

Data on the potential increased prevalence of CVD risk factors would have important implications for the provision of healthcare and for strategies to control the rising risk factors levels (245). Such data would be fundamental to highlight the problem and advocate for action (382); more resources may be allocated for CVD management as well as efforts to promote screening and prevention may be stimulated. This information, unique to the population being targeted, would assist in appropriate health service planning and be invaluable for the implementation of effective, population-specific, and gender- and age-orientated CVD risk prevention and management programmes.

Additionally, to target all potentially modifiable determinants of CVD risk factors, it is important to identify all these factors. One of the potentially modifiable risk factors includes psychosocial stress, which has been shown to be related to CVD and some of its risk factors (90, 92, 93). Notably, however, there is variance in the association of psychosocial stress with diabetes (115, 116, 118, 119) and hypertension (126, 127). There is thus a need to clearly identify whether a relationship exists between psychosocial stress and either diabetes or hypertension. Equally important, is to determine screening tools that can identify individuals with psychosocial stress who are at risk for diabetes, hypertension and the other CVD risk factors.

2.2. AIMS

To determine the prevalence of CVD risk factors in 2008/09, the changes in these between 1990 and 2008/09, and the association between psychosocial stress and the other CVD risk factors in a random sample of the 25-74-year-old urban black population of Cape Town.

2.3. HYPOTHESES

1. The prevalence of diabetes, hypertension and other CVD risk factors has increased in the urban black population of Cape Town between 1990 and 2008/09.
2. There is an association between the presence of psychosocial stress and having diabetes and/or hypertension.

2.4. OBJECTIVES

The objectives of the study were to determine:

1. The prevalence of diabetes by means of a standardised oral glucose tolerance test (OGTT) and to assess the association with potential predisposing factors.
2. The prevalence of dyslipidaemia by means of standard biochemical procedures measuring TC, HDL-C and triglycerides, and calculating LDL-C levels in fasting serum samples, and to assess the association with potential predisposing factors.
3. The prevalence of hypertension by measuring the BP electronically using standardised methodology and to assess the association with potential predisposing factors.
4. The anthropometric profile by measuring height, weight, waist and hip circumference and calculation of the BMI, raised WC and raised WHR and to assess the associations with potential predisposing and socio-demographic factors.
5. The prevalence of smoking, problematic alcohol use, degree of urbanisation, physical inactivity and high fat intake using standardised questionnaires.
6. The association between the presence of psychosocial stress and diabetes and hypertension using three validated measurements: SOC, LOC and life events questionnaires.
7. The pattern of healthcare and health services utilisation.

8. The prevalence of the MS by the harmonised JIS criteria and to assess the association with the socio-demographic factors.
9. The total cardiovascular risk by the Framingham risk equations using laboratory based lipid measurements of TC and HDL-C, as well as non-laboratory based measures of BMI replacing TC and HDL-C and to assess the associations with the socio-demographic factors.
10. And compare the CVD risk factor patterns found in 2008/09 with those found in 1990 in the same townships of Cape Town.

CHAPTER THREE: METHODOLOGY

3.1. STUDY DESIGN AND SAMPLING PROCEDURE

The city of Cape Town, located on the southwest tip of South Africa, has a population of about 3.3 million inhabitants. During apartheid, people were forced to reside in racially segregated areas with black Africans earmarked to live in townships on the outer limits of the city. These include, among other places, Langa, the oldest township in the country, and Khayelitsha, a large sprawling township which has drawn residents from the former homelands that were created during apartheid (391).

People living in these two townships, together with the residents of Guguletu, Crossroads and Nyanga, over 90% of whom are black Africans, comprised the current study population. These areas were selected for ease of comparison with previous cross-sectional studies (383, 392).

A random sample of 25-74-year-old men and women was obtained for this cross-sectional study. Based on the 2001 census, the sample size in each area was proportionate to its population density. On account of its rapid expansion, Khayelitsha comprised 60% of the current study sample compared to the 1990 study on which the sampling methodology was based and where it formed 30% of the sample size. A sample size of 1260 was based on an estimated diabetes prevalence of 8% with a two-side 95% confidence interval (CI) extending 0.015 from the observed prevalence.

Using aerial maps from 2007, a 3-stage cluster sampling stratified by area and housing type was undertaken to select the sample. Each map was divided into a number of sectors (Figure 3.1) and the houses, hostels and flats, and informal dwellings within each sector were demarcated into blocks (Figure 3.2 and Appendix A). The blocks were numbered and then selected using simple random sampling. Units were thereafter systematically selected within these blocks (Figure 3.3 and Appendix B) with the sampling proportionate to the estimated number of people living in houses and buildings.

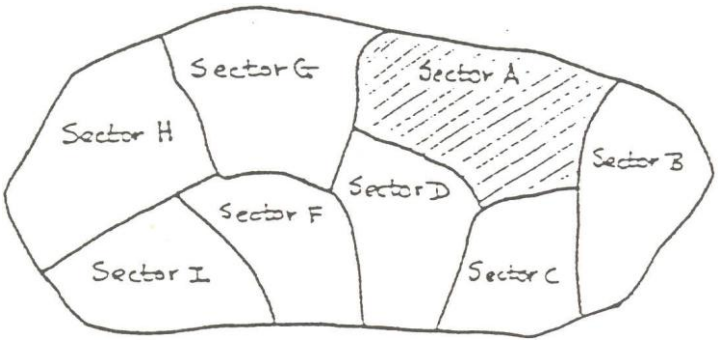


Figure 3.1: Illustration of an aerial map divided into sectors

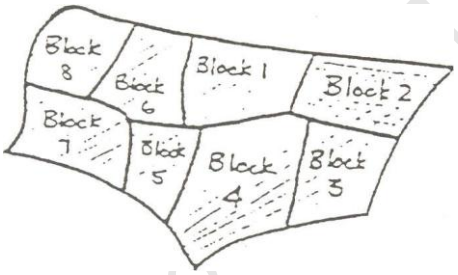


Figure 3.2: Illustration of sector A divided into blocks

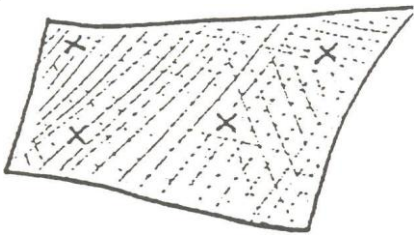


Figure 3.3: Illustration of block 2 with the units selected

If more than one dwelling/structure was found at the selected address for the houses, these were drawn on the back of the household form by the fieldworker and numbered from the bottom left hand corner in a clockwise fashion (Figure 3.4). Using random tables, a number was selected and the dwelling corresponding to that number was approached.

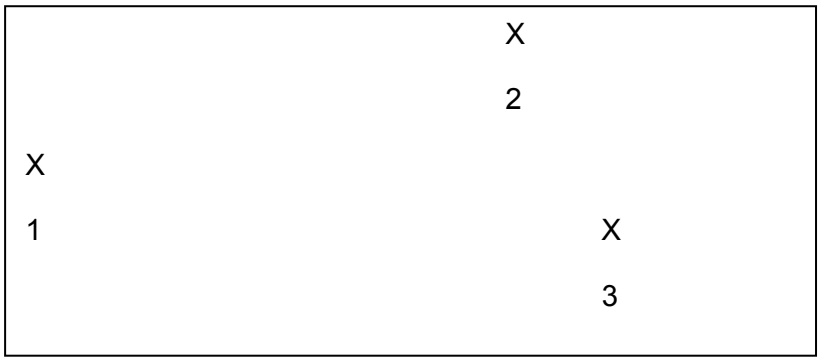


Figure 3.4: Illustration of multiple dwelling structures at a selected address

Specific flat and hostel units were selected by fieldworkers on site using random tables. For a multi-storeyed building, each level was assigned a number and selected using random tables. Thereafter, the units on the selected level were assigned numbers and again selected using random tables.

Blocks of informal dwellings were selected using simple random sampling, as done for the houses and buildings. Thereafter, the fieldworkers randomly selected the required number of units in each selected block of informal dwellings ensuring that units close to the centre as well as the periphery of the arbitrarily demarcated blocks were included.

If more than one household was living in a dwelling, the fieldworker assigned a number to each household. Thereafter, random tables were used to select a number and the household corresponding to that number was approached. A household was defined as a group of people who cooked and ate together as well as slept under the same roof.

3.2. SELECTION OF PARTICIPANTS

Individuals from households were selected on a quota for age and gender categorisation; the rationale being that the risk factors and disease prevalence differed among age groups and by gender. There were a minimum of 100 participants in each of the 10 strata, stratified for age (25-34, 35-44, 45-54, 55-64 and 65-74) and sex (men and women). Sampling across the age groups was disproportionate to ensure that at least 50 men and women, aged 65-74 years, were included in the oldest age groups within each area.

The quota corresponded with the required sample from each township. The quota list for Langa is used to explain the process in detail (Table 3.1).

Table 3.1: Quota list for Langa

	Houses		Houses		Houses		Hostels		Hostels		Shacks	
Age	Strata 1		Strata 2		Strata 3		Strata 4		Strata 5		Strata 6	
	M	F	M	F	M	F	M	F	M	F	M	F
25-34	5	5	10	10	10	10	7	7	17	18	24	25
35-54	4	4	8	8	8	8	6	7	14	15	21	22
55-64	2	2	3	3	3	3	2	2	5	5	7	7
65-75	1	1	3	3	3	3	2	2	5	5	7	7
Total	12	12	24	24	24	24	17	18	41	43	59	61
Block x Units	6 x 4		12 x 4		12 x 4		7 x 5		14 x 6		8 x 15	
Blocks Selected	28,36, 73,67 207 61		198,197, 196,136, 140,146, 149,152, 157,171, 145		109, 192 187, 127 125,102 97,133 90,21, 27,113		58,48 46,41 83,79 208		118,115 200,194 199,204 202,85 19,211 86,105, 193,94		1,5,8, 14,17 12,195 10	

The Langa map was divided into three sectors, namely, A, B and C and strata 1, 2 and 3 corresponded to the houses in sectors A, B and C, respectively. The hostels in sector A were labelled strata 4 and those in sectors B and C combined were labelled strata 5. Informal dwellings or shacks were only found in sectors A and B and these were combined into strata 6.

The rows and columns illustrated the quotas required by age and gender from the housing type within each sector. For example, from strata 1, a total of 12 men and 12 women were required with the numbers per age category shown in the table. These 24 men and women were drawn from the six blocks listed in Table 3.1 which each had four units systematically selected on the map.

Exclusions included those who were unable to give consent, on TB treatment, on ART, cancer patients having received treatment within the last year, bedridden, pregnant or lactating, or resident in Cape Town for less than 3 months. Replacements were allowed when confronted with individuals who met the exclusion criteria above, those who refused, or the randomly selected participant of the randomly selected household could not be contacted on the third attempt. Replacements were initially selected from the same household; failing that, the fieldworker approached the household immediately to the left for a replacement participant. Substitutions and refusals were recorded.

The fieldworker recorded the details (name, sex, age, date of birth) of all household members on the household form (Appendix C) and selected an appropriate participant according to the quota sheet. If more than one person was eligible to participate, the person whose birthday was closest to the current date was selected. One person per household was selected except if there was an eligible older person aged 65-74 years who filled the quota requirement; two individuals were then selected from that household to enable the inclusion of older people, proportionately fewer of whom lived in these townships.

The selected individual was screened (Appendix D) and an appointment date given if s/he agreed to participate. The participant was asked to fast overnight for at least 10 hours, not to eat breakfast on the morning of their appointment and to carry his/her prescribed chronic medication. Together with a verbal explanation, the potential participant received a detailed information sheet describing the study and the overnight fasting procedure, and an appointment slip.

3.3. DATA COLLECTION

On the day of the examination, participants were collected from their homes by the study driver and brought to a central venue for the data collection. On arrival at the examination venue, fasting blood specimens were drawn followed by the administration of the OGTT, the study questionnaire (Appendix E) and clinical assessments, with the 2-hour blood sample drawn at the requisite time. Once the interviews were completed, participants were fed a meal and returned to their homes.

The data collection was done by administered questionnaires, clinical measurements and biochemical assessments. The interviewer-administered questionnaires had been translated into Xhosa, the primary language of the participants, and back translated into English. The trained interviewers entered the data on standardised pre-coded forms which, to maximise quality control, were checked regularly for completeness, accuracy and consistency and referred back to the interviewers if required.

The questionnaire included socio-demographic and migratory information, self-reported medical and family history, physical activity patterns (GPAQ) (393), psychosocial stress, tobacco (WHO STEP-wise surveillance questionnaire) (394) and alcohol use. Problematic alcohol use was assessed using the CAGE set of four questions (186). Self-reported food intake during the preceding 24 hours was determined by a single 24-hour dietary recall using semi-structured interviews. Household assets defining wealth are a better reflection of socio-economic status

than income in developing countries (395), and included ownership of consumer items (durable goods), and the source of drinking water and toilet facilities.

Psychosocial stress was examined using the three validated psychosocial measures of SOC, LOC and the Brugha life events questionnaire. Anatovsky's SOC comprised 13 items measuring comprehensibility (cognitive), manageability (instrumental/behavioural) and meaningfulness (motivational) (136, 137, 140). A low SOC score inferred a poor ability to cope with stressors and was deemed as high psychosocial stress. The LOC consisted of six questions and a low score was construed as poor perceived control and considered a measure of high psychosocial stress (90). The Brugha Life Events questionnaire contained 12 questions related to negative life events such as illness, death, financial or marital difficulties, among other problems and their impact (148). A higher score was indicative of a greater number of adverse events experienced with higher scores for impact representing a more profound impact.

Three BP measurements were taken by trained nurses at two-minute intervals using an Omron M6 Comfort BP monitor with an appropriately sized cuff after the participant had been seated for five minutes. The average of the second and third BP measurements was used in the analysis.

Height, weight, and waist and hip circumferences were measured. With the participant standing barefoot and in light clothing, measurements taken included weight to the nearest 0.1 kg using a calibrated scale (Adam CPW Plus 200) and height to the nearest 0.1 cm using a measuring tape fixed to the wall. Measured to the nearest 0.1 cm after normal expiration, the waist measurement was taken as the smallest circumference between the xiphi sternum and the umbilicus on expiration while standing. Hip measurements were taken to the nearest 0.1 cm at the maximum posterior protuberance of the buttocks (396).

Blood samples, for glucose and lipid estimations, were drawn following an overnight fast of 10 hours. Thereafter, a standard OGTT, using 75 grams of anhydrous glucose in 250 ml of water, was administered, and blood samples taken 120 minutes later (for glucose estimation) (239). Blood samples were kept on ice and transported to the laboratory within six hours to be centrifuged, aliquoted and stored at -80° until the assays were performed. These were analysed at the internal laboratory of the Department of Endocrinology at Groot Schuur Hospital using the ACE Alera Clinical Chemistry System, Alfa Wassermann Diagnostic Technologies, Woerden, Netherlands.

3.4. DEFINITIONS

Adiposity:

BMI was calculated as the participant's weight in kilograms divided by their height in metres squared (kg/m²). Underweight (<18.5), normal weight (18.5-24.9), overweight (25-29.9) and obesity (≥30) were defined using standardised international criteria. Raised WC was defined as >94 cm in men and >80 cm and in women, and raised WHR as >1.0 in men and >0.85 in women (397).

Dysglycaemia:

Diabetes, IGT and IFG were diagnosed according to the 1998 WHO definition. Diabetes was defined as fasting plasma glucose ≥ 7.0 mmol/l, 2-hour post glucose load ≥ 11.1 mmol/l or participants with known diabetes. IGT was defined as 2-hour post glucose load plasma glucose between 7.8-11.1 mmol/l, provided that fasting glucose was <7.0 mmol/l. IFG was diagnosed when fasting plasma glucose was between 6.1-7.0 mmol/l and the 2-hour glucose was <7.8 mmol/l (239).

In addition, the 1985 WHO criteria (398) were used to compare the prevalence of diabetes in this study with that conducted in 1990 because the raw glucose/diabetes data for the initial study were unavailable for comparison. Diabetes by the 1985 criteria was defined as fasting plasma glucose ≥7.8 mmol/l, 2-hour post glucose load ≥11.1 mmol/l or participants with known diabetes. Fasting glucose <7.8 mmol/l with 2-hour glucose between 7.8-11.1 mmol/l defined IGT.

Dyslipidaemia:

Dyslipidaemia was defined as follows (265): TC >5.0 mmol/l, triglycerides >1.5 mmol/l, HDL-C <1.2 mmol/l, HDL-C/TC ratio <20% and calculated LDL-C >3.0 mmol/l using the Friedewald equation (399).

Hypertension:

Hypertension was defined as BP ≥140/90 mmHg or using antihypertensive medication (168, 400).

Metabolic syndrome:

MS was defined using the JIS criteria that required any three of five factors to be present: central obesity (raised WC: men ≥94 cm, women ≥80 cm), hypertriglyceridaemia (raised triglycerides ≥1.7 mmol/l), low HDL-C (men <1.0 mmol/l, women <1.3 mmol/l), raised BP ≥130/85 mmHg, and raised fasting glucose ≥5.6 mmol/l or on diabetes treatment (313).

Self-reported measures:

Alcohol use:

Problematic alcohol use was deemed present if two or more CAGE questions were answered affirmatively (186).

Tobacco use:

Smoking status was defined as currently smoking ≥1 cigarette a day or as smoking daily/occasionally.

Physical inactivity:

Physical inactivity was defined as <150 minutes of moderate to vigorous activity per week (198, 393).

High fat intake:

High fat intake was defined when >30% of total dietary intake was contributed by fat (8).

Table 3.2: Anatomical Therapeutic Chemical Classification (ATC) codes for CVD and associated risk factors

Conditions and medications	ATC codes
Diabetes	A10
Insulin	A10A
Biguanides	A10BA
Sulphonamides, urea derivatives	A10BB
Hypertension	C02, C03, C07, C08, C09
Diuretics (alone and in combination)	C03A, C03B, C03C, C03D, C03E, C02AA52, C02AA53, C09BA, C07B, C07C, C07D
Antiadrenergic agents- centrally acting	C02A
Reserpine-containing agents	C02AA02, C02AA52
Methyldopa	C02AB01
Antiadrenergic agents – peripherally acting	C02C
Arteriolar smooth muscle agents	C02D
ACE Inhibitors	C09
Beta-blocking agents	C07A, C07B, C07C, C07D
Calcium-channel blockers	C08
Hyperlipidemia	C10A
Drugs for other atherosclerosis-related conditions	B01AC, C01DA, C01A, C01B
Aspirin	B01AC06

Urbanisation:

In lieu of the absence of an internationally agreed definition on what constitutes an urban environment (401), the proportion of life spent in the city, used in previous studies, defined the degree of urbanisation (391). Length of urban residence was recorded by summing the duration lived in a city, from birth until the date of data collection.

Total cardiovascular disease risk assessment:

The absolute risk of having a cardiovascular event, defined as IHD, stroke, transient ischaemic attack or heart failure, within 10 years was calculated using the Framingham equations (337). A score ≥20% was considered high risk and between 10-19.99% was defined as moderate risk.

Anatomical Therapeutic Chemical Classification for medicines:

Participants' medications for CVD and risk factors including diabetes, hypertension and hyperlipidaemia were coded according to the Anatomical Therapeutic Chemical Classification (ATC) categories as indicated in Table 3.2 (402).

3.5. DATA ANALYSIS AND STATISTICAL INTERPRETATION

Data were analysed using STATA, version 11.0 (403) and SAS software version 9.3 (404). Descriptive statistics were calculated using the weights based on the sample design with the crude prevalence data adjusted for the realised sample. The SEGI World Population was used to calculate the age-standardised prevalence (405). The dietary data were analysed using the Medical Research Council (MRC) Food Composition Tables (406) and the MRC dietary analyses software Foodfinder. Only high fat intake as a proportion of total energy intake was examined in this thesis because the nutrition data form part of a master's thesis. For the assets, a principal component analysis of the pooled data was used to develop an asset index and wealth tertiles (407).

The 10-year risk of developing CVD was calculated using the laboratory and non-laboratory based Framingham equations (337), and have been recommended in the South African lipid guidelines (322). The equations are gender-specific and include the variables of age, diabetes status, smoking status, treated and untreated systolic BP, TC and HDL-C levels for the laboratory-based equations. BMI replaced lipids in the non-laboratory-based equations (337).

Laboratory-based equations: The 10-year CVD risk for women was calculated as '1-$0.95012^{\exp(\Sigma ßX - 26.1931)'}$ where ß is the regression coefficient and X is the level for each risk factor; the risk for men was calculated as '1-$0.88936^{\exp(\Sigma ßX - 23.9802)'}$(337).

Non-laboratory-based equations: The 10-year CVD risk for was calculated as $1-0.94833^{\exp(\Sigma ßX - 26.0145)}$ where ß is the regression coefficient and X is the level for each risk factor; the risk for men was calculated as $1-0.88431^{\exp(\Sigma ßX - 23.9388)}$ (337).

Univariate analyses (socio-demographic and cardiovascular risk characteristics) are presented as mean values for the continuous data and as percentages for the categorical data with standard errors by age category and with 95% CI for the total values.

A direct comparison of the 2008/09 and 1990 datasets could not be conducted because of the geographic and demographic changes that occurred in Khayelitsha during this period; the population increased markedly with a concomitant expansion in area size. This necessitated the use of 95% CI for the comparison of the means and prevalence of the CVD risk factors between the two surveys.

The CVD risk factors that were not compared between the two studies included problem drinking, physical activity and triglycerides. The different instruments used in 2008/09 and 1990 to ascertain problem drinking and physical activity, the CAGE questions and GPAQ, respectively, used to assess these risk factors in 2008/09 but not 1990 precluded any comparisons of these measures. The blood samples obtained in the 1990 study were random and not fasting as drawn in 2008/09. Seeing that fasting blood samples are required to accurately measure triglyceride levels, these were not compared between the studies but triglyceride values <4.5 mmol/l were used to calculate LDL-C levels for the 1990 study.

Survey multiple logistic regression analyses were used to determine the independent associations of the CVD risk factors as well as the MS and high total CVD risk. Variables included in all the models were age, sex, urbanisation and psychosocial factors, except for the high total CVD risk models where age and gender were omitted. Socio-demographic variables such as level of education, employment status, type of dwelling and wealth status (defined by asset index) were entered into the models for smoking, problem drinking, physical inactivity, high fat intake, adiposity, the MS and high total CVD risk. Potential predisposing risk factors for diabetes, hypertension and raised LDL-C were entered into these respective models. These included measures of adiposity, physical inactivity and high fat intake. A positive family history of diabetes or hypertension was also entered into the respective models.

The model for diabetes, for example, was adjusted for a set of modifiable (physical inactivity, fat intake, BMI, waist and hip circumference) and non-modifiable (family

history, age, sex and urbanisation) risk factors for diabetes as well as a socioeconomic confounder, housing type. Gender-specific models were done because of substantial differences in associations. To fully account for the known risk factors in the survey models, the non-linearity of their associations were investigated by means of generalised additive models (gam). To reflect the observed non-linearity, quadratic terms were added in the survey model for BMI and urbanisation in women. The waist and hip measurements, as well as their ratio, were highly correlated with BMI ($r>0.85$). Hence, only BMI was retained in the models to avoid multicollinearity. The three psychosocial measures were modelled independently as continuous variables. SOC demonstrated a non-linear association with diabetes in women (significant cubic term) and cut-points were selected to mimic this pattern to enable statistical interpretation. Gender-specific cut-points were used for SOC and are indicated in the text and table.

For the models with hypertension, variable cut-points for age, physical activity and urbanisation were selected based on the smoothed values shown in the fractional polynomials. The three psychosocial measures were modelled independently as continuous variables. A positive history of current smoking and problem drinking was included in all three models.

All the models are presented with the psychosocial measure of SOC in the tables. When LOC or adverse life events independently replaced SOC in the respective models the changes in the direction or significance of the other variables are noted in the table footnotes and the text.

3.6. ETHICAL CONSIDERATIONS

The University of Cape Town's Research and Ethics Committee approved the study. A detailed explanation of the study procedure in Xhosa, the primary language of the study participants, was followed by written informed consent from each participant in the study and confidentiality was ensured (Appendix F). Participants were given their results with a referral letter to the appropriate health services if clinically relevant abnormalities are identified.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. POPULATION CHARACTERISTICS

4.1.1. SAMPLE REALISATION

In this cross-sectional study among 25-74-year-old adults residing in the predominantly black townships of Langa, Guguletu, Crossroads, Nyanga and Khayelitsha in Cape Town, there were 1116 participants of whom 17 did not meet the inclusion criteria. The realised study sample of 1099 comprised 392 men and 707 women (63.5% and 108.1% of the planned sample, respectively) (Table 4.1, p73). A major problem during the recruiting process was making the initial contact with potential male participants, leading to the lower sample realisation in men. Contributing to this difficulty was that a large portion of the study was conducted during a period of turmoil and unrest regarding xenophobia as well as taxi strikes in the townships. This is likely to account for the low sample realisation among 25-34-year-old men (49.0%). The low sample realisation among 65-74-year-old men (43.1%) may be related to the oversampling required in this age category; this was also the lowest realised sample by age category in women (69%). The difficulty in recruiting male participants is, however, characteristic of epidemiological studies in this country and generally due to their reluctance for having blood samples drawn as well as their more frequent absences from home when compared to women. Nonetheless, the overall response rate of 85.7% for the study population was comparable between men (83.5%) and women (86.9%). Of the 187 non-responders (i.e. the selected people who did not participate), 79 (42.2%) were men.

4.1.2. SOCIO-DEMOGRAPHIC CHARACTERISTICS

The socio-demographic data reflect the socio-economic ills of inadequate education and high unemployment prevalent in South Africa as well as the shortage of adequate accommodation common in urban centres (Table 4.2, p74). Approximately a third (34.2%) of participants had less than seven years or no education with older participants less educated compared to their younger counterparts. Only 22.8% were employed and rates of unemployment were high at 61.0%; much higher than the official rate of unemployment (20.5%) among 15-64-year-olds in the Western Cape in 2009 (408). These data are, however, not directly comparable because of the different age categories and definitions of unemployment used. Just over half of the participants (51.4%) lived in informal housing illustrating that the majority were of low socioeconomic status living an impoverished existence.

Table 4.1: Realisation of the planned sample (number and percentage) stratified by gender, area and age

Age	Men						Women					
	Langa	Guguletu	Crossroads	Nyanga	Khayelitsha	Total	Langa	Guguletu	Crossroads	Nyanga	Khayelitsha	Total
25-34:												
Planned number	73	28	10	20	116	247	75	28	11	20	128	262
Realised number	22	14	3	5	77	121	71	29	10	13	112	235
% Realised	**30.1**	**50.0**	**30.0**	**25.0**	**66.4**	**49.0**	**94.7**	**103.6**	**90.9**	**65.0**	**87.5**	**89.7**
35-54:												
Planned number	61	29	11	19	117	237	64	27	11	21	125	248
Realised number	51	28	4	6	96	185	107	41	10	27	146	331
% Realised	**83.6**	**96.6**	**36.4**	**31.6**	**82.1**	**78.1**	**167.2**	**151.9**	**90.9**	**128.6**	**116.8**	**133.5**
55-64:												
Planned number	22	9	4	8	25	68	22	12	4	9	26	73
Realised number	17	6	1	9	25	58	21	16	3	20	32	92
% Realised	**77.3**	**66.7**	**25.0**	**112.5**	**100.0**	**85.3**	**95.5**	**133.3**	**75.0**	**222.2**	**123.1**	**126.0**
65-74:												
Planned number	21	13	3	6	22	65	21	17	3	7	23	71
Realised number	4	6	1	3	14	28	5	16	6	8	14	49
% Realised	**19.1**	**46.2**	**33.3**	**50.0**	**63.6**	**43.1**	**23.8**	**94.1**	**200.0**	**114.3**	**60.9**	**69.0**
Total:												
Planned number	177	79	28	53	280	617	182	84	29	57	302	654
Realised number	94	54	9	23	212	392	204	102	29	68	304	707
% Realised	**53.1**	**68.4**	**32.1**	**43.4**	**75.7**	**63.5**	**112.09**	**121.4**	**100.0**	**119.3**	**100.7**	**108.1**

Table 4.2: Socio-demographic profile and family and self-reported medical history of participants presented by age categories

Socio-demographic variables:	Age category in years											
	25-34 (n=356)	S.E.	35-44 (n=262)	S.E.	45-54 (n=254)	S.E.	55-64 (n=150)	S.E.	65-74 (n=77)	S.E.	Total (n=1099)	95% CI
Education, %:												
None	1.5	0.9	2.2	0.0	8.2	2.6	20.7	3.7	18.1	5.0	5.6	4.0 - 7.6
1-7 years	12.8	2.1	30.7	3.7	43.5	3.5	47.5	5.0	55.7	6.3	28.6	25.6 - 31.7
8-12 years	76.4	2.7	62.4	3.8	45.3	3.7	30.3	4.0	25.1	5.3	60.0	56.8 - 63.2
Higher (tertiary or diploma)	9.4	1.7	4.8	1.4	3.0	1.0	1.6	0.9	1.1	1.0	5.9	4.3 - 7.9
Employment Status, %:												
Employed	23.4	2.4	31.5	3.6	20.4	2.7	15.7	4.1	2.1	1.5	22.8	20.2 - 25.7
Unemployed	71.9	2.7	59.7	3.4	63.6	3. 4	35.7	4.4	8.6	3.5	61.0	57.6 - 64.3
Other: homemaker	1.5	0.9	1.0	0.6	2.6	1.6	2.9	1.6	0.0	0.0	1.6	0.7 - 3.8
pensioners	0.6	0.6	3.0	1.6	6.5	2.0	37.3	4.1	89.3	3.8	10.1	8.4 - 12.2
disabled	1.3	0.6	4.1	1.3	7.0	1.6	8.4	2.3	0.0	0.0	3.7	2.7 - 4.9
students	1.4	0.6	0.8	0. 6	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.4 - 1.6
Housing Type, %:												
Built formal unit (private)	19.8	3.4	17.0	3.0	28.0	3.8	28.7	4.2	27.2	4.8	22.0	18.0 - 26.7
Council/core house/hostel	23.2	2.8	24.5	2.8	28.3	3.2	36.6	4.0	39.4	5.2	26.6	22.8 - 30.7
Informal shack	57.0	4.1	58.5	3.9	43.7	4.1	34.6	4.3	33.4	5. 8	51.4	45.9 - 56.9
Occupancy rate (persons / room)	2.3	0.1	2.4	0.1	2.3	0.1	2.3	0.2	2.1	0.2	2.3	2.2 - 2.4
% life in urban area, mean	60.6	2.1	60.4	2.3	64.4	2.5	66.8	3.0	62.8	3.9	62.0	59.1 - 64.9
Asset Index by tertiles, %,												
1st (poorest)	36.5	3.4	33.4	3.7	31.5	3.6	27.3	3.9	23.3	5.0	33.2	28.6 - 38.2
2nd	32.7	3.0	41.8	4.1	24.5	3.0	37.0	4.9	38.4	5.6	33.7	29.9 - 37.6
3rd (richest)	30.9	3.5	24.9	3.6	44.0	3.6	35.7	5.1	38.4	6.2	33.1	28.6 - 38.0
Family medical history, %:												
Diabetes mellitus	18.9	2.4	26.4	3.1	26.3	3.0	20.7	3.6	17.1	4.3	22.2	19.6 - 25.1
Hypertension	37.6	3.3	42.4	3.2	39.7	3.4	37.3	4.7	32.5	5.2	38.8	35.4 - 42.4
Ischaemic heart disease	8.2	1.6	5.4	1.3	9.5	1.8	12.4	3.0	5.3	2.2	8.0	6.4 - 10.0
Stroke	6.8	1.5	9.9	2.3	10.5	2.1	6.6	2.0	5.6	2.7	8.2	6.6 - 10.3
Self-reported diagnosis, %:												
Diabetes	3.3	0.9	4.0	1.2	11.7	2.0	12.7	2.7	22.0	4.9	7.0	5.7 - 8.6
Hypertension	6.7	1.3	15.7	2.3	39.8	3. 2	53.5	4.7	72.5	5.6	23.2	20.4 - 26.2
Hyperlipidaemia	0.6	0.4	0.5	0.4	4.3	1.3	2.6	1.3	4.9	2.4	1.8	1.1 - 2.7
Ischaemic heart disease	0.8	0.4	2.9	1.1	4.7	1.4	6.5	1.9	9.1	3.3	3.0	2.2 - 4.2
Stroke	1.8	0.9	0.7	0.4	6.5	1.6	6.9	2.3	9.0	3.6	3.4	2.4 - 4.8

S.E: standard error; CI: confidence interval

While older participants were less educated and fewer were employed, a higher proportion received a pension or a disability grant. They also lived in better quality housing and were wealthier than their younger counterparts. The steady source of an income in the form of a welfare grant among the older participants may account for their better quality housing and relative greater wealth compared to younger participants as pensions have been found to improve living conditions (409).

4.1.3. FAMILY AND MEDICAL HISTORY

Family history of diabetes and hypertension were high, at 22.2% and 38.8%, respectively, with no trend by age category for either (Table 4.2, p74). The self-reported prevalence for diabetes and hypertension was 7.0% and 23.2%, respectively, and increased with age. The high prevalence of family and self-reported hypertension was in keeping with previous reports where hypertension was found to be the most prevalent CVD risk factor in adult black South Africans (385). Nevertheless, self-reported hypertension and diabetes is not likely to be a true reflection of the prevalence in the population, because the proportion of people aware of having either of these conditions is generally low. The 'rule of halves' predicts that of all those with hypertension, half are detected, half of those detected are treated and half of those treated are adequately controlled (410).

The rates of family history of IHD and stroke were both approximately 8.0% with low self-reported rates of about 3.0% each. The similar rate of IHD and stroke, for family and self-reported, may reflect the changing pattern of CVD in this population. Previously, stroke was much more common in the black population of SSA, including South Africa, but IHD has been on the rise since the 1980s (306, 411). At 6.6% and 6.5%, IHD and stroke, respectively, were the 2nd and 3rd most common causes of death in 2000 (262).

The prevalence of self-reported hyperlipidaemia was only 1.8%; lower than might have been expected given the relative higher prevalence of self-reported IHD and the known strong association between these two conditions. The low self-reported rate of hyperlipidaemia is probably a reflection of the low level of screening and detection rather than a true reflection of the disease status in the community.

Table 4.3: Pattern of healthcare utilisation presented by gender and age categories

Healthcare utilisation pattern, %	Age category in years											
	25-34	S.E.	35-44	S.E.	45-54	S.E.	55-64	S.E.	65-74	S.E*	Total	95% CI
Men	*n= 121*		*n= 99*		*n= 86*		*n= 58*		*n= 28*		*n= 392*	
Payment for healthcare services:												
Self	15.7	3.1	18.4	4.3	18.3	5.3	10.6	4.1	10.7	5.7	16.2	12.8 - 20.3
Family	5.2	2.1	1.4	1.1	0.0	0.0	1.1	1.1	0.0	0.0	2.6	1.3 - 5.2
Medical aid	3.6	2.1	1.8	1.3	3.2	1.8	3.7	2.6	0.0	0.0	2.9	1.5 - 5.8
Employer	0.0	0.0	0.5	0.4	0.5	0.5	0.0	0.0	0.0	0.0	0.2	0.1 - 0.9
Public healthcare utilised	75.4	3.9	77.9	4.5	78.0	5.2	84.6	4.8	89.3	5.7	78.1	73.3 - 82.3
Tested in past 1 year:												
Glucose	7.7	2.3	4.8	3.0	15.7	4.6	26.8	6.3	39.3	9.2	12.0	8.8 - 16.3
Blood pressure	7.5	2.3	8.7	3.5	27.1	4.6	40.5	7.3	57.1	9.5	17.3	13.8 - 21.6
Visited traditional healer in the past year for:												
Diabetes	0.0	0.0	0.0	0.0	2.5	1.7	0.0	0.0	0.0	0.0	0.5	0.1 - 2.0
Hypertension	0.0	0.0	0.0	0.0	2.5	1.7	1.1	1.1	0.0	0.0	0.6	0.2 - 2.0
Using herbal/traditional medicine for:												
Diabetes	0.8	0.8	0.0	0.0	2.3	1.6	0	0	7.1	4.9	1.2	0.5 - 2.7
Hypertension	0.0	0.0	0.0	0.0	5.1	2.7	4.8	2.8	10.7	5.9	2.0	1.1 - 3.9
Women	*n= 235*		*n= 163*		*n= 168*		*n= 92*		*n= 49*		*n= 707*	
Payment for healthcare services:												
Self	12.7	2.2	16.9	3.4	5.6	1.9	8.4	2.8	16.3	4.9	11.9	9.7 - 14.5
Family	2.6	1.0	1.8	0.9	0.5	0.4	2.5	1.4	0.0	0.0	1.8	1.0 - 3.1
Medical aid	2.4	1.0	3.7	1.7	4.7	1.7	0.8	0.8	0.0	0.0	2.9	1.9 - 4.5
Employer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Public healthcare utilised	82.4	2.4	77.6	3.8	89.2	2.4	88.2	3.1	83.7	4.9	83.4	80.5 - 86.0
Tested in past 1 year:												
Glucose	7.8	1.9	14.7	3.2	37.5	3.8	37.4	4.9	44.9	7.7	20.2	17.1 - 23.7
Blood pressure	14.1	2.4	27.2	3.7	55.2	4.2	68.1	5.0	67.4	6.4	33.2	29.2 - 37.3
Visited traditional healer in the past year for:												
Diabetes	0.0	0.0	0.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0 - 0.5
Hypertension	0.0	0.0	0.3	0.3	1.1	0.8	3.5	2.0	0.0	0.0	0.6	0.2 - 1.3
Using herbal/traditional medicine for:												
Diabetes	0.0	0.0	0.6	0.4	3.4	1.4	3.6	1.8	4.1	2.9	1.4	0.8 - 2.4
Hypertension	0.0	0.0	1.9	1.1	8.5	2.3	10.9	3.2	10.2	4.3	3.7	2.6 - 5.3

S.E: standard error; CI: confidence interval

4.1.4. HEALTHCARE AND HEALTH SERVICES UTILISATION

The low socio-economic status of the study population is reflected in the utilisation of public healthcare services: men 78.1% and women 83.4% (Table 4.3, p76). These findings are in accordance with those from the SADHS where most participants nationally also utilised public healthcare services (361) and reveal the urban black population's widespread dependence on government's provision of healthcare. A negligible proportion (2.9%) was covered by health insurance while only 16.2% and 11.9% of men and women, respectively, paid for their own healthcare. This underscores the need to provide an equitable, effective and efficient healthcare service.

Approximately a quarter (25.6%) and one in six (16.3%) participants had their BP and blood glucose checked, respectively, in the previous year. As expected, more women than men had their BP (33.2% vs. 17.3%) and blood glucose (20.2% vs. 12.0%) measured with rates generally increasing with age (Table 4.3, p76).

Very few men and women reported visiting traditional healers (<1%) or using herbal/traditional medicines (<4%) for diabetes or hypertension during the previous year. Nonetheless, treatment by traditional healers is known to be widespread in South Africa with an estimated 60-80% of the population currently using traditional healers as their first contact for advice and/or treatment of health concerns (412). The low self-reported use of traditional healers or herbal medications probably indicates a reluctance to disclose this to western health professionals and researchers for fear of disapproval.

4.2. CARDIOVASCULAR DISEASES RISK FACTORS

4.2.1. ENVIRONMENTAL AND BEHAVIOURAL RISK FACTORS

The environmental and behavioural CVD risk factors in this study are modifiable and consist of psychosocial stressors, tobacco and alcohol use, physical inactivity and unhealthy diets. The tools used to measure these risk factors, in particular, physical inactivity and dietary fat intake, were reliant on participant recall and perception, and therefore potentially subject to bias.

4.2.1.1. Psychosocial Stress

The relationship between the SOC, LOC or adverse life events scores, which were the tools used to determine psychosocial stress in this study, and CVD risk factors have not previously been examined in this population. SOC has been used as one of the measures to determine factors associated with hypertension self-management in

South Africa (413). The six-item LOC was among the psychosocial measures found to be associated with acute MI in the INTERHEART study, an international case-control study that included South Africa (90, 414).

There was no trend for perceived health status by age category with most of the men (52.5%) and women (54.8%) perceiving their health status to be average (Tables 4.4a and 4.4b, p79-80). As expected, older participants reported poor health more frequently than the younger ones. More women (28.0%) than men (13.0%) reported living with HIV-infected individuals but few perceived their own healthcare to be compromised by family illness or death (4.0%).

SOC scores were similar in men and women, and across age groups in men but not in women, in whom the lowest scores were in 45-54-year-olds and the highest in 25-34-year-olds. Mean SOC scores at 54.8 in men and 54.2 in women were lower than those reported in Sweden where mean scores ranged from 68 to 72 in various studies (415-417). Higher SOC was also found in Finland where the mean score per question was 5.5 (418) compared to 4.2 in this study. Thus, based on SOC, participants in this study experienced more stress compared to those in Sweden and Finland. This was not surprising considering the numerous socio-economic obstacles such as unemployment and poor quality housing faced by many of these participants.

Surprisingly, mean SOC in this study was similar to that of Sudanese diabetic patients with lower limb amputations whose scores were 53.1 in men and 52.0 in women (419). While it may be anticipated that individuals with lower limb amputations and diabetes may experience greater stress and have lower SOC scores compared to those without disabilities, the similar scores may be attributable to variations in interpretation of the questions between the cultures and the extent of social desirability with regard to responses (90).

Mean LOC scores were significantly higher in men than in women (19.4 vs. 18.5 $p<0.001$) (Tables 4.4a and 4.4b, p79-80) and may perhaps be related to the greater social standing afforded to men in traditional cultures. The youngest men and women had the highest LOC scores with the lowest scores in 55-64-year-old men and 65-74-year-old women. The higher scores in younger participants may be related to the greater proportions of their lives, particularly during the impressionable adolescence stage, being spent in the post-apartheid era with its greater freedom, human rights and dignity; their older counterparts, in contrast, spent larger proportions of their lives living in oppression.

Table 4.4a: Pattern of psychosocial influences presented by age categories in men

Psychosocial influences	Age category in years											
	25-34		35-44		45-54		55-64		65-74		Total	
		S.E		S.E.		S.E.		S.E.		S.E.		95% CI
	n= 121		*n= 99*		*n= 86*		*n= 58*		*n= 28*		*n= 392*	
Perceived health status, %:												
Poor	12.3	3.0	14.3	4.4	26.4	5.4	29.6	7.8	21.4	7.9	17.7	13.8 - 22.3
Average	47.7	5.7	56.5	6.0	55.3	6.0	54.9	7.6	57.1	10.0	52.5	46.4 - 58.5
Good	33.3	4.9	27.2	5.4	18.3	4.6	13.9	5.0	21.4	8.8	26.5	21.4 - 32.3
Very good/excellent	6.8	2.2	2.0	1.3	0.0	0.0	1.6	1.6	0.0	0.0	3.4	2.0 -6.0
Family illness/death limited own healthcare, %	5.6	2.7	3.9	2.0	1.1	1.2	3.7	2.5	0.0	0.0	3.8	2.0 - 7.2
Living with HIV/AIDS in the household, %	15.8	3.5	16.4	4.1	9.3	3.3	7.5	3.7	0.0	0.0	13.0	9.6 - 17.5
Psychosocial scores:												
Sense of coherence (SOC), mean	54.7	1.1	55.3	1.3	55.1	1.0	53.0	2.1	55.4	1.9	54.8	53.6 - 56.1
SOC in tertiles, %:												
Low	31.9	4.7	30.2	5.5	24.9	4.5	40.8	7.5	39.3	9.7	31.2	26.2 - 36.7
Moderate	34.1	4.8	27.4	5.2	33.7	5.7	25.0	5.6	17.9	7.1	30.7	25.9 - 36.1
High	34.1	4.8	42.5	5.3	41.4	5.5	34.2	6.7	42.9	9.4	38.1	33.1 - 43.3
Locus of control (LOC), mean	20.0	0.3	19.3	0.4	18.7	0.4	18.6	0.4	18.7	0.5	19.4	19.0 - 19.7
LOC in quartiles, %												
1st (lowest)	11.7	3.0	15.9	4.6	29.6	5.2	26.0	7. 7	21.4	7.9	18.1	14.1 - 22.9
2nd	19.3	3.8	19.6	4.2	18.9	4.2	28.2	6.3	28.6	8.8	20.5	16.8 - 24.8
3rd	27.1	3.7	29.8	5.5	21.6	4.4	28.2	6.2	28.6	8.9	26.8	22.2 - 32.0
4th (highest)	42.0	4.5	34.7	5.5	30.0	5.5	17.7	5.4	21.4	7.6	34.6	29.4 - 40.2
Life events, mean:												
Total number of life events	7.5	0.3	8.4	0.3	7.9	0.3	8.2	0.4	6.8	0.4	7.8	7.5 - 8.1
Impact: events <6 months ago	4.0	0.2	4.2	0.3	3.4	0.3	2.8	0.3	1.7	0.3	3.7	3.4 - 4.0
events >6 months ago	9.3	0.4	11.5	0.5	11.0	0.6	12.0	0.9	9.9	0.7	10.5	9.9 - 11.0

S.E: standard error; CI: confidence interval

Table 4.4b: Pattern of psychosocial influences presented by age categories in women

Psychosocial influences	Age category in years											
	25-34	S.E.	35-44	S.E.	45-54	S.E.	55-64	S.E.	65-74	S.E.	Total	95% CI
	n= 235		*n= 163*		*n= 168*		*n= 92*		*n= 49*		*n= 707*	
Perceived health status, %:												
Poor	11.2	2.2	14.1	2.7	39.2	3.9	34.3	5.5	36.7	7.1	21.2	18.1 - 24.7
Average	53.5	3.5	61.5	3.9	47.6	4.0	60.0	5.5	61.2	7.3	54.8	51.0- 58.6
Good	32.6	3.2	22.5	3.5	10.5	2.6	5.0	2.4	0.0	0.0	21.6	18.2 - 25.4
Very good/excellent	2.8	1.2	1.9	1.1	2.8	1.2	0.7	0.7	2.0	2.0	2.4	1.5 - 3.9
Family illness/death limited own healthcare, %	2.2	1.1	1.8	1.1	6.5	2.0	12.0	3.2	8.2	3.9	4.2	2.9 - 6.0
Living with HIV/AIDS in the household, %	27.1	3.3	27.2	3.9	29.2	4.0	35.0	5.6	22.5	6.0	28.0	24.1 - 32.2
Psychosocial scores:												
Sense of coherence (SOC), mean	55.6	0.8	53.8	0.8	52.2	0.9	53.0	0.9	54.7	1.4	54.2	53.3 - 55.2
SOC in tertiles, %:												
Low	26.8	3.2	32.7	3.9	46.9	4.3	32.5	5.0	24.5	6.7	32.9	29.0 - 37.1
Moderate	32.4	2.8	35.1	4.2	22.5	3.5	35.3	5.6	38.8	6.9	31.3	28 - 34.9
High	40.8	3.8	32.3	4.0	30.5	3.7	32.2	5.1	36.7	6.6	35.8	31.7 - 40.1
Locus of control (LOC), mean	19.1	0.2	18.2	0.3	18.0	0.2	18.0	0.3	17.6	0.5	18.5	18.2 - 18.7
LOC in quartiles, %												
1st (lowest)	15.3	2.5	25.6	3.5	27.4	3.8	24.2	4.5	34.7	6.9	22.0	18.6 - 25.7
2nd	25.0	3.0	26.8	4.0	31.1	4.1	32.6	5.0	30.6	5.7	27.7	23.9 - 31.8
3rd	30.8	3.4	34.8	4.3	26.7	3.9	28.7	5.1	12.2	4.6	29.6	25.7 - 33.8
4th (highest)	29.0	3.2	12.8	3.0	14.7	2.7	14.5	3.6	22.5	5.9	20.8	17.6 - 24.4
Life events, mean:												
Total number of life events	6.8	0.2	7.5	0.3	8.0	0.2	7.2	0.3	6.6	0.3	7.3	7.0 - 7.5
Impact: events <6 months ago	4.2	0.2	4.2	0.3	4.2	0.3	3.0	0.3	2.7	0.3	4.0	3.8 - 4.3
events >6 months ago	8.3	0.3	9.8	0.4	10.7	0.3	10.5	0.4	9.4	0.5	9.4	9.1 - 9.8

S.E: standard error; CI: confidence interval

Men had experienced significantly more adverse life events than women (7.8 vs. 7.3 p=0.002) (Tables 4.4a and 4.4b, p79-80). Men were more likely to have suffered a serious illness, injury or an assault, broken off a steady relationship, been fired from a job, experienced problems with the police and a court appearance, and to have had something valuable lost or stolen. The most number of adverse life events experienced among men were in 35-44-year-olds and among women in 45-54-year-olds.

4.2.1.2. Tobacco Use

Cigarette smoking contributes to a large burden of preventable disease in South Africa. In 2000, smoking accounted for 8.0-9.0% of mortality, the third most common cause, after unsafe sex/sexually transmitted disease and high BP, among 17 risk factors evaluated. While lung cancer had the largest attributable fraction because of smoking, CVDs contributed the largest proportion of deaths caused by smoking (170).

The prevalence of cigarette smoking was significantly higher among men than women (57.8% vs. 9.8% p<0.001) (Tables 4.5a and 4.5b, p83-84), in accordance with the worldwide male preponderance for tobacco use (156) including in SSA (153, 376) and in national South African surveys (360, 361). That the prevalence of smoking was highest among the youngest men with two-thirds of 25-34-year-old men smoking daily or occasionally indicates the high uptake of cigarette use in this group and the widespread acceptance of this risky behaviour.

Nonetheless, in keeping with the SADHS which reported a lower national smoking prevalence in 2003 compared to 1998 (420), there has been a decline in smoking between 1990 and the current study (Table 4.6, p85). For example, the prevalence of smoking ≥1 cigarette/day in 25-64-year-old men in 2008/09 in this study was 51.0% compared to 59.7% in 1990.

The decline in smoking prevalence is likely to be a reflection of the effectiveness of the South African government's anti-smoking initiatives (170, 421, 422); comprehensive tobacco control policies were introduced in the 1990s to address the growing epidemic of tobacco use. Furthermore, steep rises in excise taxes increased real cigarette prices by 115% between 1993 and 2003 (423). The biggest impact was likely in ≥45-year-old men, over a third of whom reported a past history of daily smoking.

In 25-64-year-old women, although the prevalence of daily cigarette smoking was low, there was no reduction between 1990 (8.4%) and 2008/09 (8.0%) (Table 4.6, p85), in keeping with the pattern found in the SADHS (420). Also suggesting the lack of a major alteration in smoking patterns among women was that smoking cessation was low with only 3.0% of women reporting a past history of daily smoking; the highest being in 65-74-year-old women (16.3%) and may possibly be related to health reasons rather than the anti-smoking initiatives.

The low smoking prevalence in women is probably attributable to the influence of gender norms and social disapproval (424), but with weakening social and cultural constraints, and greater female autonomy, women may be encouraged to smoke (425). This may be a key factor in the minimal influence of the tobacco control policies on the smoking rates in women. The steep rises in excise taxes that increased real cigarette prices, and probably contributed to lower smoking rates among men, appear to have not impacted on women; the increases in their spending power may have made cigarettes more affordable.

Notably among women, although tobacco smoking was relatively low compared to men, their use of smokeless tobacco was 11.2%, much higher than that of men (2.1%). The prevalent use of smokeless tobacco was higher in older compared to younger women. Further, the daily use of smokeless tobacco among 25-64-year-old women rose from 3.1% in 1990 to 5.5% in 2008/09, in keeping with the SADHS (420). Many users of smokeless tobacco are unaware of the health hazards of smokeless tobacco use and need to be actively discouraged from continuing or initiating the habit (426).

Despite the introduction of comprehensive legislative action to discourage tobacco use since the early 1990s, it still remains a major public health problem (170). The differential rates and pattern of tobacco smoking in men and women underscore the complex and multi-factorial influences including knowledge, perceptions and socio-cultural norms that motivate tobacco use (427). The apparent lack of an effect of the current anti-tobacco measures on smoking rates in women suggests that novel approaches are required to encourage cessation and to prevent uptake of smoking in women. In addition to the current legislative measures, culturally relevant and gender-specific smoking prevention and cessation programmes are needed, as well as dissemination of information on the harmful effects of smokeless tobacco use. Moreover, additional measures may be required to encourage cessation and to prevent uptake of smoking in men to further decrease their smoking rates.

Table 4.5a: Lifestyle behaviours and anthropometry presented by age categories in men

	Age category in years											
	25-34 (*n=121)*		35-44 (*n=99)*		45-54 (*n=86)*		55-64 (*n=58)*		65-74 (*n=28)*		Total (*n=392)*	
Lifestyle/behavioural risk factors:		S.E.		S.E.		S.E.		S.E.		S.E.		95% CI
Tobacco consumption:												
Smoke: daily/occasionally, %	66.8	4.3	58.0	6.0	54.3	5.3	37.8	7.0	32.1	9.2	57.8	52.4 - 62.9
Smoke: ≥1cigarette/day, %	56.9	4.9	51.6	6.0	45.7	5.2	33.0	6.7	21.4	8.8	49.4	43.8 - 54.9
Among daily smokers (n=183):												
Mean age when started smoking daily	18.1	0.5	18.3	0.9	20.0	1.3	22.5	2.3	19.5	1.4	18.8	17.9 - 19.7
% who smoke manufactured cigarettes	96.8	2.3	92.5	3.9	73.2	9.1	58.0	11.2	66.7	15.8	88.3	81.8 - 92.7
Past daily smokers, %	15.6	3.7	17.9	3.8	35.4	5.3	37.2	8.0	35.7	9.5	23.2	18.9 - 28.1
Current use of smokeless tobacco, %	3.6	2.2	1.6	1.2	0.0	0.0	2.7	1.9	0.0	0.0	2.1	0.9 - 5.0
Alcohol consumption:												
Alcohol consumption, %	72.4	4.4	70.2	6.2	65.7	6.1	51.0	6.9	50.0	8.8	67.5	62.0 - 72.5
Problem drinking: CAGE positive ≥2, %	54.7	4.5	56.3	6.2	48.2	6.3	27.1	6.3	25.0	8.0	49.7	44.6 - 54.9
Total moderate to vigorous physical activity:												
Mean minutes per week	1314.7	102.9	1206.9	144.3	975.8	85.8	1041.4	113.1	477.0	84.3	1150.5	1030.1-1270.9
Physical activity: <150 minutes / week, %	4.7	1.9	5.7	2.4	5.7	2.4	9.9	3.9	17.9	7.1	6.3	4.3-9.1
Diet:												
% fat intake, mean	28.7	1.2	24.1	1.4	24.0	1.8	21.4	1.7	19.0	1.9	25.5	23.9-27.1
High fat intake: >30% of energy intake, %	45.6	5.5	33.1	5.3	35.0	6.0	16.7	5.1	7.1	4.7	36.0	30.4-42.0
Anthropometry:												
Height, mean (m)	1.71	0.007	1.70	0.009	1.69	0.008	1.69	0.009	1.69	0.013	1.70	1.69 - 1.70
Weight, mean (kg)	65.8	1.2	67.7	1.6	72.5	2.4	72.4	2.1	73.3	3.5	68.6	67.0 - 70.2
Waist circumference (cm), mean	79.0	0.9	82.5	1.3	91.0	1.9	91.7	1.7	94.4	3.0	84.2	82.8 - 85.6
Hip circumference (cm), mean	93.2	0.9	94.7	1.1	96.6	1.4	98.0	1.3	97.5	2.0	94.9	93.8 - 96.0
BMI (kg/m^2), mean	22.4	0.4	23.3	0.5	25.5	0.7	25.4	0.7	25.7	1.1	23.7	23.1 - 24.2
Waist-to-hip ratio, mean	0.85	0.005	0.87	0.005	0.94	0.009	0.93	0.009	0.96	0.017	0.88	0.88- 0.89
BMI (kg/m^2), %:												
Underweight (<18.5)	7.2	2.7	9.5	3.0	7.8	2.8	2.9	2.1	7.1	4.9	7.5	5.1 -11.1
Normal weight (18.5-24.9)	74.3	4.0	64.5	5.3	47.7	6.0	60.6	6.2	42.9	9.3	63.6	57.8 - 68.9
Overweight (25-29.9)	14.1	3.4	17.7	4.0	26.7	5.6	19.1	5.0	25.0	7.6	18.6	14.7 - 23.3
Obese (≥30)	4.4	1.7	8.3	3.2	17.8	4.8	17.4	5.0	25.0	8.0	10.3	7.4 - 14.2
Raised waist circumference, %	10.1	2.7	14.2	4.3	34.1	6.2	32.4	6.5	50.0	9.5	20.1	15.9 - 24.9
Raised waist-to-hip ratio,%	1.6	1.1	1.6	1.2	23.1	5.9	16.8	5.2	35.7	8.4	9.2	6.5 -12.9

S.E: standard error; CI: confidence interval; Raised waist circumference (IDF definition): men >94 cm; women >80 cm; Raised waist-to-hip ratio (IDF definition): men >1.0; women >0.85

Table 4.5b: Lifestyle behaviours and anthropometry presented by age categories in women

	Age category in years											
	25-34 (*n=235)*		35-44 (*n=163)*		45-54 (*n=168)*		55-64 (*n=92)*		65-74 (*n=49)*		Total (*n=707)*	
Lifestyle/behavioural risk factors:		S.E.		S.E.		S.E.		S.E.		S.E.		95% CI
Tobacco consumption:												
Smoke: daily/occasionally, %	9.5	2. 2	7.3	2.0	12.4	2.7	11.3	3.3	8.2	4.0	9.8	7.4 - 12.8
Smoke: ≥1cigarette/day, %	7.6	1.9	5.9	1.8	10.1	2.5	9.8	3.1	6.1	3.5	7.9	5.8 - 10.6
Among daily smokers (n=58):												
Mean age when started smoking daily	19.7	1.4	21.6	1.4	31.6	3.6	37.8	3.9	22.0	3.3	25.3	22.2 - 28.3
% who smoke manufactured cigarettes	100.0	0.0	76.3	14.6	76.6	12.1	91.4	8.4	100.0	0.0	88.6	75.6 - 95.1
Past daily smokers, %	2.2	1.0	1.1	0.5	2.2	1.1	5.9	2.8	16.3	6.8	3.0	1.9 - 4.8
Current use of smokeless tobacco, %	6.6	1.8	10.1	2.5	16.9	3.3	19.5	4.6	16.3	5.7	11.2	8.7 - 14.2
Alcohol consumption:												
Alcohol consumption, %	32.2	3.3	25.2	3.5	21.1	3.3	25.2	4.3	18.4	5.6	26.9	23.4 - 30.8
Problem drinking: CAGE positive ≥2, %	21.3	2.8	16.9	3.0	16.2	3.2	15.8	4.1	8.2	3.8	18.1	15.3 - 21.2
Total moderate to vigorous physical activity:												
Mean minutes per week	1067.2	74.3	965.5	73.1	905.1	68.7	894.5	95.3	628.1	87.4	972.9	891.6-1054.1
Physical activity: <150 minutes per week, %	4.1	1.4	7.1	2.2	9.3	2.3	6.1	2.7	20.4	5.7	6.9	5.1-9.2
Diet:												
% fat intake, mean	26.9	0.9	25.8	0.9	23.2	1.1	25.2	1.5	24.8	1.7	25.6	24.6-26.7
High fat intake: >30% of energy intake, %	41.7	3.6	37.6	3.9	26.2	3.6	33.6	4.9	32.7	6.7	36.3	32.3-40.4
Anthropometry:												
Height, mean (m)	1.60	0.004	1.60	0.006	1.58	0.005	1.58	0.007	1.55	0.009	1.59	1.59 -1.60
Weight, mean(kg)	80.3	1.4	87.5	2.1	87.6	2.0	83.7	2.3	82.7	2.9	83.8	82.0 - 85.7
Waist circumference (cm), mean	92.5	1.1	98.6	1.4	101.7	1.2	99.6	1.5	100.5	1.9	96.8	95.5 - 98.1
Hip circumference (cm), mean	112.2	1.0	115.0	1.5	116.7	1.4	115.0	2.0	117.2	2.2	114.3	113.0 - 115.6
BMI (kg/m^2), mean	31.3	0.6	34.0	0.7	34.9	0.7	33.4	0.9	34.4	1.1	33.0	32.3 - 33.7
Waist-to-hip ratio, mean	0.82	0.005	0.86	0.006	0.87	0.006	0.87	0.009	0.86	0.009	0.85	0.84 - 0.85
BMI (kg/m^2), %:												
Underweight (<18.5)	1.0	0.7	0.3	0.3	0.6	0.6	0.0	0.0	2.0	2.0	0.8	0.3 - 1.9
Normal weight (18.5-24.9)	23.6	2.9	9.8	2.5	10.7	2. 6	14.8	3.9	10.2	4.4	16.4	13.5 - 19.8
Overweight (25-29.9)	21.7	2.8	25.5	3.7	15.9	3.2	20.6	4.1	14.3	5.5	20.8	17.4 - 24.6
Obese (≥30)	53.6	3.7	64.4	4.0	72.8	3.9	64.6	4.8	73.5	6.6	62.1	57.8 - 66.2
Raised waist circumference, %	78.4	2.7	90.5	2.3	92.5	2.2	92.8	2.9	91.8	3.9	86.0	82.9 - 88.6
Raised waist-to-hip ratio,%	32.7	3.0	55.1	4.0	63.1	3.9	60.2	5.3	57.1	7.6	47.7	43.7 - 51.7

S.E: standard error; CI: confidence interval; Raised waist circumference (IDF definition): men >94 cm; women >80 cm; Raised waist-to-hip ratio (IDF definition): men >1.0; women >0.85

Table 4.6: Comparison of selected cardiovascular disease risk factors in 25-64-year-old men and women in 1990 and 2008/09

	Men				Women				Total			
	1990		2008/09		1990		2008/09		1990		2008/09	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Tobacco consumption:												
Smoke: ≥1cigarette/day, %	59.7	53.8-65.4	51.0	45.2-56.7	8.4	6.0-11.8	8.0	5.9-10.7	35.0	31.3-39.0	28.4	24.8-32.3
Daily use of smokeless tobacco, %	0.7	0.2-2.7	0.9	0.3-2.5	3.1	1.8-5.3	5.5	3.8-7.8	1.9	1.1-3.2	3.3	2.3-4.7
Alcohol consumption:												
Alcohol consumption, %	56.7	50.7-62.5	68.5	62.7-73.7	15.1	11.7-19.3	27.4	23.7-31.5	35.5	31.7-39.5	46.9	43.1-50.7
Adiposity:												
BMI (kg/m^2), mean	24.3	23.8-24.8	23.6	23.0-24.1	33.0	32.3-33.7	29.5	28.8-30.2	27.0	26.5-27.5	28.5	27.9-29.2
BMI (kg/m^2),%:												
Underweight (<18.5)	2.7	1.3-5.7	7.6	5.0-11.4	2.1	1.0-4.3	0.7	0.3-1.9	2.4	1.4-4.0	3.9	2.7-5.8
Normal weight (18.5-24.9)	60.0	54.1-65.7	64.8	58.9-70.2	25.3	20.9-30.2	16.8	13.7-20.3	42.3	38.4-46.3	39.5	35.5-43.7
Overweight (25-29.9)	27.8	22.8-33.4	18.2	14.3-23.0	30.0	25.3-35.1	21.1	17.7-25.0	28.9	25.4-32.7	19.7	16.8-23.1
Obese (≥30)	9.5	6.7-13.3	9.5	6.5-13.6	42.7	37.5-48.0	61.5	57.1-65.7	26.4	23.2-29.9	36.8	33.0-40.7
Lipids:												
Total cholesterol, mmol/l	4.2	4.1-4.3	4.3	4.1-4.4	4.3	4.2-4.4	4.3	4.2-4.4	4.3	4.2-4.3	4.3	4.2-4.4
HDL-C, mmol/l	1.37	1.33-1.42	1.26	1.20-1.32	1.41	1.37-1.45	1.12	1.08-1.15	1.39	1.36-1.42	1.18	1.15-1.22
LDL-C, mmol/l	2.1	2.0-2.2	2.8	2.7-2.9	2.4	2.3-2.5	3.0	2.9-3.1	2.3	2.2-2.3	2.9	2.8-3.0
HDL-C:TC,%	34.1	32.9-35.3	30.0	28.8-31.1	33.7	32.6-34.7	26.3	25.7-27.0	33.9	33.1-34.7	28.1	27.4-28.8
Total cholesterol >5 mmol/l	16.7	12.8-21.5	24.4	19.1-30.7	21.8	16.4-22.5	22.2	19.0-25.7	19.3	16.4-22.5	23.3	20.0-26.8
HDL-C <1.2mmol/l	37.3	31.7-43.2	55.1	49.4-60.6	30.0	25.3-35.1	67.7	63.6-71.6	33.5	29.9-37.4	61.7	58.0-65.3
LDL-C† >3 mmol/l	12.6	9.2-17.0	36.5	31.1-42.3	21.2	17.2-25.9	44.5	40.6-48.4	17.0	14.2-20.1	40.7	37.3-44.2
HDL-C:TC <20%	4.7	2.8-7.8	13.6	9.9-18.5	4.1	2.5-6.7	18.4	15.6-21.7	4.4	3.0-6.2	16.2	13.6-19.0
Blood pressure (BP):												
Mean (mmHg):												
Systolic BP	121.4	119.7-123.1	129.4	126.8-132.0	119.4	117.7-121.1	120.4	118.5-122.3	120.4	119.2-121.6	124.6	123.1-126.2
Diastolic BP	79.1	77.7-80.5	81.6	79.8-83.4	78.0	76.7-79.3	80.9	79.7-82.1	78.6	77.6-79.5	81.2	80.2-82.3
%:												
Hypertension	20.7	16.4-25.7	35.8	30.0-42.1	22.4	18.5-26.9	35.4	31.6-39.4	21.6	18.6-24.9	35.6	32.3-39.0

CI: confidence interval; HDL-C: high density lipoprotein cholesterol; LDL-C: low density lipoprotein cholesterol; TC: total cholesterol; Hypertension: BP ≥ 140/90 mmHg or using antihypertensive agents

4.2.1.3. Alcohol Use

Alcohol misuse is a major social and health problem in South Africa with approximately one in four adult men and one in ten adult women experiencing symptoms of alcohol related problems (428). The health burden is considerable with 7.1% of mortality attributable to alcohol misuse, which is more than double the global mortality average of 3.2% (174, 179). Of the deaths attributable to alcohol misuse, CVD ranked second after injuries (179).

Approximately two-thirds of the men and just over a quarter of the women in this study reportedly consumed alcohol with the highest rates in the youngest men (72.6%) and women (32.2%) and the lowest in the oldest (50.0% and 18.4%, respectively) (Tables 4.5a and 4.5b, p83-84). A higher rate of alcohol consumption in men has been a consistent finding in South African studies, including the 1990 study conducted in this population (360, 361, 429, 430) and is also reported in Africa and other developing countries (183, 428). For example, in urban Tanzania, lifetime alcohol use was 38.5% in 15-59-year-old men compared to 23.7% in their female counterparts (431).

The prevalence of self-reported alcohol consumption in 2008/09 was higher than in 1990 in 25-64-year-old men (68.5% vs. 56.7%) and women (27.4% vs. 15.1%) (Table 4.6, p85). This was also higher than in previous South African studies (360, 361, 429) suggesting a pattern of rising intake. Of concern is the steep rise in consumption among women, who traditionally had low rates of alcohol use. The increase in alcohol consumption predisposes this population to a higher risk for hypertension along with the other ills that accompany alcohol use.

Traditionally, alcohol consumption was the preserve of elders and other senior or authority figures, and less common among the youth and women of childbearing age (432). Similar to the uptake of smoking in women, weakening of social and cultural barriers that may have previously prevented women from drinking, and increased female autonomy with greater spending power may contribute to a rise in the proportion of women, particularly younger women, who consume alcohol. That alcohol consumption was most prevalent in the youngest women, aged 25-34 years, with almost a third drinking alcohol, and lowest in 65-74-year-old women supports this suggestion. Moreover, this pattern contrasts with the 1990 study where alcohol consumption was most common among 45-54-year-old (19.0%) and least common among 35-44-year-old (12.3%) women.

In keeping with the weakening of social and cultural traditions, the highest rate of alcohol consumption among men in 2008/09 was in the youngest and the lowest was in the oldest, unlike the findings in 1990. That almost three-quarter of the youngest men drank alcohol may point to the success of alcohol advertisements, which are usually aimed at young people and placed for maximum exposure to this market (433). Drinking is linked to notions of financial and social success (190), and promoted as a lifestyle associated with fun, popularity, partying and other evening activities (177, 434). Alcohol advertising is documented to influence young people's behaviour by normalising drinking in many different settings, bringing about positive beliefs about drinking, and encouraging young people to drink alcohol sooner and in greater quantities (190).

In this study, the prevalence of problem drinking, as measured by the CAGE questionnaire, was also significantly higher in men compared to women (49.7% vs. 18.1% $p<0.001$) (Tables 4.5a and 4.5b). However, among those that drank alcohol, problem drinking was high in men (73.4%) and women (67.1%) ($p=0.107$). Despite the fact that most women did not drink alcohol, the bulk of those who did so were problem drinkers. Problem drinking was highest in 35-44-year-old men (54.7%) and in 25-34-year-old women (21.3%) and generally decreased with older age.

The pervasive nature of this drinking pattern among alcohol consumers indicates a culture of problem drinking and the high rates observed are a manifestation of the prevailing societal norms and attitudes that favour erratic heavy drinking. Among South Africans in general there seems to be very little disapproval but a high level of acceptance of heavy drinking, particularly among men (432). Alcohol misuse places a major burden on the health, economic, and social well-being of the individual (177, 429, 435, 436) and these need to be emphasised to change the South African attitude towards problem drinking.

Problem drinking seems to be on the rise among those who consumed alcohol, because it was considerably higher in this study compared to that found in ≥15-year-old urban black men (57.9%) and women (52.8%) in the 2003 SADHS (361). An increase in alcohol misuse among South Africans was also reported by Peltzer and colleagues (429).

4.2.1.4. Physical Activity

South African adults have a particularly high prevalence of physical inactivity compared to other regions globally and it was estimated to have caused 3.3% of all mortality in 2000. Of the burden attributable to physical inactivity, IHD and ischaemic

stroke were responsible for 58.9% and 20.5% of the burden in men, and 40.6% and 27.6% in women, respectively. Viewed differently, 30% of IHD, 22% of ischaemic stroke and 20% of type 2 diabetes in 2000 were caused by physical inactivity in ≥15-year-old South African adults (200).

Surprisingly, levels of self-reported physical activity using the GPAQ were high in this study; men and women engaged in 1150.5 and 972.9 minutes of moderate-to-vigorous physical activity per week, respectively (p=0.006) (Tables 4.5a and 4.5b, p83-84). Conversely, the rates of inactivity were very low with only 6.3% of men and 6.9% of women not meeting the minimum of 150 minutes of moderate-to-vigorous activity per week. These data are not congruent with previous studies that reported much higher levels of physical inactivity in South Africa, including the 2003 SADHS with use of the same GPAQ questionnaire (200, 361, 383, 437). As reported in previous studies, approximately half of the adults had insufficient levels of physical activity (200).

Considering that there is no feasible explanation for the increases in activity levels in this population, it is mandatory to interpret these data with caution. It is highly unlikely that activity levels would have increased so dramatically, particularly in urban environments that are not conducive to encouraging physical activity, and probably reflects over-reporting. Numeracy skills as well as assessing the time spent doing physical activity may have posed challenges during data collection in this study (200).

In view of the difficulties associated with measuring self-reported physical activity, there is a pressing need for a highly reproducible inexpensive and practical tool to objectively measure physical activity in South Africa and other developing regions as well as the need for a standardised methodological approach to reporting and analysing physical activity. While device-based tools such as accelerometers are commonly used in epidemiological studies in developed regions, the cost of these devices makes their widespread use in South Africa unlikely in the near future. Until that time, inconsistencies in self-reported activity levels are likely to continue.

4.2.1.5. Fat Intake

There are two distinct dietary patterns in the South African black population, with those residing in rural areas still consuming a traditional diet low in fats (<25% of energy intake) and sugar, and high in carbohydrates. In contrast, black urban residents have adopted a more western diet that is higher in fat consumption (>25% of energy intake) and lower in carbohydrates (438).

Mean fat intake as a proportion of total energy consumed was similar in men (25.5%) and women (25.6%) (Tables 4.5a and 4.5b, p83-84). In men, fat intake was highest in the youngest men (28.7%) and decreased with age. Fat intake in women was also highest in the youngest women at 26.9% but was lowest in 45-54-year-old women (23.2%). The contribution of fat to total energy intake was within the recommended range of 15-30% of total energy intake (8). However, this was higher than that consumed in traditional diets and suggests that this population is entering the transitional phase between a 'traditional' diet where <25% of energy is derived from fat to a 'western' eating pattern where >35% of energy is from fat (193, 439). This is particularly true for the younger participants (Tables 4.5a and 4.5b, p83-84); among 25-34-year-old men and women, 45.6% and 41.7%, respectively, had a high proportion (>30%) of fat intake demonstrating their shift away from the healthier traditional diets still present in the older study participants.

The contribution of fat to total energy intake in this study was comparable to the 27% reported in this population in 1990 (440), the 24.3-27.7% among residents living in informal urban housing and townships in the Transition and Health during Urbanisation of South Africans (THUSA) study reported in 2005 (441) and the 21-30% reported in urban blacks in 1974 (440). This suggests that the proportion of fat consumption seems to have remained stable over the past two to four decades. Nonetheless, despite the comparable proportions of fat consumed in this and the 1990 study, it is possible that the absolute quantity of fat consumed may have increased during this period. The comparison of these data, however, is beyond the scope of this thesis as it forms part of a Master's dissertation.

4.2.2. PHYSIOLOGICAL RISK FACTORS

The physiological CVD risk factors determined included measures of adiposity, dysglycaemia, dyslipidaemia and hypertension which each contribute to the overall risk for CVD.

4.2.2.1. Adiposity

In 2000, 7.0% of mortality in South Africa was attributable to excess body weight, with the burden approximately double in women compared to men. BMI ≥21 kg/m^2, which is considered the optimal mean for health, was responsible for 87% of diabetes, 68% of hypertensive disease, 45% of ischaemic stroke and 38% of IHD, among other conditions. The proportions of diabetes, CVD and selected cancers attributable to excess body weight in South Africa were higher than global estimates, particularly in women (229).

The mean BMI among women in this study was 33.0 kg/m^2, in the obese range, and approached that of women from Nauru who have the highest mean BMI (35.0 kg/m^2) in the world (225). Even the youngest women who had the lowest mean BMI, at 31.3 kg/m^2, were generally obese (Table 4.5b, p84).

Overweight/obesity has reached epidemic proportions, with 82.8% of women in the current study either overweight or obese, similar to that reported in a convenience sample recruited in the Heart of Soweto Study 'Heart Awareness Days' (82%) (442). The prevalence of overweight/obesity was lowest in 25-34-year-old women (75.3%) and highest in 35-44-year-olds (89.9%); however, the rate of obesity per se was highest in 65-74-year-old women (73.5%). The changes in 25-64-year-old women reveal that from 1990 to 2008/09, the mean BMI increased from 29.5 kg/m^2 to 33.0 kg/m^2 (Table 4.6, p85) and the prevalence of overweight/obesity from 72.7% to 82.6% (Figure 4.1). This was an increase in overweight/obesity of 13.6%.

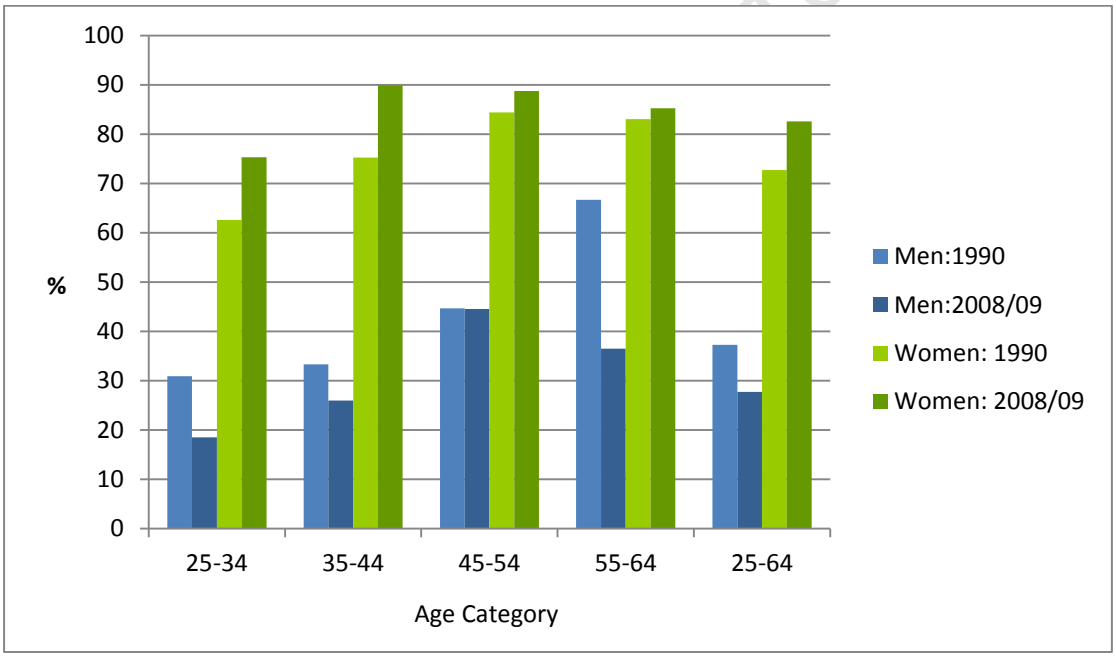


Figure 4.1: Prevalence of body mass index ≥25 kg/m^2 in 25-64-year-old men and women in 1990 and 2008/09

The overweight/obesity prevalence among women in this study is the highest found in SAA (Table 4.7, p92) and is even markedly higher than the 64.1% reported among ≥20-year-old women in the US, a nation where overweight/obesity is known to be highly prevalent (231). Moreover, the obesity rate in this study was 1.8 times greater than the 35.5% prevalence in American women (231) and considerably higher than the global average of 13.8% (225). These data are extremely disconcerting considering the morbidity, mainly attributed to CVD, associated with this condition (220).

Not only is excess body fat per se, i.e. general adiposity as defined by BMI, associated with increased risk, but the distribution of fat also leads to different health consequences (182). The distribution of excess fat predominantly in the abdomen rather than in the pelvis conveys a significantly higher CVD risk (249). Compared with general adiposity, excess fat in the abdominal region is a better predictor of IHD, diabetes and other CVDs (204, 318). Of note is that abdominal or visceral adiposity also contributes to CVD risk in healthy, non-obese individuals (318). For example, for the same level of BMI, the cardiovascular risk may be significantly higher in an individual with excess body fat predominantly distributed in the abdomen rather than the pelvis or out of proportion to total body fat (249).

Abdominal obesity, as defined by central adiposity and measured by WC and WHR (318), was also high in women (Table 4.5b, p84). At 96.8 cm, mean WC was the highest reported in the SSA region, as was the prevalence of raised WC (86.0%) when compared to studies using the same cut-off value (Table 4.7, p92). WC was reported to be a sensitive marker of insulin resistance in young black women without known disease in South Africa and has been shown to be a predictor of CVD risk in longitudinal studies in various ethnic groups (443). Therefore, the extremely high prevalence of raised WC among women in this study may contribute to high levels of dysglycaemia as shown in Section 4.3.6.

Although the rates of general and central obesity were extremely high, raised WHR, an indicator of adipose distribution was present in <50% of women. Almost half of the women with overweight/obesity (47.7%) and raised WC (45.7%) did not meet the criteria for raised WHR. This suggests that, while these women have high levels of adiposity, they have a proportionate distribution of central and peripheral adiposity which may confer a lower cardiovascular risk when compared to women with both raised WHR and raised BMI or WC.

The pattern of adiposity among men in this study was vastly different to that found in women (Table 4.5a, p83). Not only was mean BMI in men within the normal range at 23.7 kg/m^2, the prevalence of overweight/obesity (28.9%) was significantly lower than that in women ($p<0.001$). Overweight/obesity was least prevalent in the youngest (18.5%) and highest in the oldest men (50.0%). The other measures of adiposity in men, that is, raised WC rate of 20.1% and raised WHR of 9.2%, were also much lower than in women.

Table 4.7: Mean and prevalence values for adiposity in some SSA countries from urban population-based studies (except where indicated)

Country, 1st author and year	Mean BMI in kg/m^2		BMI 25-29.9 kg/m^2, %		BMI ≥30 kg/m^2, %		WC in cm		Raised WC, %	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Benin										
Sodjinou (2008) (395)	23.4	28.1	-	-	8.0	28.0	84.4	92.1	-	-
Cameroon										
Fezeu (2006) (444)	24.7	26.7	29.8	32.9	7.0	22.3	83.6	84.8	18.2	66.7
Kamadjeu (2006) (230)	23.4	25.7	21.6	28.6	6.5	19.5	80.0	81.7	13.0	49.2
Kengne (2007) (445)	-	-	23.7	28.8	7.5	21.2	-	-	-	-
Fezeu (2008) (446)	25.0	27.4	30.9	34.5	13.8	27.4	86.6	89.2	48.4	74.3
Democratic Republic of Congo										
Kasiam Lasi On'kin (2007) (447)	23.4	23.6	-	-	12.2	13.3	77.4	77.0	5.6	40.9
Eritrea										
Usman (2006) (367)	-	-	-	-	-	-	-	-	-	25-30
Ethiopia										
Tesfaye (2009) (376)	22.3	24.1	18.2	26.9	2.0	10.8	-	-	-	-
Ghana										
Amoah (2003)[1] (448)	22.6	25.6	17.5	27.1	4.6	20.2	-	-	-	-
Hill (2007) (449)	-	-	-	27.6	-	34.7	-	-	-	-
Mozambique										
Gomes (2010) (450)	-	-	16.3	23.0	5.2	16.4	78.8	79.4	-	-
Nigeria										
Ulasi (2010)[2] (451)	-	-	-	-	-	-	-	-	16.7	70.7
South Africa										
Department of Health (1999)[3] (360)	23.6	28.4	18.8	25.5	9.6	36.3	80.8	86.9	-	-
Department of Health (2007)[3] (361)	23.1	28.1	18.7	27.1	8.1	33.8	78.0	84.6	-	-

BMI: body mass index, WC: waist circumference, raised WC (IDF definition): men >94 cm; women >80 cm

1. Urban and rural combined, 2. Semi-urban, 3. Black urban residents only

The higher prevalence of excess body weight in women than in men is consistent with literature from the local national surveys (360, 361) and the SSA region (348, 357). The reasons for the gender difference are numerous and include socio-economic, environmental, behavioural and cultural factors. Nutrition deprivation in childhood is a risk for obesity in women but not in men (452); the lower caloric requirements in women compared to men as a result of their lower occupational and leisure time activity levels; and women's retention of weight gained during pregnancy, reported to be more marked among ethnic groups such as African American women (453), are likely to be key contributors to excess body weight among women in this population.

The prevalence of overweight/obesity in men, unlike the findings in women, was comparable to that found in ≥15-year-old urban black men in the national surveys conducted in 1998 (28.4%) (360) and 2003 (26.8%) (361). These rates were also within the range of those from other SSA countries where overweight/obesity in urban SSA men ranged from 20.2% in Ethiopia to 44.7% in Cameroon (Table 4.7, p92). The prevalence of obesity among men in this study, at 10.3%, was comparable to the global rate of 9.8% among ≥20-year-old men in 2008 (225).

Also in stark contrast to women, the prevalence of overweight/obesity in 25-64-year-old men was lower in 2008/09 (27.7%) than in 1990 (37.3%) (Table 4.6, p85). This was unexpected as the evidence from studies in both developed and developing regions showed that overweight/obesity usually increased over time, sometimes remained constant, but rarely decreased (446). Globally, stable or decreasing BMI trends were found only among women in central and Eastern Europe and among men in central Africa and south Asia (225). The lower prevalence in 2008/09 in men compared to 1990, despite living in an obesity-enabling environment, is difficult to explain. However, this may be attributed to the high burden of HIV/AIDS and TB in the country. While these conditions affect men and women equally, more women may be screened and treated, particularly at antenatal clinics. Men may be more reluctant to agree to screening for HIV/AIDS; consequently HIV-infected men not on treatment may lose weight compared to HIV-infected women on treatment who regain weight lost and are able to maintain a stable weight. However, all individuals who replied in the affirmative to the question on HIV status and the use of ART during screening were excluded from the current study. Further investigation is required to explain the lower current prevalence of overweight/obesity in men compared to two decades ago.

Table 4.8a: Glucose, lipid and blood pressure profiles presented by age categories in men

	Age category in years													
	25-34 (*n=121)*	S.E.	35-44 (*n=99)*	S.E.	45-54 (*n=86)*	S.E.	55-64 (*n=58)*	S.E.	65-74 (*n=28)*	S.E.	Total (*n=392)*	95% CI	Total[1]	95% CI
Number														
Glucose[2]:														
mean (mmol/l):														
Fasting glucose	4.8	0.1	4.8	0.1	5.6	0.3	5.6	0.3	6.4	0.7	5.1	4.9 - 5.3	5.2	5.0 - 5.4
2-hr glucose	5.4	0.3	5.6	0.2	7.3	0.4	7.7	0.6	8.6	0.8	6.2	5.9 - 6.6	6.3	5.9 - 6.7
%:														
Impaired fasting glycaemia	0.5	0.5	2.1	1.3	2.6	1.7	1.8	1.7	0.0	0.0	1.4	0.6 – 3.0	1.4	0.3 - 2.5
Impaired glucose tolerance	4.7	1.8	8.8	3.0	19.3	4.5	19.1	5.5	21.4	7.6	10.8	8.0 - 14.4	11.2	8.0 - 14.4
Diabetes mellitus	5.7	2.1	1.9	1.2	17.5	4.3	17.3	5.4	42.9	9.8	10.2	7.5 - 13.8	11.3	8.0 - 14.6
Lipids:														
Mean:														
Total cholesterol, mmol/l	4.0	0.1	4.4	0.1	4.7	0.1	4.4	0.2	4.8	0.2	4.3	4.2 - 4.4	4.3	4.2 - 4.4
HDL-C, mmol/l	1.2	0.0	1.4	0.1	1.3	0.1	1.2	0.1	1.2	0.1	1.3	1.2 - 1.3	1.3	1.2 - 1.3
LDL-C, mmol/l	2.6	0.1	2.7	0.1	3.1	0.1	2.9	0.1	3.3	0.2	2.8	2.7 - 2.9	2.8	2.7 - 2.9
Triglycerides, mmol/l	1.1	0.1	1.1	0.1	1.4	0.1	1.5	0.2	1.3	0.1	1.2	1.1 - 1.3	1.2	1.1 - 1.3
HDL-C:TC,%	29.8	0.7	32.4	1.3	28.1	1.4	28.8	1.4	26.3	1.9	29.8	28.7 - 30.9	29.8	28.7 - 30.9
%:														
Total cholesterol >5 mmol/l	13.9	3.6	30.4	5.9	38.0	5.8	26.0	6.0	39.3	9.4	25.2	20.0 - 31.3	25.8	20.1 - 31.4
HDL-C <1.2mmol/l	61.3	4.1	43.2	6.1	55.7	5.9	55.5	6.5	57.1	8.7	55.2	49.9 - 60.4	54.7	49.4 - 60.0
LDL-C† >3 mmol/l	29.3	4.2	38.0	5.2	51.1	6.1	32.9	6.1	57.1	9.2	37.8	32.5 - 43.4	37.9	32.6 - 43.4
Triglycerides >1.5 mmol/l	12.4	3.3	22.2	4.6	28.6	5.4	26.6	6.2	32.1	8.7	20.3	16.0 - 25.4	20.6	16.0 - 25.2
HDL-C:TC <20%	11.6	3.1	2.5	1.3	28.3	5.6	18.5	4.9	28.6	8.9	14.4	10.2 - 18.6	14.4	10.3 -18.4
Blood pressure (BP):														
Mean (mmHg):														
Systolic BP	122.2	1.6	129.7	2.0	136.8	2.9	146.6	3.6	134.5	4.9	129.7	127.2-132.2	130.2	127.7 - 132.7
Diastolic BP	76.6	1.1	83.4	1.4	87.4	1.8	86.9	1.7	79.4	2.3	81.4	79.7 - 83.2	81.5	79.8 - 83.2
%:														
Hypertension[3]	19.3	3.9	35.8	4.8	58.2	6.3	63.6	6.3	67.9	9.1	37.6	31.8 - 43.7	39.3	33.4 - 45.2

1. Age standardised to the SEGI world population; 2. Glycaemic categories based on 1998 WHO criteria; 3. Hypertension: BP ≥ 140/90 mmHg or using antihypertensive agents

S.E: standard error; CI: confidence interval; HDL-C: high density lipoprotein cholesterol; LDL-C: low density lipoprotein cholesterol; TC: total cholesterol

Table 4.8b: Glucose, lipid and blood pressure profiles presented by age categories in women

	Age category in years													
	25-34 (*n=235)*	S.E.	35-44 (*n=163)*	S.E.	45-54 (*n=168)*	S.E.	55-64 (*n=92)*	S.E.	65-74 (*n=49)*	S.E.	Total (*n=707)*	95% CI	Total[1]	95% CI
Number														
Glucose[2]:														
mean (mmol/l):														
Fasting glucose	4.8	0.1	5.1	0.2	6.3	0.3	6.1	0.3	6.7	0.5	5.4	5.2 - 5.6	5.5	5.2 - 5.7
2-hr glucose	5.8	0.2	6.6	0.3	8.8	0.5	8.5	0.5	9.4	0.8	7.0	6.7 - 7.3	7.1	6.8 - 7.5
%:														
Impaired fasting glycaemia (IFG)	1.0	0.7	2.2	1.3	0.3	0.3	0.0	0.0	2.0	2.0	1.1	0.5 - 2.4	1.1	0.3 - 1.9
Impaired glucose tolerance (IGT)	5.2	1.5	10.6	2.8	18.0	3.1	14.8	4.2	18.4	5.7	10.7	8.4 - 13.4	11.1	8.5 - 13.7
Diabetes mellitus	5.9	1.5	10.1	2.5	23.3	3.3	26.9	4.5	34.7	6.3	13.8	11.6 - 16.5	14.7	12.1 - 17.3
Lipids:														
Mean:														
Total cholesterol, mmol/l	4.0	0.1	4.3	0.1	4.8	0.1	5.0	0.1	4.9	0.2	4.4	4.3 - 4.4	4.4	4.3 - 4.5
HDL-C, mmol/l	1.1	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.1	1.1 - 1.2	1.1	1.1 - 1.2
LDL-C, mmol/l	2.8	0.0	2.9	0. 1	3.4	0.1	3.5	0.1	3.4	0.2	3.0	3.0 - 3.1	3.1	3.0 - 3.1
Triglycerides, mmol/l	0.8	0.0	1.1	0.1	1.3	0.1	1.3	0.1	1.4	0.1	1.1	1.0 - 1.1	1.1	1.0 - 1.1
HDL-C:TC,%	26.6	0.4	27.3	0.7	25.2	0.8	25.6	0.8	27.2	2.8	26.4	25.7 - 27.1	26.4	25.7 - 27.1
%:														
Total cholesterol >5 mmol/l	11.1	2.1	19.5	3.2	38.0	3.7	45.8	5.4	38.8	7.5	23.1	20.0 - 26.5	24.1	20.8 - 27.5
HDL-C <1.2mmol/l	71.7	3.0	69.3	3.9	61.3	3.8	59.7	5.6	51.0	7.9	66.8	62.9 - 70.5	66.1	62.3 - 69.9
LDL-C >3 mmol/l	33.5	3.3	41.6	4.0	64.5	3.7	68.8	4.9	73.5	6.4	47.0	43.1 - 50.9	48.3	44.5 - 52.2
Triglycerides >1.5 mmol/l	5.6	1.5	10.6	2.7	19.0	3.3	25.1	5.0	30.6	5.3	12.5	10.1 - 15.4	13.3	10.6 - 16.0
HDL-C:TC <20%	17.3	2.5	15.3	3.0	20.7	3.1	27.3	4.9	26.5	5.4	18.9	16.0 - 21.9	19.2	16.3 - 22.1
Blood pressure (BP):														
Mean (mmHg):														
Systolic BP	111.6	1.0	122.6	1.9	129.6	2.0	137.0	2.6	143.3	4.5	121.6	119.6-123.5	122.7	120.6 - 124.7
Diastolic BP	76.3	0.8	83.8	1.1	84.9	1.1	87.2	1.4	84.6	1.9	81.1	79.9 - 82.3	81.4	80.2 - 82.6
%:														
Hypertension[3]	14.9	2.5	35.4	3.9	60.6	4.0	77.1	4.2	75.5	6.1	37.5	33.7 - 41.4	39.4	35.5 - 43.4

1. Age standardised to the SEGI world population; 2. Glycaemic categories based on 1998 WHO criteria; 3. Hypertension: BP ≥ 140/90 mmHg or using antihypertensive agents

S.E: standard error; CI: confidence interval; HDL-C: high density lipoprotein cholesterol; LDL-C: low density lipoprotein cholesterol; TC: total cholesterol

4.2.2.2. Dysglycaemia

In South Africa, diabetes was the 7th most common cause of death in 2000 when excess mortality attributable to IHD, stroke, hypertensive and renal diseases were taken into consideration (454). Over 20 000 deaths, accounting for 4.3% of all mortality, were estimated to be caused by diabetes and a significant proportion (47%) occurred in the working-age population aged <65 years. Diabetes morbidity further exacerbates the burden of the disease. In South Africa, it is the most common cause of non-traumatic amputations, a leading cause of blindness and accounts for a significant proportion of end-stage renal disease requiring dialysis and transplantation (454). The unacceptably high burden of diabetes can be ascribed to late diagnosis and inadequate management of the condition and its predisposing factors (245, 250).

Diabetes Mellitus

Mean fasting plasma glucose was higher but not significantly so in women (5.4 mmol/l) than men (5.1 mmol/l) (p=0.069), but the 2-hour glucose was significantly higher in women than men (7.0 mmol/l vs. 6.2 mmol/l, p=0.001). The crude and age-standardised prevalence of diabetes by the SEGI world population was 12.1% (95% CI: 10.2-14.0) and 13.1% (95% CI: 11.0-15.1), respectively, with higher rates found in women (crude: 13.8%, 95% CI: 11.4-16.3; age-standardised: 14.7%, 95% CI: 12.1-17.3) compared to men (crude: 10.2% (95% CI: 7.1-13.4); age-standardised: 11.3% (95% CI: 8.0-14.6)) (Tables 4.8a and 4.8b, p94-95).

The age-standardised diabetes prevalence, by the 1985 WHO criteria, was 12.2% (95% CI: 10.2-14.2) compared with the 8.0% (95% CI: 5.8-10.3) prevalence found in 1990 in the same population in those aged >30 years (383). Figure 4.2 demonstrates that the diabetes prevalence in 2008/09 was higher for men and women by all age categories, except for men aged 35-44 years, than in 1990.

The age-standardised diabetes prevalence of 13.1% in this study by the 1998 WHO criteria was among the highest reported in SSA. Comparable diabetes prevalence was only reported in 25-64-year-old adults in Seychelles (11.5%), where about two-thirds of the population is of predominantly African descent (455). Though, a small opportunity sample (n=281) of 17-68-year-old urban Kenyans in whom a 12.2% prevalence with a high degree of uncertainty (95% CI: 5.4-23.2) was found, is not directly comparable (456). In 1990 too, the prevalence of diabetes was considerably higher than that reported from elsewhere in SSA (250, 383).

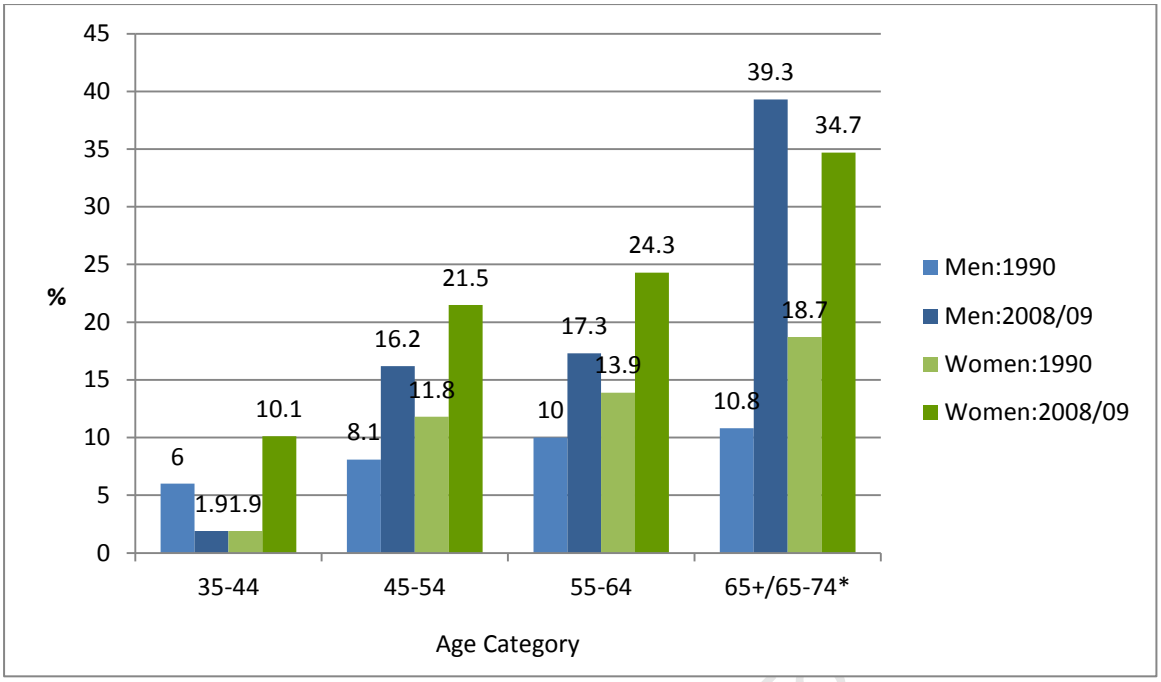


Figure 4.2: Diabetes prevalence based on 1985 WHO criteria presented by age categories for men and women in 1990 and 2008/09. *65+ years: 1990, 65-74 years: 2008/09

Another notable finding was the sharp increase in diabetes prevalence in participants older than 45 years, peaking in 65-74-year-old men (42.9%) and women (34.7%). The steep rise in those older than 45 years has implications for the country's economy with a potential loss of productivity because of diabetes-related morbidity and mortality occurring in individuals who are still part of the workforce. The peak diabetes prevalence in this study was in keeping with SSA studies with most reporting a peak at either 65 years or older, indicating that the effect of ageing of this population on diabetes was already evident (243). This is similar to developed countries where diabetes occurs predominantly in those ≥65 years (240, 457).

The low diabetes prevalence in 35-44-year-old men (1.9%) was unexpected and an explanation is not readily apparent. It is unlikely to be related to a small number of participants in this age group as they numbered approximately 100. However, it is, conceivable that this may be a survivor effect, in that those who had AIDS at an earlier age have died and this may subsequently reduce the number of individuals at risk for diabetes (240). Supporting this theory is death notifications in South Africa which indicate that HIV has contributed to mortality, particularly in 35-39-year-old men (458).

Impaired Glucose Tolerance

The crude and age-standardised prevalence of IGT by the 1998 WHO criteria (10.7% (95%CI: 8.9-12.6) and 11.2% (95%CI: 9.2-13.1), respectively) (Tables 4.8a and 4.8b,

p94-95) was among the highest found in SSA where IGT has generally been reported to be <10% (243, 459). As with diabetes, the prevalence of IGT increased markedly in those over 45 years. This demonstrates the increased risk for diabetes in the working-age population.

The age-standardised IGT prevalence, according to the 1985 WHO criteria, rose from 7.0% (95%CI: 4.9-9.1) in 1990 (383) to 11.7% (95%CI: 9.8-13.7) in 2008/09. Considering that up to 70% of those with IGT may progress to diabetes (456), this increase over time may indicate a dramatic rise in future diabetes in this population.

Impaired Fasting Glucose

The crude and age-standardised prevalence of IFG was low (1.2% (95%CI: 0.6-1.9) and 1.2% (95%CI: 0.6-1.9), respectively) and unexpected (Tables 4.8a and 4.8b, p94-95). This underscores the need for the OGTT in epidemiological studies to identify those with IGT when estimating future trends in diabetes. IGT and IFG are not interchangeable and denote different abnormalities of glucose regulation, one in the fasting state (IFG) and one post–prandial (IGT) (239). Their determinants differ with raised hepatic glucose output and a defect in early insulin secretion characteristic of IFG, while peripheral insulin resistance is most characteristic of IGT (460). The low IFG prevalence in this study would be related to low mean fasting glucose levels, in accordance with the reported levels from SSA for men and women (241). Globally, SSA men had the lowest mean fasting glucose levels, while women had the 2nd lowest levels after the high-income Asia-Pacific region.

This, together with the finding that only 16 (27.1%) of the newly diagnosed diabetic participants (n=59) in this study were diagnosed on fasting glucose levels, in keeping with previous studies from SSA in which diabetes prevalence rates were lower when based only on fasting glucose compared to the OGTT (243, 388), emphasises the need for OGTT in epidemiological studies in the region. However, OGTTs are cumbersome and inconvenient (461, 462).

An alternative diagnostic option may be the use of HbA_{1C}, which is convenient as it can be performed in the non-fasting state and is much less time consuming than an OGTT (242, 462). However, the discordant diagnosis of diabetes with HbA_{1C} and the glucose criteria used are of concern (242). Numerous studies have demonstrated a lower prevalence of undiagnosed diabetes using HbA_{1C} compared to OGTT criteria. The HbA_{1C} criteria have high specificity (>90%) but lower and great variability in sensitivity in diagnosing diabetes when compared to OGTT. The sensitivity ranges

from 17% in Australians to 78% in Asian Indians for HbA_{1C} ≥6.5%. The use of alternative HbA_{1C} cut-points as well as ethnic-specific cut-points has been proposed.

Furthermore, the wide adoption of HbA_{1C} as a diagnostic criterion would inevitably result in different prevalence estimates to that found with OGTT. The use of different methodologies to diagnose diabetes would therefore impact considerably on the ability to compare longitudinal changes in dysglycaemia in populations (242).

Table 4.9: Prevalence of awareness, treatment, control and drug use in men and women with diabetes, hypertension and raised low-density lipoprotein cholesterol (LDL-C)

	Total	Men	Women	P
Diabetes mellitus (n=160)	12.1	10.2	13.8	0.099
% of diabetic participants that were:				
Aware of diagnosis	57.9	48.2	64.4	0.077
Receiving treatment	38.6	31.3	43.5	0.233
Receiving combination therapy	22.4	16.6	26.4	0.260
% of diabetic participants on treatment with (n=68):				
Fasting glucose <7 mmol/l	26.8	22.6	28.8	0.619
% of diabetic participants that used:				
Insulin (A10A)	10.5	8.8	11.7	0.621
Oral agents: Biguanides (A10BA)	28.2	17.9	35.0	0.064
Sulphonylureas (A10BB)	25.0	21.1	27.5	0.487
Hypertension (n=461)	37.5	37.6	37.5	0.984
% of hypertensive participants that were:				
Aware of diagnosis	52.0	32.7	69.5	<0.001
Receiving treatment	39.6	21.9	55.7	<0.001
Controlled on treatment (BP<140/90 mmHg)	22.0	10.4	32.4	<0.001
% of hypertensive participants that used:				
Diuretics (C03)	35.5	19.4	50.1	<0.001
ACE inhibitors (C09AA)	23.5	14.2	31.8	<0.001
β-Blockers (C07A)	7.2	4.4	9.8	0.029
Calcium channel blockers (C08)	15.8	9.6	21.4	0.001
Other (reserpine: C02AA02, hydralazine: C02DB02)	3.6	2.3	4.9	0.182
Raised LDL-C >3 mmol/l or on lipid lowering drugs (n=520)	42.6	37.8	47.0	0.008
% of these participants that were:				
Aware of diagnosis	2.6	2.3	2.8	0.703
Receiving treatment	2.7	2.0	3.2	0.455
Controlled on treatment (LDL-C ≤3mmol/l)	1.5	0.4	2.3	0.049

Management

The prevalence of known diabetes in this study, at 57.9% (Table 4.9), was comparable to the 58.8% reported in ≥40-year-old diabetic participants in Nigeria (463) and the 54.0% in Seychelles (455). The minimal improvement in the proportion of participants with a prior diagnosis of diabetes compared to the 1990 study (52.2%) (383) indicates that screening for this increasingly common condition may not be receiving the necessary attention. Diabetes awareness and education is also crucial to enable regular screening and early detection, especially considering that over 80% of those with diabetes in this study were <65 years old.

The minimally higher prevalence of those with diabetes who were on treatment in 2008/09 (38.6%) (Table 4.9, p99) compared to 1990 (35%) (383) supports the notion that PHC for diabetes is still inadequate. Further, of those on treatment in this study, only 26.8% had fasting glucose levels <7.0 mmol/l as recommended by the Society for Endocrinology, Metabolism and Diabetes of South Africa (SEMDSA) (464). Reinforcing the suboptimal management of patients with diabetes in this community was the low level of controlled diabetes in the public sector community health centres. Steyn and colleagues reported that only 42% had non-fasting blood glucose levels <11.1 mmol/l (465).

4.2.2.3. Dyslipidaemia

A substantial amount of CVD in South Africa can be attributed to non-optimal cholesterol levels, resulting in a high proportion of deaths and disability. High cholesterol was estimated to cause 4.6% of all deaths in South Africa in 2000. Approximately 59% of IHD and 29% of ischaemic stroke burden in ≥30-year-old adults were attributable to raised cholesterol (≥ 3.8 mmol/l) with deaths attributable to the latter in women double those in men (262).

Of the so-called racially defined population groups (black, white, coloured and Indian) in South Africa, dyslipidaemia affects some groups more than others (389). The prevalence in ≥30-year-old adults was lowest in the black population (27.6%) compared to the other South African population groups whose rates exceeded 80% (262). Even among South Africans with diabetes, black men and women had significantly lower mean TC levels compared to their white counterparts (466). The black population usually has lower TC and higher HDL-C levels than other populations; indicative of a protective pattern against developing atherosclerosis and subsequent IHD (233).

Mortality attributable to non-optimal TC was only 1.8% in the black population. Most of the burden attributable to non-optimal TC was on account of IHD (74.0%-91.4%) in the other three population groups compared to the black population, where IHD accounted for 58.1% and ischaemic stroke for 41.9%, with approximately similar proportions contributing to the burden of raised TC (262).

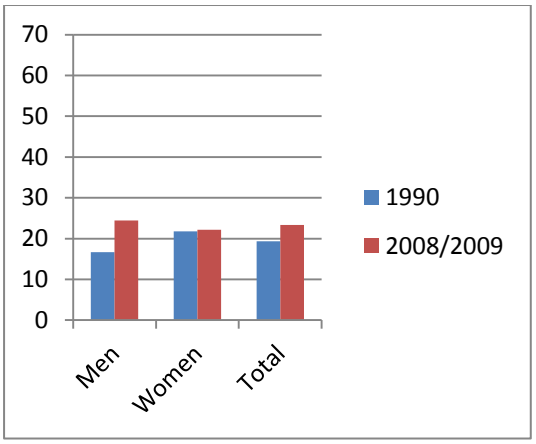
In contrast to previous findings, this study reveals that dyslipidaemia was a major CVD risk factor in this population. Low HDL-C was the most prevalent dyslipidaemia abnormality and more common in women than in men (66.1% vs. 54.7% p<0.001) (Tables 4.8a and 4.8b, p94-95). Further, there has been a marked change in the prevalence of low HDL-C since 1990, when in 25-64-year-old men and women the prevalence was 37.3% and 30.0% (p=0.060), respectively, compared to 55.1% and 67.7% (p<0.001), respectively, in 2008/09 (Table 4.6, p85). Sumner and colleagues state that over the last four decades HDL-C levels have been gradually declining in Africa as documented by various studies and may be attributed to urbanisation and the attendant changes in BMI, diet and physical activity patterns (467). Although lower than the findings in this study, low HDL-C was also the most prevalent dyslipidaemia in Ghanaian women (59.1%) (449) and in urban Tanzanian men (10.3%) (468).

The prevalence of low HDL-C peaked in 24-34-year-old men (61.3%) and women (71.7%). The trend in men echoed other studies which found that age does not appear to be associated with HDL-C levels (469). In women, however, the prevalence of low HDL-C decreased with age.

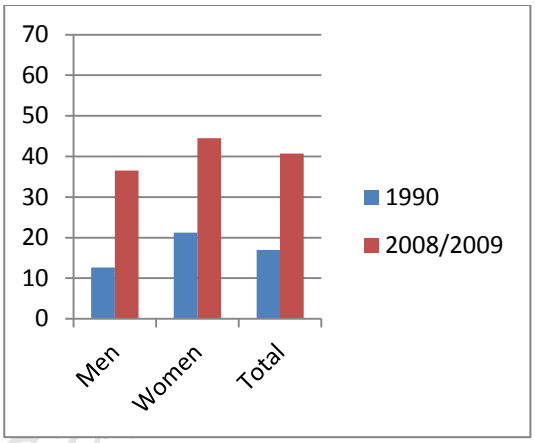
The higher prevalence of low HDL-C as well as the lower mean HDL-C levels in women (1.1 mmol/l) compared to men (1.3 mmol/l) was unexpected considering that generally more men than women are identified as having low HDL-C (469) as was found in this population in 1990 (Table 4.6, p85 and Figure 4.3c). The causes of low HDL-C levels are largely unknown (469) and the reasons for worse HDL-C profiles in women compared to men can only be speculated. The considerably higher prevalence of overweight/obesity in women may be a contributory factor. On the other hand, smoking prevalence, a contributory factor to low HDL-C levels, was higher in men than in women. Among African-Americans, higher mean HDL-C levels were found in men compared to women and this was thought to be related to a genetic/racial predisposition to reduced activities of hepatic lipase (324).

Among both men and women, an additional contributor to the markedly low HDL-C levels in this setting may be the HIV/AIDS epidemic. HIV-infected individuals are

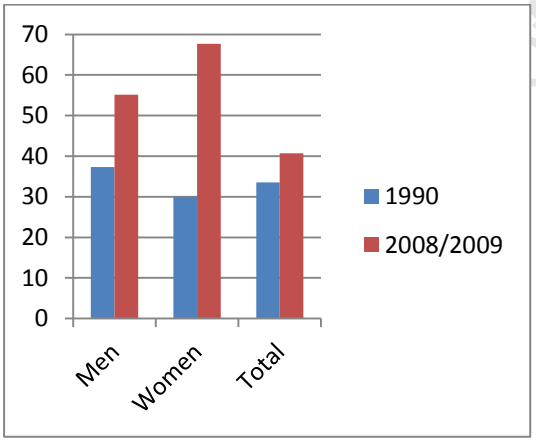
known to have altered lipid profiles, in particular low HDL-C levels, which are exacerbated with ART specifically regimens that contain protease inhibitors (470, 471). This is especially relevant in South Africa, as the country has the highest prevalence of HIV/AIDS in the world with over 30% of the sexually active population infected with HIV (472). Although known HIV-infected individuals and those receiving ART were excluded from the study, many South Africans are not aware of their HIV status. Therefore, it is likely that a proportion of study participants may have been HIV-positive.



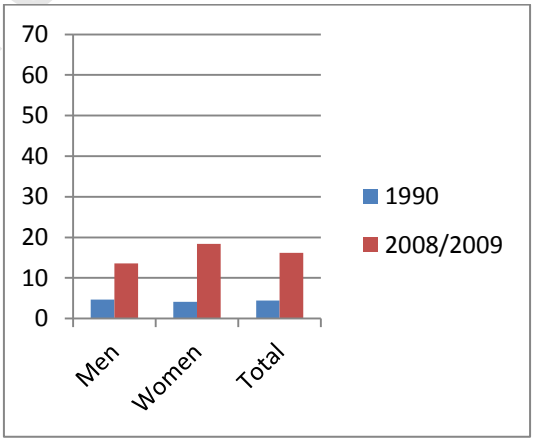
a) TC >5.0 mmol/l



b) LDL-C >3.0 mmol/l



c) HDL-C <1.2 mmol/l



d) HDL-C/TC <20%

Figure 4.3: Prevalence of raise total cholesterol (TC), low high-density lipoprotein cholesterol (HDL-C), high low-density lipoprotein cholesterol (LDL-C) and low HDL-C/ TC ratio in 25-64-year-old men and women in 1990 and 2008/09

The prevalence of low HDL-C/TC was also significantly higher in women compared to men (18.9% vs. 14.4% p<0.001). Low HDL-C/TC peaked in 65-74-year-old men (28.6%) and in 55-64-year-old women (27.3%).

The steep rise in the prevalence of low HDL-C/TC over the past two decades, with rates being 4.5 times higher in women and 2.9 times higher in men in 2008/09 compared to 1990, is worrying (Table 4.6, p85 and Figure 4.3d). HDL-C/TC has been found to be a better predictor of atherosclerosis and CVD than any other single lipid

parameter, and was more than twice as informative as TC (473, 474). Low HDL-C/TC was shown to be associated with higher BP, increased triglycerides and hyperinsulinaemia; each of these an independent risk factor for CVD (473). The additional protective effect of their previously high HDL-C/TC levels against atherosclerosis-related diseases in the black population, compared to the other three South African population groups (389), is now likely to be reduced.

Raised LDL-C was the second most common lipid abnormality with rates of 37.8% in men and 47.0% in women (p=0.008) (Tables 4.8a and 4.8b, p94-95). Once again, the prevalence of raised LDL-C was significantly higher in 2008/09 (men: 36.5%, women: 44.5%) compared to 1990 (men: 12.6%, women: 21.2%) among 25-64-year-old participants (Table 4.6, p85 and Figure 4.3b).

Despite the significant differences in HDL-C and LDL-C between men and women, mean TC levels were comparable at 4.3 mmol/l and 4.4 mmol/l, respectively. Mean TC levels and hypercholesterolaemia peaked in 65-74-year-old men and 55-64-year-old women. The prevalence of hypercholesterolaemia was 25.2% and 23.1% in men and women, respectively. Between 1990 and 2008/09, the prevalence of hypercholesterolaemia among 25-64-year-old participants remained similar in women (21.8% vs. 22.2%) but rose in men (16.7% vs. 24.4%) (Table 4.6, p85 and Figure 4.3a).

The markedly higher rates of raised LDL-C and low HDL-C, compared to the lesser changes in raised TC, between 1990 and 2008/09 illustrates the importance of measuring all the lipid parameters and not just TC, particularly in individuals of African descent. If only TC was measured in this study, almost half (48.5%) of the participants with raised LDL-C would have been missed and the deterioration in lipid profiles from 1990 would have remained unrecognised. Therefore, to accurately assess the lipid-related risk for IHD in this population, it would be prudent to focus on measuring LDL-C levels (262) as this is the usual target of treatment, along with the other lipid components, which are independently related to cardiovascular risk. Other studies have also shown that the disadvantage of using only TC as a screening tool is that it overlooks specific lipid parameters that are important in determining IHD risk (473).

Previously, the favourable lipid profile has been cited as the reason for the slower emergence of IHD compared to stroke among the black South African population, despite the presence of other CVD risk factors, particularly hypertension (475). However, this protective mechanism against IHD is no longer evident with high LDL-

C and low HDL-C levels now prevalent. This may well be a pointer to an eventual increase in IHD in this population as raised LDL-C is known to be the driving force for atherosclerosis (262, 389, 476). Indeed, a rise in the caseload of IHD in the urban black population of South Africa has already been noted (389, 477).

The treatment of dyslipidaemia is one of the cornerstones of CVD prevention with the association of lower blood cholesterol with a reduced risk of IHD demonstrated in studies (476). The dyslipidaemic patterns of high levels of LDL-C and/or low HDL-C, characteristic of many participants in this study, impart a high risk for developing IHD and justify aggressive treatment to reduce cardiovascular risk (262). For every mmol/l reduction in LDL-C, mortality is reduced by 10%, all-cause morbidity by 20%, major cardiac events by 23% and stroke by 17% (322). Nonetheless, in the current study dyslipidaemia is mostly unrecognised and consequently not treated; only 14 participants (2.6%) were aware of their diagnosis (Table 4.9, p99).

Of those with raised LDL-C, only 2.7% (n=16) were on treatment and 1.5% (n=10) had LDL-C ≤3mmol/l (Table 4.9, p99). The management of dyslipidaemia in South Africa has also been shown to be suboptimal in other studies (477-480). Few patients in South Africa are treated for hyperlipidaemia with lipid-lowering agents (480) or are even aware of their cholesterol status. This particularly evident among participants on treatment, where less than half (45.2%; n=7) were aware of their condition, highlighting the lack of awareness even among those receiving treatment. The lack of awareness of poor lipid profiles would likely translate into a failure to modify lifestyles such as diets high in saturated fats and minimal attempts at weight loss, which are the cornerstone of management (322). Medication is not a substitute for a healthy diet and lifestyle (322, 389, 473) and the emphasis of management is to reduce cardiovascular risk by healthy diets and regular exercise (322).

4.2.2.4. Hypertension

Studies have demonstrated that hypertension is a strong contributor to CVD in individuals of African descent (376) including in South Africa where high BP contributes substantially to the CVD burden (481). In the SADHS of 1998, using 140/90 mmHg as the cut-off, a hypertension prevalence of 21.5% and 25.4% in urban black African men and women was reported, respectively (360). In 2000, after sexually transmitted diseases, high BP was the second leading risk factor contributing to mortality in South Africa. Almost 47 000 deaths or 9% of total mortality was attributable to high BP indicating the profound effect of this disease burden on the local population. Approximately 50% of stroke, 42% of IHD, 72% of hypertensive

disease and 22% of other CVD burden in ≥30-year-old adults was on account of high BP. Moreover, a significant proportion of mortality attributable to high BP occurred in those aged <60 years (481).

Mean systolic BP was higher in men (129.7 mmHg) compared to women (121.6 mmHg) (p<0.001) but their diastolic BP was similar (81.4 mmHg vs. 81.1 mmHg, p=0.750) (Tables 4.8a and 4.8b, p94-95). The crude and age-standardised (SEGI world population) prevalence of hypertension was 37.5% (95%CI: 34.2-40.9) and 39.4% (95%CI: 36.0-42.7), respectively, representing an enormous burden in this population. The similar prevalence in men and women (p=0.984) agreed with findings in developing regions in a systematic review of 35 countries by Pereira and colleagues (281). In contrast, hypertension prevalence in developed regions was usually higher in men compared to women.

However, the hypertension prevalence among men in this study was higher than the 32.2% shown in developing regions, but comparable to the 40.8% in developed countries. The rates in women were also higher than those found in developing regions (30.5%) and, unlike in men, higher than that reported in developed regions (33.0%) (281). Nevertheless, the high hypertension burden in this population is not unique in SSA as demonstrated by high rates in other SAA centres (Table 4.10, p106). Higher rates compared to this study were found among 25-64-year-old men in Seychelles (44.0%) but rates in their female counterparts were lower (36.0%) (482).

In the current study, there was a sharp increase in hypertension prevalence in ≥45-year-old men and women. The peak age for hypertension by sex was in 65-74-year-old men (67.9%) and in 55-64-year-old women (77.1%) (Tables 4.8a and 4.8b, p94-95).

Among 25-64-year-old participants, the hypertension prevalence was much higher in 2008/09 (35.6%) than in 1990 (21.6%) (Table 4.6, p85). The prevalence in 2008/09 was significantly higher than in 1990 for men and women but by age category it reached significance only in those younger than 45 years (Figure 4.4).

That the disease burden associated with raised BP is high in South Africa (481), notwithstanding the availability of safe and effective treatment, indicates that the detection and management of hypertension has been suboptimal. Confirming this were the low levels of hypertension awareness, treatment and control found in this study, particularly in men. In 2008/09, hypertension awareness, treatment and control among participants with hypertension were 32.7%, 21.9% and 10.4% in men, and 69.5%, 55.7% and 32.4% in women, respectively (Table 4.9, p99).

Table 4.10: Hypertension prevalence, awareness, treatment and control in some SSA countries from population-based studies (urban and rural combined except where indicated)

Country, 1st author and year	Hypertension prevalence			Awareness among hypertensives			Treatment among hypertensives			Control among hypertensives		
	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total
Benin												
Houinato (2012) (483)			27.9									
Cameroon												
Kamadjeu (2006) (300)	25.6	23.1	24.6	-	-	23.0	-	-	10.8	-	-	2.0
Kengne (2007) (445)	-	-	20.8	-	-	-	-	-	-	-	-	-
Fezeu (2010) (295)	39.6	37.2	-	-	-	-	-	-	-	-	-	-
Ethiopia												
Tesfaye (2009)[1] (376)	31.5	28.9	-	-	-	35.2	-	-	11.0	-	-	<0.1
Eritrea												
Usman (2006) (367)	-	-	16.0	-	-	20.0	-	-	-	-	-	-
Ghana												
Amoah (2003) (448)	27.6	29.5	28.3	-	-	34.0	-	-	18.0	-	-	4.0
Cappuccio (2004)[2] (484)	29.9	29.0	28.7	13.9	27.3	22.0	7.8	13.6	11.3	4.4	1.7	2.8
Agyemang (2006)[1] (378)	33.4	28.9	-	27.2	44.2	-	22.8	34.9	-	5.1	7.0	-
Hill (2007)[1] (449)	-	40.2	-	-	-	-	-	-	-	-	-	-
Mozambique												
Damasceno (2009)[1] (485)	40.0	41.0	-	15.2	32.2	-	<0.1	20.4	-	<0.1	0.1	-
Namibia												
Hendriks (2012)[1] (486)	-	-	38.0	-	-	38.0	-	-	17.0	-	-	18.0
Nigeria												
Adedoyin (2008)[3] (487)	-	-	36. 7	-	-	-	-	-	-	-	-	-
Seychelles												
Danon-Hersch (2007) (482)	44.0	36.0	40.0	55.0	75.0	64.0	49.0	72.0	59.0	12.0	30.0	20.0
South Africa												
Department of Health (1999)[4](360)	21.5	25.4	-	23.7	54.3	-	17.5	35.6	-	8.2	18.7	-
Tanzania												
Edwards (2000)[1] (488)	37.3	39.1	-	-	-	18.0	-	-	10.0	-	-	0.4
Bovet (2002)[1] (489)	27.1	30.2	-	22.8	37.0	31.0	7.6	13.7	11.2	2.6	4.3	6.5
Hendriks (2012)[1] (486)	-	-	23.7	-	-	18.0	-	-	9.0	-	-	5.0

1. Urban only, 2. Semi-urban and rural combined, 3. Semi-urban, 4. Black urban residents only

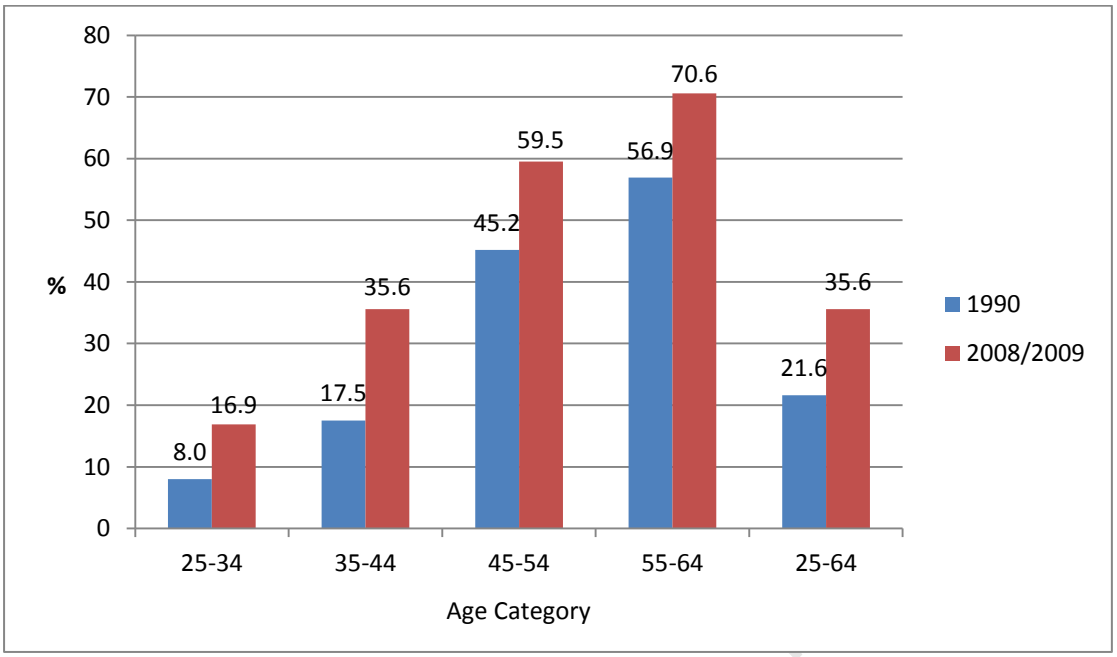


Figure 4.4: Prevalence of hypertension presented by age categories (25-64 years) in 1990 and 2008/09

The sub-optimal management of hypertension prevailing in this study is a common thread in other South African studies. Poor rates of hypertension control of only 18% were reported in the African Programme on Genes in Hypertension study in Soweto, while approximately 51% of hypertensive patients received treatment (490). In the 1998 SADHS, rates of hypertension awareness, treatment and control among hypertensive urban black men and women were 23.7%, 17.5% and 8.2% vs. 54.3, 35.6% and 18.7%, respectively (360). In a study among urban black hypertensive patients attending Ga-Rankuwa day clinics hypertension control rates of only 41.4% were found (491).

The differentially better management of hypertension in women compared to men accounts for the lower systolic BP in women despite the similar hypertension prevalence between the sexes in this study. The better hypertension management in women is in keeping with findings from the SADHS (360), SSA (Table 4.10, p106) and other developing regions (37) as well as developed nations (281). Of interest is that this pattern was evident even in populations where hypertension management was very poor (485). The likely explanation is that women are more in contact with healthcare services because of maternal and child health programmes, and display greater health-seeking behaviour resulting in greater chances for BP measurements (302, 485, 492). Men may also be more likely to be employed or looking for

employment and consequently time constrained from attending healthcare clinics during office hours.

In other regions of SSA, despite an increasing prevalence of hypertension, hypertension awareness, treatment and control remains very low in most countries (298, 300, 306) with reported rates lower than that found in this study (Table 4.10, p106). The lower levels in the region are probably a reflection of more limited access to healthcare both in terms of inadequate provision of healthcare services by governments and the inability of individuals to pay for healthcare. Along with this is a lack of awareness among those with hypertension of the need to treat a condition with essentially no symptoms (281, 378, 492-494).

Two SSA countries with comparable or higher rates of hypertension awareness and treatment to this study include Seychelles (482) and Ghana (492). In the former, hypertension prevalence was similar to the current study (40.0%), hypertension awareness (64.0%) and treatment (59.0%), were much higher but hypertension control was equally poor (20.0%) (482). Among Ghanaian civil servants aged 25-68 years with a hypertension prevalence of 30.3%, the rate of awareness at 54.1% was similar to this study, but rates of treatment (31.3%) and control (12.7%) were lower (492). The low levels of hypertension management in SAA, including South Africa present a serious challenge for the prevention of morbidity and mortality from hypertension complications.

Suboptimal hypertension management is a worldwide problem with inadequate rates of hypertension control found in developed and developing regions (281). Nonetheless, reports from high-income countries demonstrate that it is possible to achieve better hypertension management. While far from optimal, in recent reports from the US, the prevalence of hypertension awareness, treatment and control was found to be 70%, 59% and 30%, respectively (134). Whereas in the NHANES 2003–2006 study, rates among African-Americans were 79.5%, 71.8% and 44.6%, respectively (495). In each instance these rates were much higher than those found in this study.

Figure 4.5 illustrates the rising prevalence of hypertension awareness, treatment and control by age category, with significantly higher rates in older compared to younger participants ($p<0.001$ for all). The highest rates were among 65-74-year-old hypertensive participants: awareness: 85.5%, treatment: 75.7% and control: 43.7%. The differential hypertension management by age, with better management in older compared to younger hypertensive participants, mimics the 1998 SADHS (496).

Older participants may utilise healthcare services more frequently resulting in greater opportunities for BP testing and may be more adherent with their treatment. Then again, healthcare professionals may consider younger individuals to have lower cardiovascular risk, compared to older people, and may therefore screen and treat them less frequently.

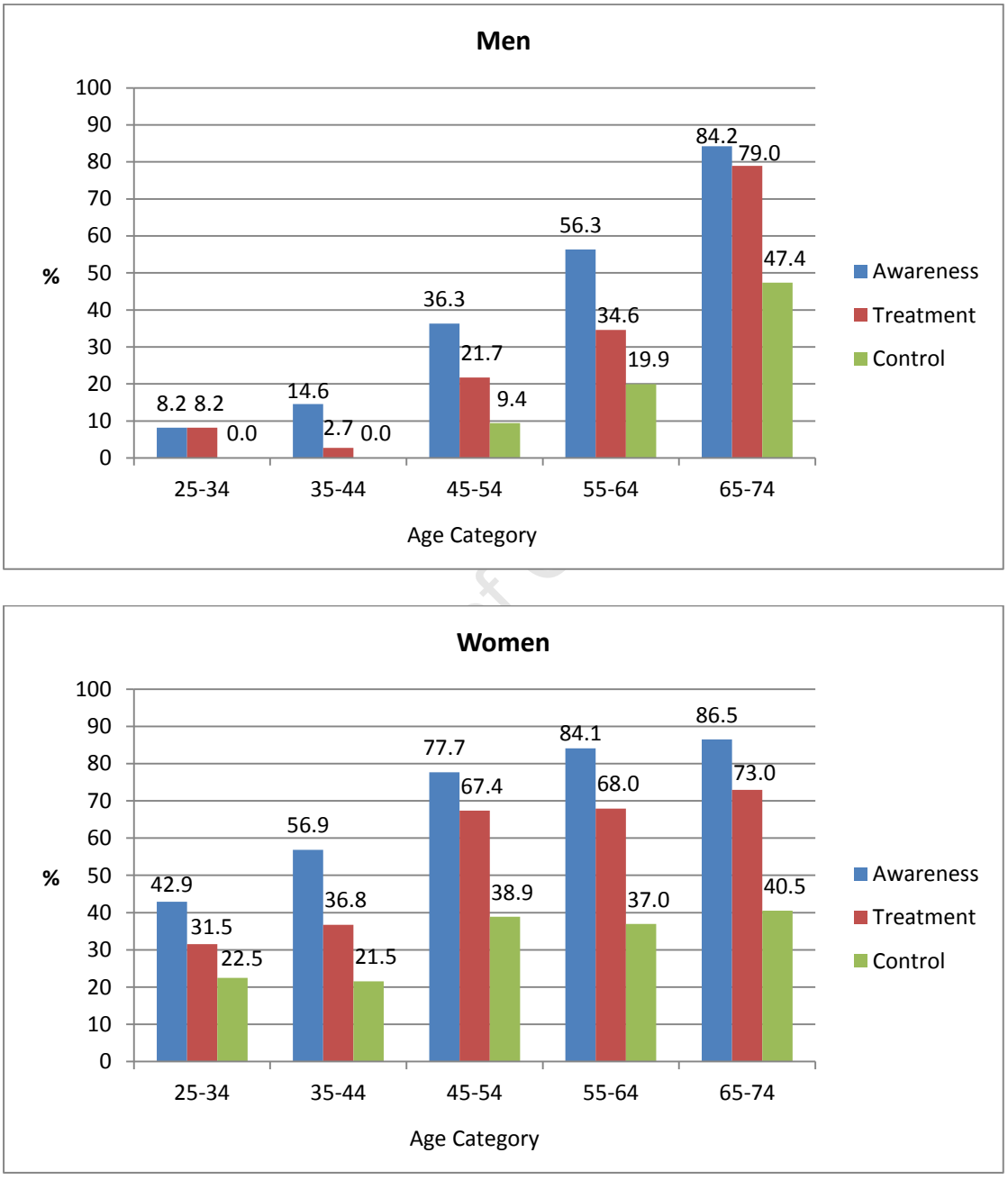


Figure 4.5: Prevalence of hypertension awareness, treatment and control presented by age categories in men and women with hypertension in 2008/09

There was no improvement in the rate of hypertension awareness and treatment among 25-64-year-old hypertensive men in 2008/09 compared to 1990 (Figure 4.6). In fact, even though not statistically significant, their prevalence of hypertension control was much lower in this study (2008/09: 6.4% (95% CI: 3.5-11.4); 1990: 12.6%

(95% CI: 6.3-23.5)). Despite the higher hypertension prevalence in 2008/09, the availability of newer medications and increasing awareness of the consequences of even mildly elevated BP, the recognition and appropriate management of hypertension with optimal BP control remains extremely poor in men.

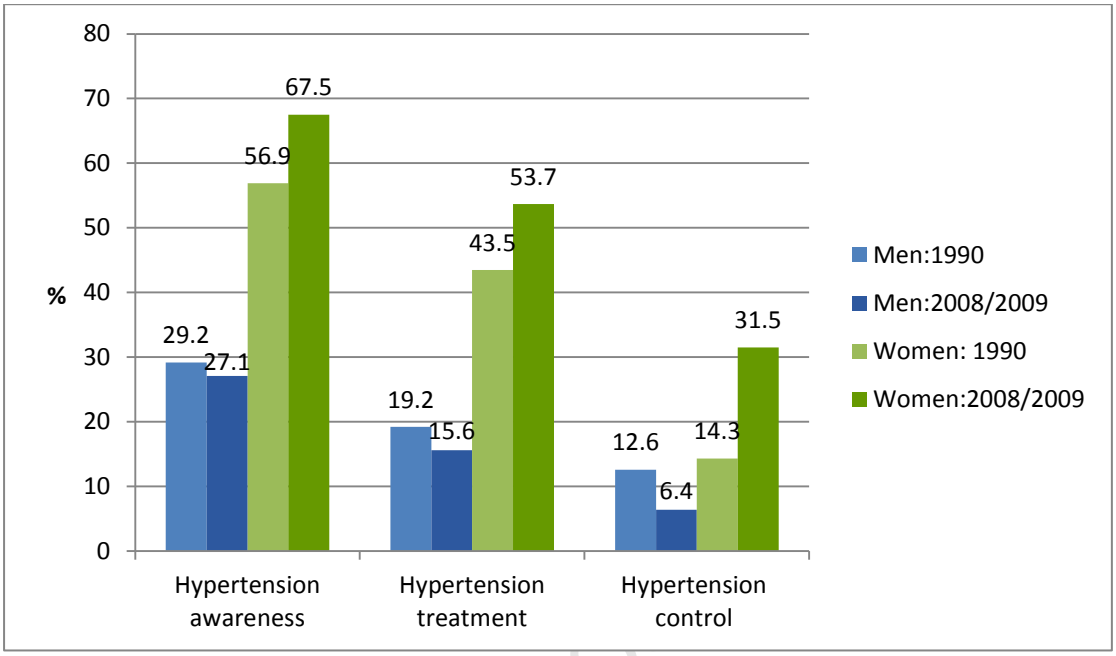


Figure 4.6: Prevalence of hypertension awareness, treatment and control among 25-64-year-old men and women with hypertension in 1990 (n=166) and 2008/09 (n=405)

In contrast, among 25-64-year-old hypertensive women, the prevalence of hypertension awareness, treatment and control was higher in 2008/09 compared to 1990 (Figure 4.6). However, only hypertension control improved significantly: 2008/09: 31.5% (95% CI: 25.9-37.7); 1990: 14.3% (95% CI: 8.4-23.2). This may be because of the availability of better antihypertensive agents or enhanced compliance in that women may be more likely to accept treatment or lifestyle changes more readily (492). To identify ways to achieve optimal hypertension treatment and control, further research is required to understand the dynamics that differentially influence hypertension control in men and women in this population.

4.2.3. SUMMARY OF THE CARDIOVASCULAR DISEASE RISK FACTOR PATTERNS

Prevalence

The prevalence of CVD risk factors in the urban black population of Cape Town was high and among the highest reported in South Africa as well as SSA. There were gender differences with smoking and problem drinking more prevalent in men, and dyslipidaemia and overweight/obesity higher in women. Diabetes prevalence was higher in women than in men, but the difference was not significant, while

hypertension and high fat intake were similar by gender. Most risk factors were higher in 2008/09 than in 1990, with the exception of smoking and overweight/obesity in men, which were lower. The prevalence of self-reported physical inactivity was low in men and women, and is likely to have been underestimated.

Treatment

The high burden of these CVD risk factors represents a major public health challenge because of their magnitude, difficulty in management and associated complications and costs. These and other data have demonstrated that prevention, early detection and management of CVD risk factors are inadequate (245, 465, 477, 497, 498)**.** The management of diabetes and hypertension was suboptimal, while awareness, detection and treatment of dyslipidaemias were almost non-existent in this population. There are currently no concerted efforts to encourage weight loss or smoking cessation through effective community-based programmes.

Comprehensive multi-facetted intervention strategies are urgently required to combat the high levels of CVD risk factors and prevent the predicted CVD epidemic in South Africa (387). CVD programmes need to be population-based, culturally appropriate, and gender and age-orientated for optimal effectiveness (249). An integrated approach is required for the control of all major risk factors and the reduction of total cardiovascular risk; the treatment of each risk factor must be seen within the broader framework of CVD prevention (306, 322).

4.3. ASSOCIATIONS AMONG CARDIOVASCULAR DISEASE RISK FACTORS

The importance of determining the variables associated with each CVD risk factor is to gain a better understanding of the dynamics related to the development of CVD. Additionally, a combination of risk factors markedly increases the risk for CVD, as will be discussed later in this chapter.

In the multiple logistic models, the three psychosocial measures were entered independently for all risk factors discussed. The models with SOC are presented in the tables. The association of the other psychosocial variables with the CVD risk factors are also presented at the bottom of the table and any changes in the direction of association of the other variables in the models have been noted.

The psychosocial variable SOC was modelled as a continuous or categorical variable with different cut-points based on the association demonstrated between SOC and the individual CVD risk factor. Since urbanisation was a known risk factor it was

controlled for in the best way possible which meant different cut-points for different outcomes.

4.3.1. Smoking

Figure 4.7 illustrates the prevalence of the physiological CVD risk factors by smoking status. The prevalence of diabetes (14.7 vs. 5.2, p<0.001), high LDL-C (46.7% vs. 31.8%, p<0.001) and overweight/obesity (70.6% vs. 22.1%, p<0.001), but not hypertension (38.9% vs. 34.0, p=0.247) was significantly higher in those who did not, compared to those who did, smoke daily. This may be because fewer women smoked but had higher rates of overweight/obesity, raised LDL-C and diabetes compared to men.

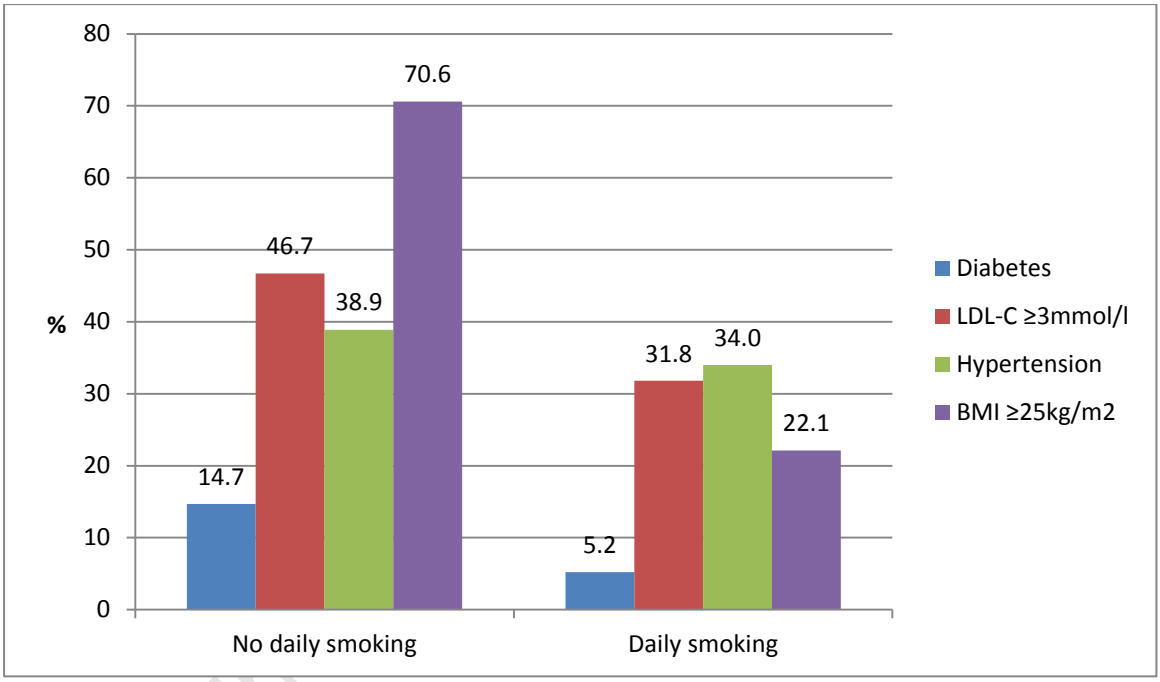


Figure 4.7: Prevalence of diabetes, raised LDL-C, hypertension and overweight/obesity presented by presence or absence of daily smoking in 25-74-year-old adults in 2008/09

The multiple logistic models examined the associations of socio-demographic and psychosocial variables with smoking ≥1cigarette/day (Table 4.11, p113). Age and asset index were entered as continuous variables while urbanisation was defined as having spent ≥50% of one's life in the city. SOC was defined as low, moderate and high but LOC and adverse life events were entered as continuous variables in their respective models.

Table 4.11: Multiple logistic regression models for socio-demographic associations with behavioural risk factors of smoking, problem drinking and physical inactivity

	Smoke ≥1cigarette/day (n=241)				Problem drinking: CAGE ≥2 (n=318)				Physical activity <150 min/week (n=77)			
	Odds Ratio	95% Confidence Interval		p-value	Odds Ratio	95% Confidence Interval		p-value	Odds Ratio	95% Confidence Interval		p-value
		Lower limit	Upper limit			Upper limit	Lower limit			Upper limit	Lower limit	
Age (years): decreasing	1.04	1.02	1.06	**0.001**	1.02	1.00	1.49	0.106	-	-	-	**-**
increasing	-	-	-	**-**	-	-	-	**-**	1.04	1.02	1.06	**0.001**
Sex: male	12.31	8.41	18.01	**<0.001**	4.98	3.62	6.86	**<0.001**	0.88	0.54	1.43	0.607
Education: ≤7 years	1.65	1.06	2.57	**0.027**	-	-	-	**-**	1.14	0.64	2.05	0.652
>7 years	-	-	-	**-**	1.61	1.05	2.47	**0.030**	-	-	-	**-**
Urbanised: ≥50% life in city	1.98	1.28	3.06	**0.002**	1.80	1.23	2.64	**0.003**	0.82	0.50	1.34	0.423
Work: Employed	1.00				1.00				1.00			
Unemployed	1.29	0.82	2.05	0.271	1.72	1.06	2.78	**0.029**	1.83	0.73	4.56	0.193
Pensioners	1.24	0.53	2.92	0.614	0.76	0.37	1.59	0.469	1.87	0.70	4.97	0.209
Other *	1.14	0.52	2.52	0.745	1.34	0.67	2.70	0.401	0.89	0.21	3.76	0.873
House: Informal shack	1.00				1.00				1.00			
Council/core house/hostel	1.40	0.89	2.22	0.144	1.12	0.74	1.70	0.579	0.30	0.12	0.73	**0.009**
Built formal unit (private)	0.90	0.48	1.70	0.745	1.43	0.81	2.52	0.222	1.01	0.54	1.90	0.973
Decreasing asset index:	1.09	1.01	1.17	**0.032**	1.10	1.02	1.18	**0.015**	1.01	0.91	1.12	0.850
Sense of coherence (SOC): Low	1.00				1.00				1.00			
Moderate	0.63	0.40	0.99	**0.045**	0.78	0.52	1.19	0.255	0.99	0.48	2.01	0.970
High	0.66	0.44	0.98	**0.038**	0.52	0.34	0.78	**0.002**	1.61	0.83	3.13	0.155
Increasing locus of control (LOC)**	0.99	0.93	1.06	0.831	0.95	0.90	1.00	0.068	1.02	0.94	1.12	0.632
Increasing number of adverse life events**	1.01	0.94	1.08	0.829	1.14	1.08	1.21	**<0.001**	0.86	0.77	0.97	**0.016**

*Other: housewives, disabled, students. **When LOC and adverse life events independently replaced SOC in above models, there were no changes in the direction or significance of the other variables except education was no longer significant in life events model for problematic alcohol use (p=0.067)

Men were more likely to smoke than women (odds ratio (OR): 12.31, 95% CI: 8.41-18.01, p<0.001). Smokers were more likely to be younger rather than older (OR: 1.04, 95% CI: 8.41-18.01, p=0.001). This indicates that despite comprehensive tobacco control measures in the country smoking uptake has not been adequately curtailed. Participants who had spent ≥50% of their lives in urban areas, compared to those who had spent less, were more likely to be daily smokers (OR: 1.98, 95% CI: 1.28-3.06, p=0.002), in accordance with the higher rates of smoking in urban compared to rural areas reported in the SADHS (420).

The poorer and less educated participants in this study smoked significantly more than their counterparts. The odds for smoking increased with declining wealth (as defined by the asset index) (OR: 1.09, 95% CI: 1.01-1.17, p=0.032) and in those with ≤7 years of education compared to more educated participants (OR: 1.65, 95% CI: 1.06-2.57, p=0.027). This was in line with the national surveys (420), the THUSA study (499), SSA studies (153), and with 74 studies from high-, medium- and low income economies, which showed that poorer men (according to income, education or profession) were more likely to smoke, regardless of each economy's level of development (13). The concentration of smoking in individuals with lower socio-economic status may be attributable to a lack of awareness of the health hazards of smoking among these less educated and poorer individuals (153, 164).

Compared to participants in the lowest SOC tertile, those with moderate (OR: 0.63, 95% CI: 0.4-0.99, p= 0.045) and high (OR: 0.66, 95% CI: 0.44-0.98, p= 0.038) SOC scores were significantly less likely to smoke. Current smokers compared to former or never smokers also had lower SOC by the 3-item SOC questionnaire in a British study (138). It is possible that those with higher SOC scores and less psychosocial stress may more easily resist smoking uptake or find smoking cessation easier.

4.3.2. Alcohol Use

Figure 4.8 illustrates the prevalence of the physiological CVD risk factors by CAGE scores. There was no trend by CAGE scores for any CVD risk factor; however, diabetes, raised LDL-C and overweight/obesity were much higher in participants with no CAGE components compared to those with any combination of components. This may be because of the lower likelihood of women consuming alcohol but having significantly higher rates of overweight/obesity and raised LDL-C as well as diabetes (not significant) compared to men.

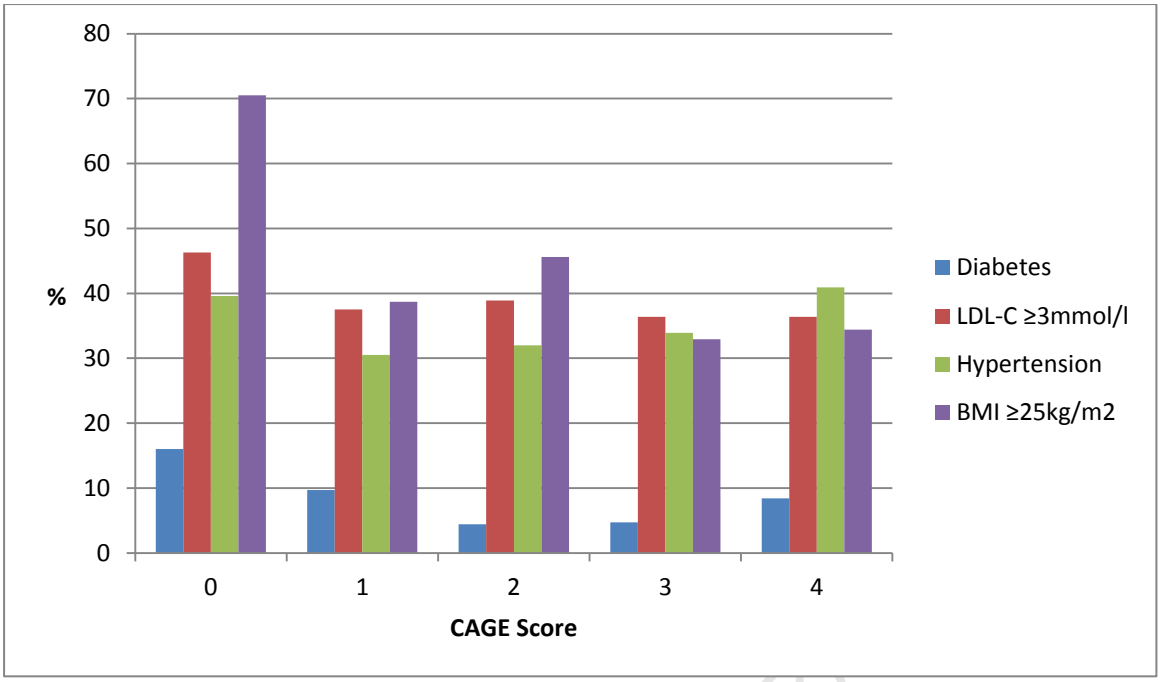


Figure 4.8: Prevalence of diabetes, raised LDL-C, hypertension and overweight/obesity presented by CAGE scores for problematic alcohol intake in 25-74-year-old adults in 2008/09

The multiple logistic models examined the associations of socio-demographic and psychosocial variables with problematic alcohol intake defined as CAGE ≥2 (Table 4.11, p113). The continuous variables were age and asset index, as were LOC and adverse life events in their respective models. Among the categorical variables were urbanisation defined as having spent ≥50% of one's life in the city and SOC defined in tertiles of low, moderate and high.

Similar to the pattern for smoking, in the model with SOC, men were more likely than women to be problem drinkers (OR: 4.96, 95%CI: 3.62-6.86, p<0.001) as were unemployed (OR: 1.72, 95%CI: 1.06-2.78, p=0.029), poorer (OR: 1.10, 95%CI: 1.02-1.18, p=0.015) but better educated (OR: 1.61, 95%CI: 1.05-2.47, p=0.030) participants, compared to their employed, wealthier and less educated counterparts, respectively. A review by Henkel that found risky alcohol consumption (associated with hazardous, binge and heavy drinking) was more prevalent among the unemployed (500) confirmed findings in this study. In a recent study in Finland, a significant association between prolonged unemployment and risky alcohol intake was also found (501). The association of poverty with problematic alcohol intake speaks to the relative low real price of alcohol in South Africa, with easy access to alcoholic beverages likely contributing to easier uptake and over-indulgence (432).

The significant association of higher education level with problem drinking in men was unexpected in light of the association with unemployment. However, there was

no significant difference in unemployment level (p=0.832) among men with no education (58.9%), 1-7 years of education (60.6%), 8-12-years education (61.4%) or a tertiary education/diploma (52.0%). The higher odds for problem drinking among more educated men may possibly be related to greater frustration at being unemployed. In the model with adverse life events, the association of education with problem drinking was no longer significant (OR: 1.49, 95% CI: 0.97-2.28, p=0.067).

Participants who had spent more than half their lives in the city were more likely to be problem drinkers than participants who had spent less (OR: 1.80, 95%CI: 1.23-2.64, p=0.003). Urbanisation is accompanied by a unique set of advantages and disadvantages with rapid and often unplanned urban growth frequently found to be associated with poverty and alcoholism (502).

Unemployment, poverty and urban living are likely to be associated with psychosocial stress, which may also predispose individuals to problematic alcohol intake. Supporting an association between psychosocial stress and problem drinking in this study was the finding that participants with high SOC, and thus less stress, were about half as likely to be problem drinkers (OR: 0.52, 95% CI: 0.34-0.78, p=0.002) compared to those with low SOC. Similarly, in the model with adverse life events, participants who experienced greater adversity (and consequently more stress) were also more likely to be problem drinkers (OR: 1.14, 95% CI: 1.08-1.21, p<0.001).

4.3.3. Physical Activity

Figure 4.9 illustrates the prevalence of the physiological CVD risk factors by levels of physical activity. Although the absolute level of activity seems to have been overestimated in this study, as pointed out earlier, the expected protective impact of the highest levels of physical activity is observed in these data. Diabetes was least prevalent in participants who spent ≥1000 minutes on moderate to vigorous physical activity/week compared to those who spent less (p=0.041), although there was no clear pattern by activity levels. The prevalence of hypertension decreased with rising levels of physical activity and was most prevalent among the least (53.6%) compared to the most active (33.0%) (p=0.013). Overweight/obesity decreased, but not significantly, with increasing physical activity levels and there was no pattern by raised LDL-C level.

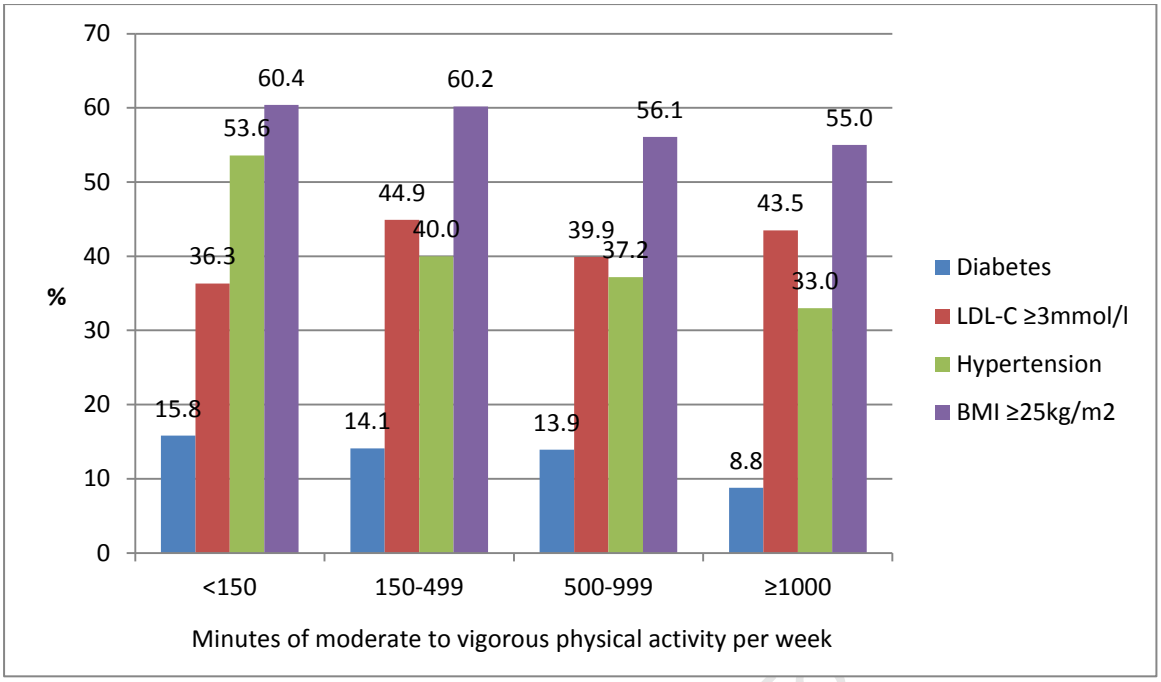


Figure 4.9: Prevalence of diabetes, raised LDL-C, hypertension and overweight/obesity presented by physical activity levels (minutes of moderate to vigorous activity per week) in 25-74-year-old adults in 2008/09

The multiple logistic models examined the associations of socio-demographic and psychosocial variables with <150 minutes of physical activity per week (Table 4.11, p 113). In their respective models, SOC was entered as a categorical variable while LOC and adverse life events as continuous variables. In the model with SOC, older age (OR: 1.04, 95% CI: 1.02-1.06, p=0.001) was significantly associated with physical inactivity as would be expected. Participants who lived in council houses or hostels were less likely to be inactive (OR: 0.29, 95% CI: 0.12-0.71, p=0.007) compared to those living in informal areas. In the multiple logistic model where adverse life events replaced SOC, participants who had experienced a greater number of adverse events were less likely to be inactive after adjusting for the other factors (OR: 0.86, 95% CI: 0.77-0.97, p=0.016).

4.3.4. Fat Intake

Figure 4.10 illustrates the prevalence of the physiological CVD risk factors by dietary fat intake as a proportion of diet. The prevalence of diabetes was lowest in participants with dietary fat intake comprising <10% of diet compared to those with higher intake but there was no trend with rising fat intake. Raised LDL-C and overweight/obesity increased with rising fat intake although these were not significant.

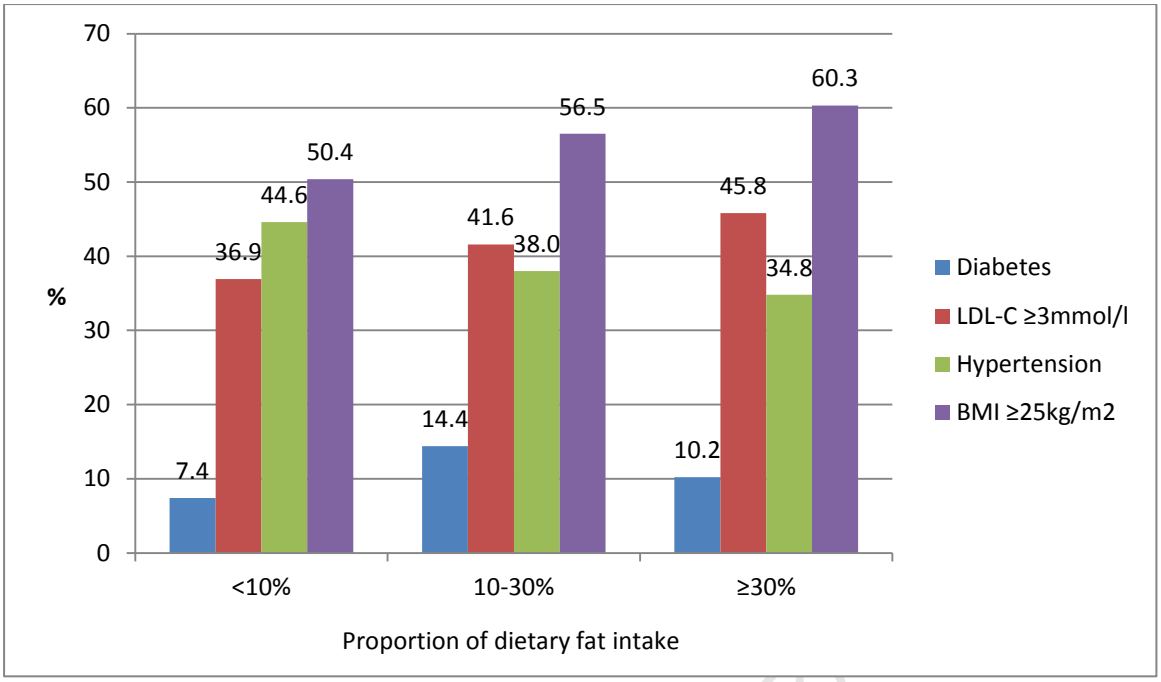


Figure 4.10: Prevalence of diabetes, raised LDL-C, hypertension and overweight/obesity presented by proportion of dietary fat intake in 25-74-year-old adults in 2008/09

The observation that overweight/obesity was prevalent in half the participants that reported <10% intake of dietary fat is in keeping with the findings of Kruger and colleagues from the THUSA study conducted in the North-West Province, South Africa. They found high rates of overweight/obesity with relatively low fat intake among black women (390). These data suggest that overweight/obesity can occur even with relatively low fat intakes with other factors contributing to the development of the condition. Nonetheless, difficulties in obtaining accurate dietary data from a free-living population cannot be excluded (390). Ideally at least three dietary intake data should be documented, instead of a single intake as obtained in this study.

The multiple logistic models examined the associations of low physical activity, and socio-demographic and psychosocial variables with a high fat diet (Table 4.12, p119). The continuous variables entered were age, asset index and the psychosocial variables in their respective models. Urbanisation was defined as having spent ≥65% of one's life in the city. In the models, fat intake comprising ≥30% of the diet was significantly associated with younger age (OR: 1.02, 95% CI: 1.01-1.04, p=0.003), which may be related to a differential generational response to social and economic changes, in the model with SOC. Younger individuals may adopt new dietary patterns more quickly, while the elderly maintain their more traditional low-fat dietary habits (222).

Table 4.12: Multiple logistic regression model for socio-demographic associations with high fat intake

	Fat intake ≥30% of diet (n=395)			
	Odds Ratio	95% Confidence Interval		p-value
		Lower limit	Upper limit	
Decreasing age (years)	1.02	1.01	1.04	**0.003**
Sex: female	1.04	0.76	1.42	0.800
Physical activity <150 minutes/week	0.90	0.49	1.67	0.743
Urbanised: ≥65% life in city	1.42	1.05	1.92	**0.024**
Education >7 years	1.67	1.12	2.49	**0.013**
Work: Employed	1.00			
Unemployed	1.05	0.73	1.51	0.780
Pensioners	0.89	0.46	1.72	0.725
Other*	1.28	0.74	2.21	0.378
House: Informal shack	1.00			
Council/core house/hostel	1.14	0.77	1.70	0.503
Built formal unit (private)	1.10	0.68	1.77	0.706
Increasing asset index	1.09	1.02	1.16	**0.014**
Decreasing sense of coherence (SOC)	1.02	1.01	1.03	**0.034**
Increasing locus of control (LOC)**	0.98	0.93	1.04	0.577
Increasing number of adverse life events**	1.06	1.01	1.12	**0.020**

*Other: housewife, student, disabled
**When LOC and adverse life events independently replaced SOC in above model, there were no changes in the direction or significance of the other variables

Spending ≥65% of life in urban centres (OR: 1.42, 95% CI: 1.05-1.92, p=0.024), >7 years of education (OR: 1.67, 95% CI: 1.12-2.49, p=0.013) and increasing wealth (OR: 1.09, 95% CI: 1.02-1.16, p=0.014) were also significantly associated with high fat intake. The association of urbanisation with high fat intake was in keeping with the 1990 study conducted in this population which found a positive association between the proportion of life spent in urban settings and increasing dietary atherogenicity (440). Urbanisation and socio-economic advancements are known to be associated with westernisation of lifestyles and increased uptake of energy-dense foods high in fats (227). These foods are likely to be more affordable to individuals with higher socioeconomic status (the affluent and better educated) but may still be out of the price range of lower socio-economic groups, particularly in developing regions (503).

A lower SOC, indicative of higher psychosocial stress, was significantly associated with high fat intake (OR: 1.02, 95% CI: 1.01-1.03, p=0.034). In the model where adverse life events replaced SOC, a greater number of adverse events experienced

was significantly associated with high fat intake after adjusting for the other factors (OR: 1.06, 95% CI: 1.01-1.12, p=0.020). Seeing that many factors impact on food choices and methods of preparation (439), it is possible that individuals with higher stress levels may not have the time or the inclination to cook healthier meals and therefore select easy-to-prepare foods and snacks which are high in fats.

4.3.5. Adiposity

Figure 4.11 illustrates the prevalence of the physiological CVD risk factors by BMI categories. Obesity is known to markedly increase the risk of diabetes, hypertension and dyslipidaemia (233) and the higher prevalence of these conditions in participants with overweight/obesity was as expected. The observed higher prevalence of these physiological CVD risk factors in overweight/obese participants together with the marked rise in overweight/obesity over the last two decades, as discussed in Section 4.2.2., suggest that these diseases are likely to increase in the future.

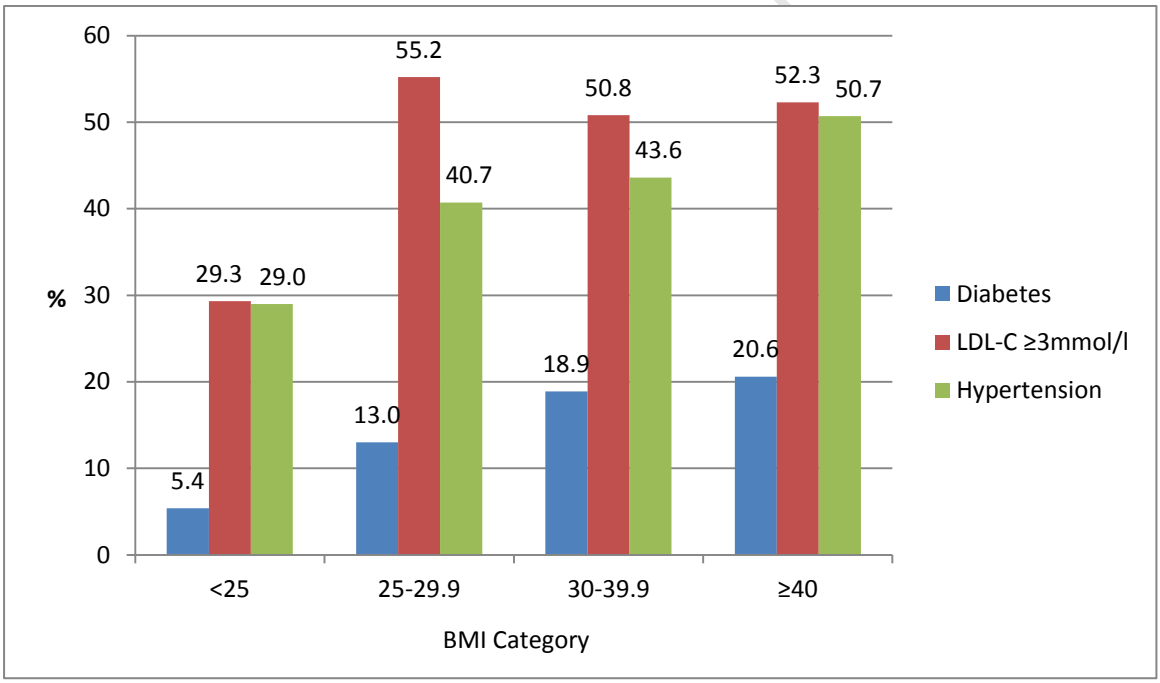


Figure 4.11: Prevalence of diabetes, raised LDL-C and hypertension presented by BMI categories (kg/m^2) in 25-74-year-old adults in 2008/09

The multiple logistic models examined the associations of physical activity, fat intake, and socio-demographic and psychosocial variables with raised BMI, central obesity and raised WHR (Table 4.13, p122). The categorical variables included high fat intake defined as ≥30% of diet, and asset index and SOC in tertiles. Urbanisation was entered as a continuous variable as were LOC and adverse life events in their respective models. The association of older age with all measures of adiposity in the multivariate analyses was in accord with the positive correlation between age and

BMI in women in the THUSA study (390). The increased odds in women compared to men for all measures of adiposity were expected and the reasons for this association have been discussed in Section 4.2.2.

The richest compared to the poorest participants, as defined by the asset index, were significantly more overweight/obese by all measures of adiposity in the models with SOC: BMI ≥25 kg/m^2: OR: 4.33, 95% CI: 2.55-7.33, p<0.001, raised WC: OR: 3.29, 95%CI: 1.74-6.22, p<0.001, raised WHR: OR: 1.92, 95% CI: 1.15-3.21, p=0.013. This is in keeping with other South African studies where socio-economic status defined by various measures including education, occupation, income and household amenities was related to increased BMI (390, 497, 499) as well as with studies from many SSA countries (227, 348, 395, 444, 503, 504). In contrast, in developed regions, there is an inverse relationship between overweight/obesity and measures of socio-economic status (227, 230, 444, 450). The positive relationship between overweight/obesity and asset index in this study population is suggestive of the early stages of the nutrition transition. Excess weight initially presents among the affluent before progressively shifting to lower-income groups, as has been demonstrated in middle-income developing and developed countries at later stages of the epidemiologic and nutrition transitions (395, 505).

High dietary fat intake was associated with overweight/obesity defined by raised BMI (OR: 1.46, 95% CI: 1.05-2.04, p=0.026) but not raised WC (OR: 1.41, 95% CI: 0.95-2.09, p=0.087) or raised WHR (OR: 1.12, 95% CI: 0.79-1.58, p=0.520). This confirms the observations of Kruger and colleagues, who found a significant association between fat intake and BMI, but not WC, in black South African women in the THUSA study (390). That dietary fat intake is usually positively related to body weight (390) is probably because fats compared with protein or carbohydrates have a higher caloric density (223). Nonetheless, it must be noted that high fat intake is not a proxy for high energy consumption and does not promote overweight/obesity independently of total energy intake (390).

The measures of psychosocial stress were not related to adiposity except in the model with raised WHR and SOC. The least stressed participants, as represented by the highest SOC tertile, were approximately half as likely as those with the lowest scores (most stressed) to have raised WHR (OR: 0.58, 95% CI: 0.40-0.84, p=0.004).

Table 4.13: Multiple logistic regression models for associations with adiposity: overweight/obesity, raised waist circumference and raised waist-to-hip ratio

	Overweight/Obesity: BMI ≥25 kg/m^2				Waist: men >94 cm; women >80 cm				Waist-to-hip ratio men >1.0; women >0.85			
	Odds Ratio	95% Confidence Interval		p-value	Odds Ratio	95% Confidence Interval		p-value	Odds Ratio	95% Confidence Interval		p-value
		Lower limit	Upper limit			Upper limit	Lower limit			Upper limit	Lower limit	
Increasing age (years)	1.05	1.03	1.07	**<0.001**	1.06	1.04	1.08	**<0.001**	1.07	1.05	1.09	**<0.001**
Sex: female	17.42	11.81	25.70	**<0.001**	39.41	24.90	62.38	**<0.001**	13.36	9.17	19.47	**<0.001**
Fat intake ≥30% of diet	1.46	1.05	2.04	**0.026**	1.41	0.95	2.09	0.087	1.12	0.79	1.58	0.520
Physical activity <150 minutes/week	0.95	0.45	2.00	0.894	1.26	0.58	2.74	0.564	0.84	0.45	1.59	0.592
Education: <7 years	0.79	0.50	1.27	0.333	1.06	0.58	1.95	0.844	1.12	0.75	1.69	0.573
Increasing urbanisation	1.00	0.99	1.00	0.261	1.00	0.99	1.00	0.34	1.00	1.00	1.01	0.735
Work: Employed	1.00				1.00				1.00			
Unemployed	0.64	0.39	1.03	0.067	0.68	0.37	1.25	0.216	1.32	0.93	1.88	0.121
Pensioners	0.81	0.31	2.09	0.660	0.92	0.36	2.40	0.871	0.68	0.29	1.57	0.362
Other*	0.54	0.24	1.19	0.127	0.77	0.28	2.12	0.616	2.38	1.13	5.03	**0.023**
House: Informal shack	1.00				1.00				1.00			
Council/core house/hostel	0.83	0.53	1.32	0.433	0.91	0.56	1.47	0.697	0.42	0.27	0.65	**0.000**
Built formal unit (private)	0.95	0.58	1.57	0.843	0.88	0.51	1.51	0.634	0.66	0.38	1.15	0.144
Asset index: 1st (poorest)	1.00				1.00				1.00			
2nd	2.13	1.42	3.19	**<0.001**	2.09	1.27	3.43	**0.004**	1.39	0.98	1.97	0.062
3rd (richest)	4.33	2.55	7.33	**<0.001**	3.29	1.74	6.22	**<0.001**	1.92	1.15	3.21	**0.013**
Sense of coherence (SOC): Low	1.00				1.00				1.00			
Moderate	1.16	0.75	1.81	0.499	0.98	0.59	1.62	0.923	0.76	0.45	1.29	0.311
High	1.29	0.86	1.96	0.221	1.10	0.71	1.72	0.663	0.58	0.40	0.84	**0.004**
Increasing locus of control (LOC)**	1.05	0.98	1.12	0.18	1.08	0.99	1.17	0.082	0.98	0.92	1.04	0.547
Higher number of adverse life events**	1.00	0.93	1.07	0.990	0.99	0.92	1.08	0.850	1.00	0.95	1.05	0.882

*Other: housewife, student, disabled;
**When LOC and adverse life events independently replaced SOC in above models, there were no changes in the direction or significance of the other variables

The lack of association between urbanisation and any measure of adiposity in this study was surprising, but may be related to the definition of urbanisation as the proportion of life spent in the city, which is a blunt proxy. There is, however, no international agreed definition on how urbanisation should be measured (401).

The lack of association between urbanisation and adiposity may also reflect the rapidity with which new migrants to the city adopt unhealthy lifestyle behaviours that predispose to adiposity. In Tanzania, declines in physical activity, dietary changes and weight gain in rural migrants occurred within six months to a year of arrival in the city (363, 506). Furthermore, with frequent population flows between urban and rural areas, lifestyle habits may be changing with uptake of unhealthier diets and sedentary lifestyles that contribute to obesity occurring even in rural settings.

The lack of association between physical inactivity and adiposity was contrary to the expected beneficial effect and reiterates the importance of using an objective instrument to ascertain activity levels rather than the self-reported measure used in this study. Nevertheless, if found to be valid, these findings may suggest that physical activity at levels reported in this study may not influence the risk of obesity and will have implications for strategies to reduce overweight/obesity in this population (507). While greater physical activity should be encouraged, obesity control programmes should encompass interventions beyond promoting primarily physical activity; nutritional interventions may be of greater benefit than increasing the intensity or duration of physical activity.

4.3.6. Diabetes Mellitus

Other CVD risk factors are known to cluster with diabetes and accords with the higher prevalence in this study of overweight/obesity, hypertension and raised LDL-C in participants with, compared to those without, as illustrated in Figure 4.12. In addition to hyperglycaemia, these factors exacerbate the development of atherosclerosis and macro-vascular complications in diabetes (257, 269).

Survey multiple logistic regression analysis was used to determine the independent associations of diabetes with the psychosocial factors, adjusting for a set of modifiable (physical inactivity, fat intake, BMI, waist and hip circumference) and non-modifiable (family history, age, sex and urbanisation) risk factors for diabetes as well as a socioeconomic confounder, housing type. Gender-specific models were done due to substantial differences in associations. To fully account for the known risk factors in the survey model, the non-linearity of their associations was investigated by means of generalised additive models (gam). To reflect the observed non-linearity,

quadratic terms were added in the survey model for BMI and urbanisation for females. The waist and hip measurements as well as their ratio were highly correlated with BMI (r>0.85) and hence only BMI was retained in the models to avoid multicollinearity. The three psychosocial measures were modelled independently as continuous variables. SOC demonstrated a non-linear association with diabetes in women (significant cubic term) and cut-points were selected to mimic this pattern so as to enable statistical interpretation. Gender specific cut-points were used for SOC and are indicated in the text and in Tables 4.14a and 4.14b, p125-126.

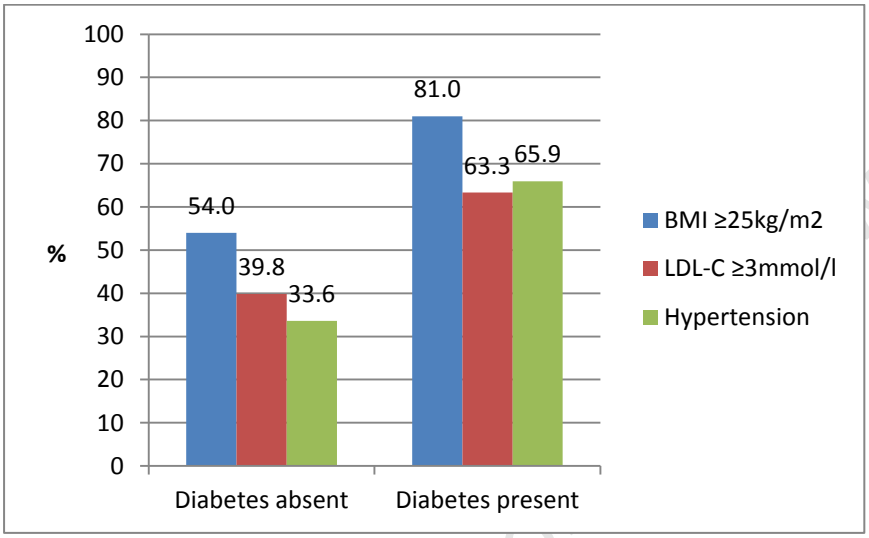


Figure 4.12: Prevalence of overweight/obesity, raised LDL-C and hypertension presented by presence or absence of diabetes in 25-74-year-old adults in 2008/09

The importance of age as a relevant risk factor for diabetes in SSA and elsewhere (243) is in keeping with this study findings where age was shown to be independently associated with diabetes. In the multivariate logistic regression analyses (Table 4.14a, p125), older age was significantly associated with diabetes in men (OR: 1.05, 95% CI: 1.02-1.08, p=0.002) and women (OR: 1.05, 95% CI: 1.03-1.08, p<0.001) in the models with SOC.

A positive family history of diabetes was associated with diabetes in women (OR: 3.13, 95% CI: 1.92-5.12, p<0.001) but not in men (OR: 1.09, 95% CI: 0.51-2.32, p=0.829). This gender difference may be related to a lack of awareness in men or to the small number of men with diabetes (n=45). A positive family history of diabetes was reported to be an independent risk factor for the disease in rural South Africa (388) but not in the earlier 1990 study (383).

Table 4.14a: Multiple logistic regression models for associations with diabetes in women and men (model with body mass index (BMI))

Variables	Women (n=115)				Men (n=45)			
	Odds Ratio	95% Confidence Interval		p-value	Odds Ratio	95% Confidence Interval		p-value
		Lower limit	Upper limit			Lower limit	Upper limit	
Increasing age (years)	1.05	1.03	1.08	**<0.001**	1.05	1.02	1.08	**0.002**
Family history of diabetes (yes)	3.13	1.92	5.12	**<0.001**	1.09	0.51	2.32	0.829
BMI: linear (kg/m^2)	1.48	1.20	1.82	**<0.001**	1.10	1.04	1.18	**0.003**
quadratic $(kg/m^2)^2$	0.995	0.992	0.998	**0.001**	NA	-	-	**-**
Moderate to vigorous physical activity(<150 min/week)	1.99	0.90	4.42	0.090	NA	-	-	**-**
Moderate to vigorous physical activity (min/week)	N/A	-	-	**-**	1.00	0.98	1.02	0.734
Dietary fat intake (%)	1.01	0.99	1.03	0.554	0.99	0.97	1.01	0.403
Urbanisation: linear (% of life in city)	1.04	0.98	1.10	0.111	1.00	0.99	1.01	0.552
quadratic (% of life in city)^2	1.00	0.99	1.00	0.130	N/A	-	-	**-**
Housing Type: Informal shack/other	1.00				1.00			
Council/core house/hostel	1.56	0.86	2.86	0.144	2.28	0.98	5.33	0.057
Built formal unit (private)	1.75	1.01	3.04	**0.047**	1.24	0.54	2.86	0.613
Sense of coherence score (SOC): scored ≤40	2.57	1.37	4.80	**0.003**	NA	-	-	**-**
scored ≤68	N/A	-	-	**-**	2.18	0.49	9.64	0.301
Increasing locus of control (LOC)	1.03	0.95	1.12	0.450	1.07	0.93	1.22	0.354
Increasing number of adverse life events	1.00	0.96	1.03	0.857	1.02	0.98	1.06	0.448

N/A: this factor is not applicable for the gender specific model. Men: quadratic terms for BMI and urbanisation not used in the model. Physical activity used as a continuous variable in men because too few had <150 min/week of activity. Gender specific cut-points used for SOC score. When LOC and adverse life events independently replaced SOC in above models, there were no changes in the direction or significance of the other variables

Table 4.14b: Multiple logistic regression models for associations with diabetes in women and men (model with waist circumference)

Variables	Women (n=115)				Men (n=45)			
	Odds Ratio	95% Confidence Interval		p-value	Odds Ratio	95% Confidence Interval		p-value
		Lower limit	Upper limit			Lower limit	Upper limit	
Increasing age (years)	1.05	1.03	1.07	**<0.001**	1.04	1.01	1.08	**0.016**
Family history of diabetes (yes)	3.06	1.87	5.02	**<0.001**	1.09	0.51	2.36	0.821
Waist circumference: linear increase (till 110 cm)	1.29	1.09	1.51	**0.003**	1.04	1.01	1.07	**0.004**
quadratic $(cm)^2$	0.999	0.998	0.999	**0.006**	NA	-	-	**-**
Moderate to vigorous physical activity(<150 min/week)	1.94	0.85	4.44	0.116	NA	-	-	**-**
Increasing moderate to vigorous physical activity (min/week)	N/A	-	-	**-**	1.00	0.98	1.02	0.734
Increasing dietary fat intake (%)	1.01	0.99	1.03	0.520	0.99	0.97	1.01	0.423
Urbanisation: linear increase (% of life in city)	1.05	0.99	1.10	0.096	1.00	0.99	1.01	0.547
quadratic (% of life in $city)^2$	1.00	0.99	1.00	0.111	N/A	-	-	**-**
Housing Type: Informal shack/other	1.00				1.00			
Council/core house/hostel	1.72	0.93	3.20	0.084	2.29	0.98	5.39	0.057
Built formal unit (private)	1.85	1.06	3.24	**0.030**	1.28	0.56	2.93	0.560
Sense of coherence score (SOC): scored ≤40	2.67	1.42	5.02	**0.002**	NA	-	-	**-**
scored ≤68	N/A	-	-	**-**	2.18	0.49	9.84	0.306

N/A: this factor is not applicable for the gender specific model. Men: quadratic terms for waist circumference and urbanisation not used in the model. Physical activity used as a continuous variable in men because too few had <150 min/week of activity. Gender specific cut-points used for SOC score.

The high prevalence of diabetes and IGT in this study may be attributed to the high rate of some diabetes risk factors, in particular overweight/obesity. Raised adiposity, the most potent of the risk factors (249), was present in ≥50% of the total study sample, and in over 80% of participants with diabetes when measured by BMI ≥25 kg/m^2. This is concordant with reports from the Study to Help Improve Early evaluation and management of risk factors Leading to Diabetes (SHIELD) and the National Health and Nutrition Examination Surveys (NHANES) in the US that found ≥75% of those with diabetes were overweight/obese (508). In 2000, in South Africa, 94% of the diabetes burden in women and 75% in men was attributable to BMI ≥21 kg/m^2 (229). Centralisation of fat, as evidenced by WC and WHR, was also common in the whole sample and higher in those with compared to those without diabetes.

Of note is that both increasing BMI and WC were associated with diabetes in the regression analyses for men and women. In the model with SOC for women, higher BMI levels were significantly associated with diabetes (OR: 1.48, 95% CI: 1.20-1.82, p<0.001) reaching a plateau after 30 kg/m^2 while in men the odds were 1.10, 95% CI: 1.04-1.18, p=0.003.

When WC replaced BMI in the model with SOC, the odds for diabetes with higher WC in women, after adjusting for the other factors (age, family history, physical activity, dietary fat intake, urbanisation and housing type), was 1.29, 95% CI: 1.09-1.51, p=0.003; the risk increased till 110 cm then remained high (Table 4.14b, p126). When WC replaced BMI in the model with SOC for men, the risk for diabetes, after adjusting for the other factors, increased 4.0% for every centimetre around the waist (OR: 1.04, 95% CI: 1.01-1.07, p=0.004). There was no change in the significance or direction of the other variables in either of these models. The association of adiposity with diabetes in this study is in agreement with findings from other South African studies, including the last diabetes prevalence study conducted in this community in 1990 (383, 388), as well as most SSA studies (243).

In men, although overweight/obesity was significantly associated with diabetes in this study, other factors are likely to have also contributed to the higher diabetes prevalence in 2008/09 compared to 1990 given the marked fall in overweight/obesity prevalence during this period. Factors such as foetal and early life nutritional status, diet quality and physical activity may possibly have contributed to the higher diabetes prevalence in men (241). Metabolic changes induced by HIV/AIDS may be worth considering as another potential influencer of glucose levels in view of its high prevalence in South Africa although known HIV positive individuals were excluded from the study. Factors contributing to the development of diabetes in HIV disease

include inflammation and viral factors, among other influences, while ART causes insulin resistance and decreased insulin secretion (509).

The lack of an overall significant association between low physical activity levels and diabetes in the regression models was unexpected and may reflect over-reporting of activity as discussed earlier in Section 4.2.1.4. This reiterates the need for an objective measure of physical activity.

The absence of a significant independent association between high fat intake and diabetes in men and women may be attributed to the use of a single rather than multiple 24-hour dietary recall assessments that should ideally be obtained to improve accuracy when collecting data in free-living populations (390). Nonetheless, as already mentioned, high fat intake is not a proxy for high energy consumption.

Urbanisation was, surprisingly, not associated with diabetes in the regression models for men or women. The reasons may be similar to that discussed for the absence of an association between urbanisation and adiposity in Section 4.3.5., namely, the 'bluntness' of the proxy used for urbanisation and the rapid adoption of unhealthy lifestyle behaviours. Other SSA studies have found higher rates of diabetes in urban compared to rural areas (243, 250).

Housing was used as a proxy for urbanisation in the model for diabetes as most newcomers to urban areas usually lived in informal shacks (475) and participants living in built formal units were likely to be more urbanised. In the regression analysis, diabetes was significantly associated with women living in the built formal housing compare to those living in informal housing (OR: 1.75, 95% CI: 1.01-3.04, p=0.047) (Table 4.14a, p125). Better quality housing may also be an indicator of higher socio-economic status and suggests the increased likelihood of diabetes among more privileged women.

In the multiple logistic models with SOC, women with SOC scores ≤40 had an increased risk for diabetes (OR: 2.57, 95% CI: 1.37-4.80, p=0.003). The crude diabetes prevalence in women with low SOC was 27% (18-39%, observed frequency: 21/70) compared to 13% (11-16%, observed frequency: 94/615) in women with higher scores. In the model for men, however, SOC was not related to diabetes: SOC ≤68: OR: 2.18, 95% CI: 0.49-9.64, p=0.301 (Table 4.14a, p125).

The association of low SOC with diabetes in women in this study was similar to that reported in 35-56-year-old women in Sweden (120). It has been postulated that individuals with low SOC may be more likely to lead unhealthy lifestyles, thereby contributing to disease. However, the lack of an independent association between

SOC and WC or BMI, reported in Table 4.13, as well as the absence of an association between SOC and high fat intake (Table 4.12, p119) suggests that SOC may exert an independent risk for the development of diabetes. Other factors related to low SOC such as higher chronic stress and inadequate coping skills have been suggested to also contribute to the association with diabetes (115).

As this is a cross-sectional study, no causal relationship can be assumed between SOC and diabetes in women. Local cohort studies investigating the development of diabetes in individuals with high stress are needed to further our understanding of the association of psychosocial stress with diabetes. If proved instrumental in the development of diabetes in this setting, optimal diabetes care will ideally need to include approaches to tackle these psychosocial influences. Strengthening SOC in women may possibly play a role in attempts to curtail the rising diabetes prevalence (136).

Although there was no relation between SOC and diabetes in men, similar to that reported in the Stockholm Diabetes Prevention Program study (120), this may possibly be because of the small number of men with diabetes (n=45) in the current study. A cohort study in Finland reported a 46% higher risk of diabetes in men with low SOC who were ≤50 years old on entry into the study (136). Interestingly, the Copenhagen City Heart Study, which used different stress measures, found that while stress was not associated with diabetes at baseline, stressed men were more than twice as likely to develop diabetes during follow-up compared to men with low stress (118).

4.3.7. Raised Low-Density Lipoprotein Cholesterol

Other CVD risk factors were shown to cluster with raised LDL-C; participants with LDL-C ≥3 mmol/l had significantly higher rates of adiposity, dysglycaemia and hypertension. Figure 4.13 demonstrates the higher prevalence in participants with, compared to those without, raised LDL-C of overweight/obesity (70.6% vs. 47.3%, p<0.001), diabetes (17.1% vs. 8.6%, p<0.001) and hypertension (47.4% vs.30.2%, p<0.001).

The multiple logistic models examined the associations of age, sex, BMI, fat intake, physical activity and psychosocial variables with LDL-C ≥3 mmol/l. Apart from sex and high fat intake, the socio-demographic variables were modelled as continuous variables as were the three psychosocial measures which were modelled independently. In the model with SOC for raised LDL-C (Table 4.15, p131), older age was significantly associated with raised LDL-C (OR: 1.04, 95%CI: 1.03-1.05,

p<0.001). Therefore, with demographic changes and ageing of this population raised LDL-C will likely increase in the future.

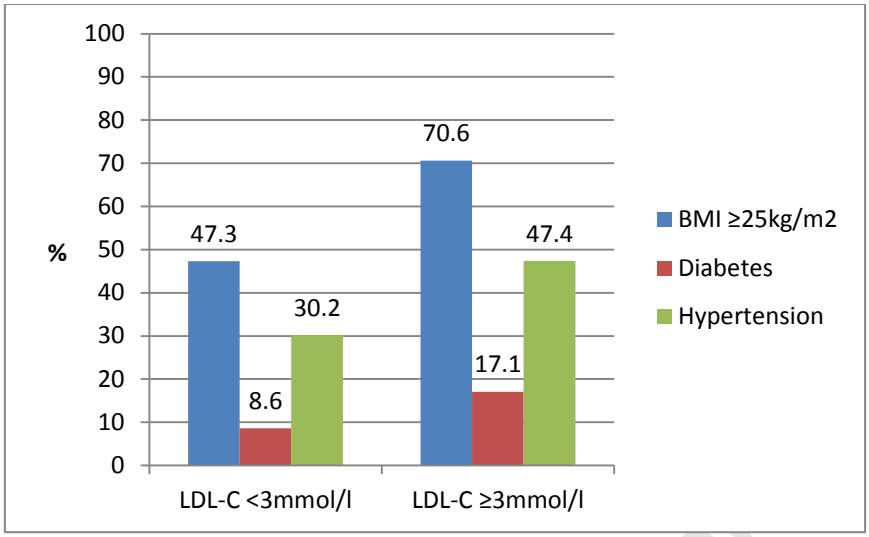


Figure 4.13: Prevalence of overweight/obesity, diabetes and hypertension presented by presence or absence of LDL-C ≥3 mmol/l in 25-74-year-old adults in 2008/09

Increasing BMI correlated positively with raised LDL-C (OR: 1.03, 95%CI: 1.01-1.05, p=0.004) and is in line with the relationship between obesity and LDL-C reported in the THUSA study conducted in another South African province (441). The link between adiposity and dyslipidaemia is an important one with dyslipidaemia found to progressively develop with BMI ≥21 kg/m^2 (205). The significant association between BMI and raised LDL-C also suggests that the higher obesity levels in 2008/09 (36.8%) compared to 1990 (26.4%), and attributable to the higher prevalence in women, may have contributed to the worsening lipid profile in this population.

Another significant variable associated with raised LDL-C was high fat intake (OR: 1.37, 95%CI: 1.01-1.85, p=0.042) which strengthens the importance of dietary modifications to improve lipid profiles. A recent analysis of the impact of dietary trends on TC in Sweden over 25 years showed that changes in dietary fat intake resulted in parallel shifts in TC levels with increased fat intake correlating with higher TC levels (510). Other studies have also reported the association of dietary fat intake with TC including the Dietary Approaches to Stop Hypertension (DASH) trials (205).

Variables not associated with raised LDL-C included sex, physical inactivity, urbanisation, problematic alcohol use and the psychosocial stressors. The absence of an association between physical activity and raised LDL-C is in agreement with findings from other studies (206). The evidence suggests that regular physical activity may increase LDL-C particle size but there is no significant reduction in LDL-C levels independent of weight loss.

Table 4.15: Multiple logistic regression model for associations with raised low-density lipoprotein cholesterol (LDL-C)

Variable	LDL-C ≥3 mmol/l or using lipid lowering drugs (n=520)			
	Odds Ratio	95% Confidence Interval		p-value
		Lower limit	Upper limit	
Increasing age (years)	1.04	1.03	1.05	**<0.001**
Sex: female	1.16	0.83	1.61	0.384
Increasing BMI (kg/m^2)	1.03	1.01	1.05	**0.004**
Fat intake ≥30% of diet	1.37	1.01	1.85	**0.042**
Increasing moderate to vigorous activity (min/week)	1.00	0.99	1.00	0.158
Increasing urbanisation	1.00	1.00	1.01	0.503
Increasing sense of coherence (SOC)	1.00	0.98	1.01	0.516
Increasing locus of control (LOC)*	1.03	0.99	1.09	0.639
Increasing number of adverse life events*	1.03	0.97	1.08	0.327

*When LOC and adverse life events independently replaced SOC in above model, there were no changes in the direction or significance of the other variables

4.3.8. Hypertension

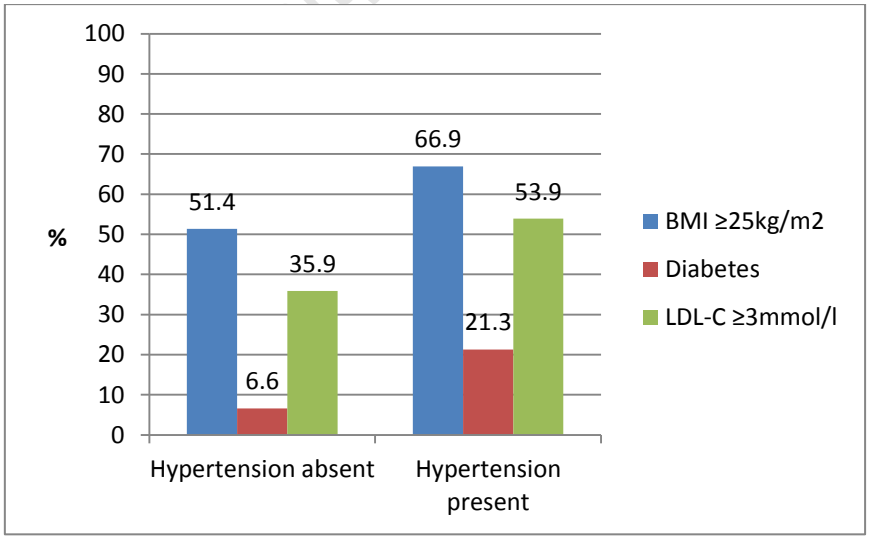


Figure 4.14: Prevalence of overweight/obesity, diabetes and raised LDL-C presented by presence or absence of hypertension in 25-74-year-old adults in 2008/09

The clustering of the physiological CVD risk factors is a common theme shown earlier for overweight/obesity, diabetes and raised LDL-C, and now for hypertension (Figure 4.14). Overweight/obesity, diabetes and raised LDL-C were all significantly

higher (p<0.001) in participants with compared to those without hypertension. Hypertension rarely occurs in isolation and the association with other CVD risk factors increases the overall risk for CVD and contributes to its progression (486, 511). The association of various CVD risk factors with hypertension conforms with reports from other SSA populations (357, 486, 512, 513) and South Africa (514).

Table 4.16: Multiple logistic regression model for associations with hypertension

Variable	Hypertension (n=461)			
	Odds Ratio	95% Confidence Interval		p-value
		Lower limit	Upper limit	
Age category: ≤30 years	1.00			
31-40 years	3.30	1.79	6.07	**<0.001**
41-50 years	7.71	4.13	14.38	**<0.001**
51-60 years	19.51	10.55	36.07	**<0.001**
>60 years	23.68	11.57	48.47	**<0.001**
Sex: female	0.85	0.56	1.30	0.444
Family history of hypertension: yes	1.49	1.10	2.03	**0.011**
Increasing BMI (kg/m^2)	1.04	1.02	1.07	**0.002**
Moderate to vigorous physical activity: <150 min/week	1.00			
150-500 min/week	0.52	0.31	0.87	**0.012**
500-1000 min/week	0.47	0.25	0.88	**0.018**
>1 000 min/week	0.41	0.24	0.69	**0.001**
% life in city: <50%	1.00			
50-90%	1.62	1.13	2.34	**0.010**
90-100%	1.55	1.04	2.31	**0.033**
Problem drinking : CAGE ≥2	1.50	1.05	2.16	**0.027**
Current smoking : daily/occasionally	0.96	0.61	1.51	0.855
Sense of coherence (SOC): higher	1.02	1.01	1.04	**0.011**
Locus of control (LOC)*: higher	0.98	0.93	1.04	0.509
Number of adverse life events*: higher	1.00	0.98	1.02	0.810

*When LOC and adverse life events independently replaced SOC in above model, there were no changes in the direction or significance of the other variables

The multiple logistic models examined the associations of the potential predisposing factors, including psychosocial stress, with hypertension. Cut-points for variables such as age, physical activity and proportion of life spent in the city were selected

based on the smoothed values shown in the fractional polynomials. The three psychosocial measures were modelled independently as continuous variables.

In the three models for hypertension, where the psychosocial variables were entered independently, the model with SOC is shown in Table 4.16, p132. Similar to the 1990 study (392), older participants were more likely to have hypertension; the odds of being hypertensive in >60-year-old participants were 23.68, 95% CI: 11.57-48.47, p<0.001 compared to those ≤30 years old. The well-known association of increasing age with hypertension or BP in SSA studies (357, 378, 445, 482, 489, 492, 504, 515-522) is highly relevant in the region, and particularly in South Africa, because future increases in hypertension will likely be fuelled by demographic shifts towards older age following better medical care and the control of infectious diseases, especially HIV/AIDS.

The association of a positive family history of hypertension, present in this study, is well established (OR: 1.49, 95% CI: 1.10-2.03, p=0.011).

The risk for hypertension with higher BMI rose 4.0% for every unit increase in BMI (OR: 1.04, 95% CI: 1.02-1.07, p=0.002) and accords with the well-documented strong association between BP and body weight reported in various populations (482) including in developing regions (37), SSA (286, 295, 378, 445, 449, 482, 489, 492, 504, 515-522) and South Africa including the 1990 study (392, 514). Indeed, 68% of hypertensive disease in South Africa was attributable to BMI ≥21 kg/m^2 in 2000 (229).

Higher mean BMI among women in 2008/09 compared to 1990 (33.0 kg/m^2 vs. 29.5 kg/m^2) was likely an important contributor to their higher hypertension prevalence in 2008/09. Similarly, rising BMI levels were also associated with hypertension and increasing BP in Cameroon over a 10-year period (295). Even in men, participants with hypertension had significantly higher mean BMIs (30.4 kg/m^2) than those without hypertension (27.5 kg/m^2) (p<0.001), reinforcing the relationship between higher BMI and hypertension.

However, despite the much lower levels of overweight/obesity in men compared to women, their prevalence of hypertension was similar; comparable to findings in rural South Africa where men were slimmer than women but had same BP levels (523). Given that the mean BMIs in men were similar in 2008/09 (23.6 kg/m^2) and 1990 (24.3 kg/m^2), other hypertensive risk factors probably contributed to their rising hypertension prevalence during this period. The contributors to hypertension are complex and multifactorial (284) and may likely include the higher alcohol

consumption in 2008/09 than in 1990; problematic alcohol intake was present in about half (49.7%) of all the men in this study. However, direct comparison of problematic alcohol use between the current and the 1990 study was not possible owing to the different measures used to assess alcohol intake. Nonetheless, it must be noted that factors not examined in this study, such as high salt intake, may be responsible for the high hypertension prevalence. Numerous studies support the concept that salt consumption is the major factor contributing to increasing BP in populations (37, 307) with black individuals reported to be particularly sodium sensitive (37, 284). Overconsumption of salt is responsible for up to 30% of all cases of hypertension (80).

In line with the known linear relationship between alcohol consumption, BP levels and hypertension (524), problematic drinking, as defined by CAGE ≥2, was significantly associated with hypertension (OR: 1.50, 95% CI: 1.05-2.16, p=0.027). Other SSA countries reporting a significant direct association between alcohol intake and hypertension or BP included Uganda (517), Seychelles (482) and Ghana (men only) (378) although others have reported no association (519). The absence of an association may be as a result of an inaccurate ascertainment of alcohol intake as many individuals are reluctant to reveal this history. This may likely have contributed to the absence of a relationship between alcohol intake and hypertension in the 1990 study (392).

Compared to physically inactive participants (<150 minutes/week of moderate to vigorous activity), those with higher activity levels were approximately half as likely to have hypertension; the odds with >1 000 minutes/week of activity was 0.41, 95% CI: 0.24-0.69, p=0.001. This was in keeping with the well-known inverse association of physical activity with hypertension (525) and also reported in the THUSA study where overweight/obese women with moderate activity levels had lower systolic BP levels compared to inactive overweight/obese women (437).

Participants who had spent more than half their lives in urban centres, compared to those who had spent less, had a greater likelihood of having hypertension: 50-90% of life spent in city: OR: 1.62, 95% CI: 1.13-2.34, p=0.010; >90% of life spent in city: OR: 1.55, 95% CI: 1.04-2.31, p=0.033. In addition to reports from other South African studies including the 1990 study (392, 514), this finding was consistent with the available literature from SSA (353, 357, 378, 395, 484, 488, 504, 516) and other developing regions where urbanisation is considered to be a key driver of the increasing hypertension prevalence (37, 295). This association suggests that with the

inevitable increase in urbanisation and the adoption of unhealthy lifestyles the future hypertension prevalence in this population will likely rise (516, 521).

The positive association of higher SOC (OR: 1.02, 95% CI: 1.01-1.04, p=0.011), an indicator of lower stress, with hypertension was unexpected and may be attributable to the complex relationship between psychological stress and hypertension (96). Additionally, psychosocial stress is difficult to define objectively and consists of several different (and inter-related) elements resulting in the measurement of stress being complex and difficult (90). Reinforcing this, is that when LOC (OR: 0.98, 95% CI: 0.93-1.04, p=0.509) and adverse life events (1.00, 95% CI: 0.98-1.02, p=0.810) replaced SOC in their respective models, neither were related to hypertension after adjusting for the other factors. Further research, including longitudinal studies, is required to identify a suitable psychosocial instrument to assess the association between stress and hypertension in this population.

4.3.9. Summary of the Interrelationships among Cardiovascular Disease Risk Factors

The salient findings include the independent correlation of older age and adiposity with diabetes, raised LDL-C and hypertension. Regarding gender, being male was significantly related to smoking and problem drinking, while being female was associated with all measures of adiposity. Smoking and problem drinking were more prevalent in poorer participants whereas high fat intake and all measures of adiposity were correlated with wealth. Urbanisation was significantly associated with hypertension and the unhealthy behaviours of smoking, problem drinking and high fat consumption but not diabetes. Measures of psychosocial stress were independently associated with diabetes, raised WHR, smoking, problem drinking and high fat intake. Unexpectedly, lower stress was related to hypertension. These associations need to be interpreted with care because the associations between the variables in a cross-sectional study such as this do not imply causality.

Should psychosocial factors be found to be instrumental in the development of diabetes and other CVD risk factors in this population in future cohort studies, educating high-risk individuals to cope with the stressors may be beneficial in reducing the incidence of CVDs (111).

4.4. METABOLIC SYNDROME

As was shown in the previous sections, individuals are highly likely to have more than one CVD risk factor; because of the subsequent greater risk for macro- and micro-vascular complications that it confers. Therefore, it is imperative to examine

patients for other CVD risk factors if one is present (45). Clustering of the cardio-metabolic risk factors commonly occur in the MS, a multiplex risk factor for atherosclerotic CVD (324).

There are minimal data available on the prevalence of MS in South Africa, particularly according to the JIS criteria. Using the ATPIII criteria, MS was present in 31% of 30-60-year-old non-diabetic corporate executives (526) and in 33.5% of non-diabetic participants in Guguletu (527).

The prevalence of the MS in this study, particularly among women, was high and reflected the high rates of CVD risk factors in this population (Table 4.17, p137). The crude and age-standardised rates of the MS were 30.7% and 31.7%, respectively, much higher than the age-standardised prevalence of 22.1% reported in rural South Africans using the same criteria (331). The current prevalence was comparable to the 30.3% age-standardised prevalence of the MS by the JIS criteria reported in 25-64-year-old adults in Seychelles (528) and the crude rate of 34.6% in ≥18-year-old Kenyans living in Nairobi (335).

Reports from some other SSA countries showed a low MS prevalence of <10% by various criteria (359, 529, 530)**.** However, rates ≥10.0%, using the IDF criteria, were found in urban Benin (11.0%) (530), Nigeria (15.9%) (451), urban Ethiopian bankers and teachers (17.9%) (531) and Seychelles (30.3%) (528).

Crude and age-standardised rates were significantly higher among women (43.5% and 44.9%, respectively) than men (16.5% and 17.3%, respectively) (p<0.001) (Table 4.17, p137). Even in the multiple logistic models, the odds for women having the MS were much higher than for men: OR: 5.29, 95% CI: 3.48-8.04, p<0.001 (Table 4.18, p138). So too was the MS more common in women (25.0%) than in men (10.5%) in rural South Africa (331). In the Kenyan study, while the prevalence of the MS was comparable to this study among women (crude: 40.2%), the prevalence in their male counterparts (29.0%) was much higher than among men in this study (335).

Table 4.17: Metabolic syndrome prevalence and total cardiovascular disease risk scores using the Framingham laboratory and non-laboratory risk estimates

	Age category in years													
	25-34		35-44		45-54		55-64		65-74		Total		Total*	
		S.E.		S.E.		S.E.		S.E.		S.E.		95% CI		95% CI
Men	*n= 121*		*n= 99*		*n= 86*		*n= 58*		*n= 28*		*n= 392*		*n=392*	
Metabolic syndrome, % (any 3+ variables)	8.3	2.6	9.2	3.3	28.1	5.5	32.4	6.6	42.9	9.3	16.5	12.7 - 21.2	17.3	13.4-21.9
Framingham CVD risk using lipid profiles:	*n=118*		*n=98*		*n=78*		*n=51*		*n=24*		*n=369*		*n=369*	
Mean, SE	2.4	0.2	5.1	0.3	15.3	1.3	23.9	2.0	38.9	3.3	9.0	7.7-10.3	10.1	8.5-11.7
Moderate (10-19.99), %	1.1	1.1	4.7	2.0	37.4	5.6	31.5	7.0	16.7	7.7	12.2	9.2-16.0	12.7	9.7-16.5
High (≥20), %	0.0	0.0	0.0	0.0	24.2	5.3	55.9	7.6	83.3	7.7	13.0	9.9-17.0	15.6	11.9-20.2
Framingham CVD risk using BMI:														
Mean, SE	3.0	0.2	7.0	0.4	18.6	1.4	29.9	2.1	43.8	3.7	11.1	9.6-12.6	12.3	10.5-14.1
Moderate (10-19.99), %	1.1	1.1	19.3	4.4	41.1	6.3	29.3	6.2	12.5	6.8	16.2	12.6-20.7	16.7	13.0-21.2
High (≥20), %	0.0	0.0	0.0	0.0	39.9	6.4	70.7	6.2	87.5	6.8	17.4	13.8-21.8	20.2	16.1-25.0
Women	*n= 235*		*n= 163*		*n= 168*		*n= 92*		*n= 49*		*n= 707*		*n=707*	
Metabolic syndrome, % (any 3+ variables)	21.7	2.8	46.6	4.2	66.4	3.9	74.3	4.3	67.4	6.3	43.5	39.2 - 47.9	44.9	40.5-49.3
Framingham CVD risk using lipid profiles:	*n=230*		*n=153*		*n=150*		*n=82*		*n=41*		*n=656*		*n=656*	
Mean, SD	1.1	0.1	3.1	0.2	9.2	0.7	15.6	1.4	23.8	2.6	5.4	4.7-6.1	6.1	5.3-7.0
Moderate (10-19.99), %	0.0	0.0	2.1	1.0	19.2	3.6	33.8	5.5	26.8	6.9	8.3	6.3-10.9	9.4	7.2-12.2
High (≥20), %	0.0	0.0	0.0	0.0	9.5	2.6	23.7	4.9	48.8	7.5	6.1	4.6-8.0	7.6	5.7-10.0
Framingham CVD risk using BMI:														
Mean, SE	1.3	0.1	4.0	0.3	11.3	0.9	20.5	1.8	30.7	3.0	6.8	5.9-7.7	7.7	6.6-8.8
Moderate (10-19.99), %	0.5	0.5	2.6	1.3	23.9	3.9	37.0	5.7	34.2	7.2	10.3	8.2-12.8	11.5	9.3-14.2
High (≥20), %	0.0	0.0	1.2	0.9	14.7	3.2	32.8	5.6	53.7	7.0	8.4	6.4-10.9	10.1	7.8-12.9

*Age standardised to the SEGI world population; S.E: standard error; CI: confidence interval

Participants with a self-reported history of IHD (n=42) or stroke (n=40) were excluded from the Framingham risk estimates; Non-laboratory CVD risk scores used BMI instead of lipids.

Table 4.18: Multiple logistic regression models for associations with the metabolic syndrome and high Framingham risk scores

	Metabolic Syndrome (n=406)				Laboratory-based risk scores ≥20% (n=114)				Non-laboratory-based scores ≥20% (n=152)			
	Odds Ratio	95% Confidence Interval		p-value	Odds Ratio	95% Confidence Interval		p-value	Odds Ratio	95% Confidence Interval		p-value
		Lower limit	Upper limit			Upper limit	Lower limit			Upper limit	Lower limit	
Increasing age	1.07	1.05	1.09	**<0.001**	-	-	-	**-**	-	-	-	-
Sex: female	5.30	3.48	8.06	**<0.001**	-	-	-	**-**	-	-	-	-
Education: <7 years	1.15	0.74	1.81	0.534	2.47	1.57	3.90	**<0.001**	2.36	1.48	3.77	**<0.001**
Increasing urbanisation	1.00	1.00	1.00	0.927	-	-	-	**-**	-	-	-	-
% life in city: <50%	-	-	-	**-**	1.00							
50-90%	-	-	-	**-**	1.97	1.12	3.46	**0.018**	2.23	1.33	3.73	**0.002**
90-100%	-	-	-	**-**	0.91	0.47	1.77	0.791	1.01	0.57	1.80	0.973
Work: Employed	1.00				1.00							
Unemployed	0.73	0.47	1.15	0.174	2.05	1.03	4.07	**0.042**	2.06	1.13	3.74	**0.018**
Pensioners	0.76	0.38	1.52	0.431	16.58	8.22	33.42	**<0.001**	14.28	7.34	27.78	**<0.001**
Other	1.18	0.56	2.47	0.662	1.82	0.60	5.53	0.288	2.73	0.90	8.31	0.076
House: Informal shack/other	1.00				1.00							
Council/core house/hostel	0.97	0.67	1.41	0.876	1.92	1.16	3.17	**0.011**	1.69	1.06	2.68	**0.028**
Built formal unit (private)	1.24	0.80	1.91	0.342	1.93	1.07	3.48	**0.028**	1.90	1.16	3.11	**0.011**
Asset index: 1st (poorest)	1.00				1.00							
2nd	1.64	1.10	2.44	**0.015**	0.66	0.41	1.07	0.092	0.65	0.41	1.03	0.066
3rd (richest)	1.90	1.17	3.07	**0.009**	0.96	0.52	1.79	0.900	1.17	0.68	2.02	0.562
Increasing sense of coherence (SOC)	1.02	1.01	1.03	**0.049**	1.00	0.98	1.02	0.845	1.00	0.98	1.02	0.841
Increasing locus of control (LOC)*	1.07	1.01	1.14	**0.028**	0.96	0.90	1.03	0.243	0.94	0.88	1.01	0.110
Higher number of adverse life events*	1.00	0.95	1.06	0.981	1.03	0.95	1.11	0.513	1.02	0.96	1.10	0.476

*When LOC and adverse life events independently replaced SOC in above models, there were no changes in the direction or significance of the other variables.

The higher prevalence of MS in women has been reported in several SSA countries (335, 528, 530, 531) as well as in African-Americans (324, 330). However, non-African-Americans (324, 330) and other developed nations do not demonstrate a clear trend for the MS between the sexes (324, 528). The reason for the clear gender differences in the MS rates in SSA and African-Americans may be related to cultural values and positive social attitudes toward fatness (335), which will be discussed in Chapter 5.

The key contributing factors to the higher MS prevalence in women compared to men was central obesity (86.0% vs. 20.1%) and low HDL-C (75.0% vs. 33.4%) (Figure 4.15). These were also the most prevalent of the MS components in women in the rural South African (331) and urban Kenyan studies (335), and were associated with an increased prevalence of the MS in African-American women. This may reflect a sex-specific effect of overweight/obesity on glucose homeostasis, lipid profiles and atherosclerosis (532).

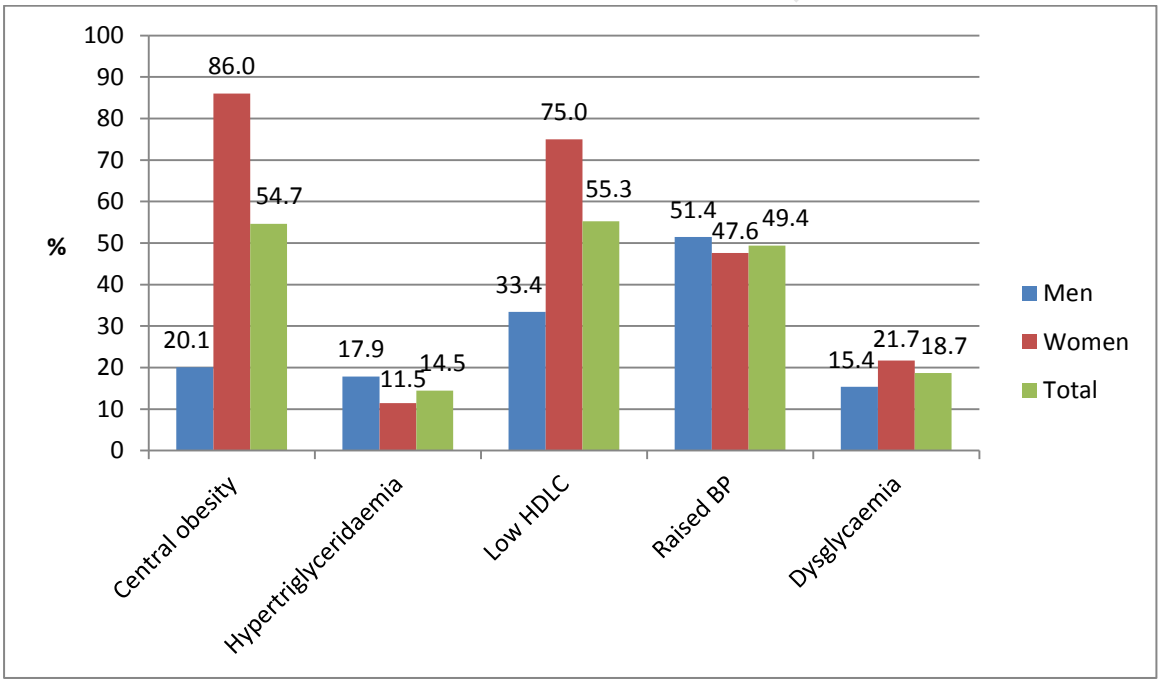


Figure 4.15: Prevalence of the metabolic syndrome components in men and women
Metabolic syndrome traits: Raised waist: men ≥94cm, women ≥80cm; raised triglycerides: >1.7 mmol/l; Low HDL-C: men <1.0 mmol/l, women <1.3 mmol/l; hypertension: BP ≥130/85 mmHg or on hypertension treatment; dysglycaemia: raised fasting glucose ≥5.6 mmol/l or on diabetes treatment.

In men, the most frequent component of the MS was raised BP (51.4%) (Figure 4.15) and, notwithstanding the different prevalence, was also most prevalent in rural South Africa (331) and urban Kenya (335). Low HDL-C and central obesity were the ensuing most prevalent MS components among men in these studies.

The high prevalence of the MS in women is of concern; even the youngest women had rates >20.0% whereas in men only those ≥45 years of age had rates over 20.0% (Table 4.17, p137). Younger women with MS are at a significantly higher risk of MI compared with younger and older men (533). Furthermore, the association between MS and CVD death was reported to be more than two-fold higher in women as in men, possibly on account of the stronger diabetes-CVD association in women (532).

While the MS prevalence was different in men and women, the pattern by age group was similar. The lowest rates were in the youngest participants while the oldest participants, aged 65-74 years, had the highest MS prevalence (men: 42.9%, women: 67.4%). Also, in the multiple logistic model with SOC, MS was significantly associated with increasing age (OR: 1.07, 95% CI: 1.05-1.09, p<0.001) (Table 4.18, p138). The changing demography with ageing populations in South Africa will probably result in higher rates of the MS in the future. Also fuelling the escalation of the MS may be the widespread use of ART and the high prevalence of HIV/AIDS in South Africa (248).

The odds for the MS were higher in the wealthier compared to the poorest participants; middle tertile: OR: 1.64, 95% CI: 1.10-2.44, p=0.015, richest tertile: OR: 1.89, 95% CI: 1.16-3.07, p=0.011. This reflected the pattern demonstrated in Section 4.3.5 for adiposity with wealth.

In their respective models, both higher SOC (OR: 1.02, 95% CI: 1.01-1.03, p=0.048) and higher LOC (OR: 1.07, 95% CI: 1.01-1.14, p=0.029), representing lower psychosocial stress, were significantly associated with the MS after adjusting for the other factors. These associations were unexpected and with no plausible explanation apparent. Longitudinal studies are needed to delineate the nature and direction of the relationship between psychological stress and the MS over time.

While the merits of the MS in clinical practice may be argued, it undoubtedly highlights the clustering of cardiovascular risk factors and underscores the need for a comprehensive and integrated approach to tackle CVD. This also reiterates the importance of total CVD risk assessment and the need to determine other CVD risk factors if a single risk factor is present.

4.5. TOTAL CARDIOVASCULAR DISEASE RISK ASSESSMENT

The conventional single risk factor approach with each CVD risk factor managed as a distinct entity unrelated to the other risk factors often results in an unacceptably high risk of cardiovascular events. This is because of suboptimal control, as shown in this study, and the failure to address other coexistent risk factors. Effective CVD

prevention warrants a paradigm shift from the treatment of single risk factors in isolation to the management of total cardiovascular risk (44) with an improvement in the profile of all risk factors that will lead to the development of CVD.

Guidelines for individual-based interventions now recognise the multi-factorial involvement of CVD risk factors and screen for those at high risk for CVD on the basis of multiple risk factors (5). The South African Heart Association (SA Heart) and the Lipid and Atherosclerosis Society of Southern Africa (LASSA) (322) as well as the Southern African Hypertension Society (SAHS) in conjunction with the National Department of Health (DOH) (400) have adopted a cardiovascular risk stratification approach. In the absence of locally validated total CVD risk assessment tools and seeing that the Framingham risk scores have been validated in white and black populations and are transportable to other culturally diverse populations, this approach was considered more appropriate for local use than, for example, the European guidelines whose scoring system is based on an exclusively European population (322).

The age-standardised mean 10-year risk for a CVD event, estimated using the laboratory-based lipid profiles, was 10.1% in men, significantly higher than in women (6.1%) ($p<0.001$) (Table 4.17, p137). This difference is a function of the equation which allocates greater weight to men. Nonetheless, the lower scores in women do not necessarily imply low risk and factors beyond the risk scores need to be considered when determining therapy (340).

The age-standardised prevalence of high risk (≥20) at 15.6% in men and 6.3% in women ($p<0.001$) in this study was modest. This suggests that for cost-effective management a relatively smaller proportion of participants require treatment compared to those with prevalent individual risk factors. This is especially relevant in light of the potential burden that maybe imposed on healthcare services if all individuals with, for example, high BP were treated with medication. Basing treatment decisions on a total CVD risk-assessment approach enables the identification of individuals who would benefit the most from treatment and also results in optimal and cost-effective management, as shown by Gaziano and colleagues in an analysis of the South African hypertensive guidelines (45, 534).

That the mean risk scores were low and the prevalence of high risk was nil in those <45-years-old was not surprising. All younger individuals will have low absolute 10-year risk, regardless of their risk factor levels, because age is the most heavily weighted variable in the 10-year model for absolute cardiovascular risk calculation

and modest elevations in risk factors would therefore have little effect on 10-year risk (30, 338, 535). Some younger individuals will, nonetheless, have a high risk relative to their peers, which will not be identified when applying the 20-% risk threshold for intervention (535).

Lloyd-Jones comments that low-risk scores in younger individuals are not because of the 10-year risk score per se nor incorrect risk prediction, but rather that they are related to the decision thresholds imposed on the risk estimates and the short time span imposed by 10-year risk estimations (338). An alternative to address these limitations may be to lower the treatment thresholds in younger adults, for example, treat those under 50 years with 10-year risk >5% (338). If the cut-point of >5% was used, almost a fifth more men below 45 years (19.0%) and women below 55 years (18.6%) would be treated. Younger individuals with an adverse risk profile, but low 10-year risk, may benefit more if interventions are started at a younger age rather than waiting until they cross the 20-% threshold (535). However, in resource-limited settings like South Africa such an approach cannot be recommended. As medical interventions carry risks, the net potential gain, acceptability, and cost effectiveness of early intervention is unclear. Further research is required to understand the clinical utility and impact of risk estimations (338, 535).

As expected, considering that age is the strongest determinant of 10-year risk, the mean risk scores increased with age peaking in the oldest men (38.9%) and women (23.8%) as did the prevalence of high risk (83.3% and 48.8%, respectively). Compared to younger individuals, assessment of risk in the elderly poses a different challenge (30). Using current thresholds in older individuals may result in overmedication; therefore, further investigation is required to define the optimal threshold for high risk in the elderly.

The interval of 10 years for risk estimation was selected because this time horizon identifies those individuals who are most likely to benefit from medical intervention in the short-term, thereby improving cost-effectiveness and safety of therapy (338). While there are some recognised limitations, 10-year risk estimations represent an improvement over clinical judgment alone for appropriate risk stratification. A systematic approach to total CVD risk estimation seems to result in better risk factor control (30).

The age-standardised mean 10-year risk for a CVD event using non-laboratory parameters was 12.3% in men and 7.7% in women ($p<0.001$) (Table 4.17, p137). Age-standardised rates of high total CVD risk (≥20) were 20.2% and 10.1% in men

and women, respectively (p<0.001) peaking in the oldest men (87.5%) and women (53.7%). A very high proportion of participants identified with high risk on the laboratory-based estimates was also identified by the non-laboratory estimates (97.2%) confirming that the use of the non-laboratory scores in clinical practice may be a feasible alternative in this setting. Eliminating the need for costly laboratory measurements will enhance accessibility and utility of the total CVD risk assessment tool (30) and is particularly relevant in low-resource settings such as South Africa that face a high burden of multiple diseases.

The independent associations with laboratory-based high risk scores (≥20%) in the multiple logistic model with SOC included <7 years of schooling (OR: 2.47, 95% CI 1.57-3.90, p<0.001), spending 50-90% of life in the city compared to <50% (OR: 1.97, 95% CI 1.12-3.46, p=0.018) and being unemployed (OR: 2.05, 95% CI 1.03-4.07, p=0.042) or a pensioner (OR: 16.58, 95% CI 8.22-33.42, p<0.001) compared to being employed (Table 4.18, p138). Living in a council house/hostel (OR: 1.92, 95% CI 1.16-3.17, p=0.011) or a private residence (OR: 1.93, 95% CI 1.07-3.48, p=0.028) was significantly associated with higher risk compared to living in informal dwellings. Similarly, these variables were also significantly associated with high risk scores by the non-laboratory estimates. These associations are mainly a reflection of the socio-demographic characteristics of older participants who were more likely to be less educated, pensioners and live in better quality housing compared to their younger counterparts.

4.6. STRENGTHS AND LIMITATIONS OF THE STUDY

Strengths

Conducting this study in the same areas surveyed in 1990 allowed for more accurate comparisons of the CVD risk factors between the two studies. The detailed sampling strategy to ensure proportionate representation by area, age and sex contributed to the increased likelihood of accurate estimations of the CVD risk factors prevalent in this population. The administration of the OGTT to determine diabetes is the gold standard for use in population-based studies and strengthens the findings of this study as opposed to the use of fasting glucose levels only. The drawing of fasting blood specimens to determine dyslipidaemia provided an accurate assessment of triglycerides and LDL-C estimates. The use of three psychosocial tools to determine psychosocial stress increased the likelihood of ascertaining associations between the CVD risk factors and stress.

Limitations

The cross-sectional design of this study precludes the inference of causal associations with variables significantly associated with the CVD risk factors. The low sample realisation in men (64%) necessitated higher sampling weights and a loss of precision. The difficulty in recruiting male participants is, however, characteristic of epidemiological studies in this country and is probably because of their reluctance for having blood samples drawn as well as their more frequent absence from home when compared to women.

In the clinical context, hypertension is usually diagnosed from BP measurements taken on at least three separate occasions. However, in this study three BP readings were taken on one occasion and the average of the second and third measurements used to diagnose hypertension, which was the same method used in 1990. This may have led to some overestimation of the hypertension prevalence.

For greater accuracy, at least three 24-hour dietary recalls should be obtained when assessing food intake, but a single 24-hour dietary recall of the previous day's food intake was obtained in this study and may have contributed to a lack of significant associations with high fat intake. Additionally, the definition of high fat intake was a relative measure as a proportion of total dietary intake instead of an absolute measurement. For example, two individuals with the same proportion of dietary fat intake may have vastly different absolute amounts of fat consumption. Also, this study did not differentiate between good (polyunsaturated) and bad (saturated) fat intake, which would differentially influence the CVD risk factors. Diet was not assessed in detail for the purpose of this thesis as the nutrition data is being analysed for a Master's dissertation.

The use of self-reported rather than objectively measured ambulation or physical activity is likely to have resulted in an overestimation of activity. In fact, the unexpected low levels of inactivity strongly suggest inadequate assessment of actual physical activity. This may have contributed to the absence of an association between variables when one was expected, namely, between inactivity and measures of obesity, diabetes or raised LDL-C level.

The self-reported histories of tobacco and alcohol use may have resulted in an underestimation of these risky behaviours on account of their perceived social unacceptability, particularly for smoking in women and for alcohol in general. However, the CAGE questionnaire used to assess excessive alcohol intake is an indirect measure that has been found to be reliable in this setting.

In some cases the different instruments used in 1990 and 2008/09 to assess certain CVD risk factors precluded a comparison across time. For example, the CAGE questionnaire used to ascertain problem drinking and the GPAQ for physical activity were used in 2008/09 but not 1990.

Glycaemic control among known diabetic participants would have been better determined by analysing HbA_{1C} levels. However, this blood test was not done and fasting glucose levels were used instead.

Since HIV testing was not done in this study, it is possible that some study participants could be infected with the virus. This could potentially influence the prevalence of dyslipidaemia with possible higher rates compared to those in a HIV negative population but is unlikely to have a significant impact on the prevalence of diabetes (Prof Levitt, personal communication).

The absence of a gold standard to measure psychosocial stress necessitated the use of several instruments to measure this variable. The lack of an association between psychosocial stress and some CVD risk factors found in this study does not preclude a relationship with other psychosocial tools. Therefore, the associations or lack thereof shown for SOC, LOC and adverse life events are not generalizable to other psychosocial instruments.

These study findings are not generalizable to rural settings on account of the differing lifestyle behaviours as well as healthcare access but may be generalizable to other urban black populations in South Africa. Notably, however, the diabetes prevalence in this population two decades ago was found to be higher than similar studies conducted in Durban (384) and the Free State (385) at that time, and may have remained higher.

The townships selected for inclusion in this study were those included in the 1990 studies for ease of comparison. The numerous new townships and informal residential areas that have arisen in the Cape Peninsula were not included and people in these newer areas may potentially have different CVD risk factor patterns than those in the more established townships.

These limitations notwithstanding, this study provides valuable data on the prevalence of diabetes, hypertension, dyslipidaemia, other CVD risk factors and their correlates in an urban black population in South Africa.

CHAPTER FIVE: MANAGEMENT OF CARDIOVASCULAR DISEASE RISK FACTORS IN SOUTH AFRICA: POPULATION-BASED AND INDIVIDUAL HIGH-RISK APPROACHES

5.1. INTRODUCTION

The findings reported in this study illustrate the current high prevalence of modifiable lifestyle risk factors such as high fat intake, tobacco and problematic alcohol use. The resultant high prevalence of the metabolic CVD risk factors of diabetes, hypertension, dyslipidaemia and overweight/obesity in the urban black African population of Cape Town is of considerable concern. So too is the observation that most of these risk factor rates have risen from two decades ago. Moreover, given the high rates of IGT (predictive of future diabetes), hypertension and dyslipidaemia, and the extremely high levels of overweight/obesity, in an increasingly urbanising country with an ageing population, the burden of CVD is likely to increase exponentially in the future.

The high prevalence of CVD risk factors and low levels of care in this population underline the importance of developing strategies for primary prevention, detection, and the urgent need for effective treatment options. Evidence from numerous countries suggests that premature cardiovascular events can be postponed and reduced with maximum impact, efficiency and cost-effectiveness via a combination of interventions that target high-risk individuals and population-based strategies (37, 44, 536).

5.2. POPULATION-BASED APPROACHES

Notwithstanding scarce healthcare resources and an underperforming healthcare system, there is much that South Africa can do to address the CVD epidemic and reduce the risk factor burden (536). CVD as well as other NCDs are largely preventable through attention to the four major modifiable risk factors of tobacco use, excessive alcohol consumption, unhealthy diets and physical inactivity. Access to, affordability and awareness of, as well as attitudes toward tobacco, alcohol, and unhealthy and processed food products are largely influenced by system factors such as national taxation policies, advertisements, global rules and ethics of marketing (29). Legislations that incorporate population-based primary prevention strategies to tackle the surge in CVD and other NCDs are the most cost-effective instruments with the potential to yield the greatest benefits (25, 29, 306, 536). In addition, it is crucial to impart the skills to make healthy choices so as to facilitate the uptake of healthier lifestyle behaviours.

5.2.1. TOBACCO USE

One of the most effective population-based strategies for CVD and other NCD prevention is a comprehensive tobacco control programme. South Africa has been a frontrunner in this regard with the introduction of comprehensive legislation in the form of the Tobacco Products Control Act of 1993 (536, 537). This legislation introduced health warnings on cigarette packs and advertising material, and the 1999 amendment banned tobacco advertising and the sale of tobacco to minors (537, 538). The effectiveness of these policies are reflected in the lower smoking rates among men in 2008/09 compared to 1990, as well the lower rates reported in the 2003 compared to the 1998 SADHS (420). While it cannot definitely be attributed to the legislation, there has been a decrease and stabilisation in the number of smoking-related CVD deaths, consistent with the declining smoking trend (536).

Although the tobacco control legislation has influenced a decline in smoking prevalence, this has plateaued in recent years. This suggests a need for the strengthening of interventions and a review of tobacco control policies. The aim is a further 10% reduction in tobacco use by 2016 and a 20% reduction by 2020 (539).

Recent amendments to the act in 2007 and 2008 include stringent restrictions on smoking in public places (540) and prohibiting the sale of tobacco products to those younger than 18 years, thereby raising the minimum age from 16 years (541). The Government Notice of March 2012 plans to prohibit smoking in public spaces, particularly in the presence of children (542). Additionally, the regulations on the display of tobacco products at the point of sale were published for public comment in August 2012 (543). Further legislation in the formative phase includes graphic health warnings with pictorial messages on cigarette packages (539). Such initiatives will hopefully further deter smoking uptake in the young and enable current smokers to stop or at least decrease their cigarette consumption.

Anti-smoking campaigns are imperative to prevent smoking uptake in women and the young. These need to link the abstinence of tobacco use with values prized, particularly among black women, such as upward mobility or access to personal and social development, personal dignity and family welfare (424).

Tobacco use is a powerful addiction that requires support to stop, necessitating smoking cessation programmes to assist smokers to quit. Nicotine replacement treatments and other pharmacological aids to quit smoking can approximately double the chance that an individual will successfully quit (162). Seeing that approximately

half the male participants in this study smoked daily, smoking cessation programmes have the potential to drastically reduce the smoking prevalence in this population.

5.2.2. ALCOHOL USE

The successful reduction in tobacco control is in stark contrast with the failure to acknowledge and address alcohol as an increasingly important factor, not only for CVD and other NCDs, but also for the current extremely high burden of violence and injury in the country (544). South Africa has thus far approached alcohol policy development in a piecemeal fashion (191). A comprehensive national alcohol strategy that cuts across different sectors including health, social welfare, crime prevention, trade and industry, and agriculture, and is supported by a broad grouping of stakeholders, is urgently required to curtail the misuse of alcohol in South Africa (428, 436). Furthermore, there needs to be increased awareness among the general population of the problems associated with alcohol abuse (179). In addition, multilevel interventions are required to target high-risk drinkers.

Evidence shows that the most cost-effective ways to reduce the harm caused by alcohol is to make alcohol less available and more expensive and to prohibit alcohol advertising (190, 434). These measures are supported in WHO policy documents such as the Global Strategy to Reduce the Harmful Use of Alcohol and the Global Status Report on NCDs, 2010 (190). A broad public health approach is emphasised to address alcohol misuse rather than simply seeking to change individual behaviour, as advocated by the liquor industry.

There has been a renewed interest in addressing the problem of rising alcohol misuse in South Africa (545). The Minister of Health has suggested a ban on alcohol advertising and sponsorship, and to increase the age of legal alcohol consumption from the current 18 to 21 years (190, 546). The Minister's stance is based on the decrease in smoking that followed the ban on tobacco advertising. The extent to which this will translate into meaningful policies is unclear (545).

Nevertheless, to this end the Inter Ministerial Committee has mandated the DOH to introduce legislation banning alcohol advertisements and sponsorships. The target for reducing alcohol consumption in South Africa is a litre reduction from 20 to 19 litres in the per capita consumption of alcohol by 2016 and a 20-% reduction in the relative per capita consumption of alcohol by 2020 (539). Such targets can only be achieved through multiple interventions including effective legislation that deters the consumption of alcohol through increased taxation that makes alcohol less affordable in addition to measures to make it less desirable by prohibiting advertisements.

5.2.3. DIETARY INTERVENTIONS

To provide for individuals with nutrition-related CVD risk factors such as overweight/obesity, diabetes, hypertension and the MS, it is imperative to improve dietary patterns (222). Focusing on medical management, smoking reduction, and regulating sodium in the diet will not necessarily halt the rising epidemic of obesity and other cardio-metabolic problems. The findings of this study reinforce the urgent need to highlight the prevention of overweight/obesity, particularly in women, as well as the development of diabetes, dyslipidaemia and hypertension as relevant topics for the public health agenda in South Africa. Effective interventions require evidence-based, carefully evaluated programmes and policies (222).

Public measures need to extend beyond the healthcare sector and address the physical, economic and socio-cultural environment to enable individuals to make healthier choices concerning diet and physical activity (444, 505). So far, measures introduced by the South African DOH to address nutrition-related CVD risk factors have included specific objectives in the Integrated Nutrition Programme of 2002 aimed at reducing obesity in women to 25% by 2007 (229, 547). In 2004, the National Food-Based Dietary Guidelines were launched (229, 548), and revised in 2012, for the prevention and management of overweight/obesity.

As observed by the spiralling rates of obesity among women in this study, as well as the higher rates of diabetes, hypertension and dyslipidaemia compared to two decades ago, the current measures to curb the CVD epidemic have been dismally ineffective. Awareness campaigns often elude their target audience, particularly in rural areas (549, 550). While the South African government has acknowledged the need to address the rising burden of CVD risk factors with policies and guidelines related to the control of these risk factors being developed, translating them into effective programmes remains elusive and challenging (551).

Currently, food marketing tends to promote less healthy foods (high in fat, sugar, and salt) which are more widely accessible and cheaper. Therefore, it is of little surprise that the epidemic of overweight/obesity has flourished without an appropriate public health response (442). The environment needs to be conducive to the uptake of healthier lifestyles in terms of easy access to cheaper healthier food options and safe convenient spaces for exercising. The current environment in South Africa makes it difficult to live healthier lifestyles, particularly for the poor majority, who are restricted in their choices by the lack of availability of healthy foods in the poorer sector of society, limited knowledge and monetary costs. Changing the environment is beyond

the control of the healthcare sector and requires input from motivated stakeholders in other government departments.

Comprehensive national and local interventions need to be developed that utilise every opportunity to encourage and promote active living, healthy eating, and energy balance (229). The DOH needs to drive the development of integrated, comprehensive and multi-sector policies for the prevention of CVD and other NCDs. The DOH in the South African Declaration on the Prevention of NCDs acknowledged that there needed to be a shift towards a 'whole of government' and a 'whole of society' approach with regards to NCDs, including CVDs, as these were caused or influenced by behavioural, environmental, social and economic factors (552).

The draft South African Strategic Plan for NCDs, 2012-2016 suggests that consideration may be given to taxing undesirable processed foods while exempting healthier choices from taxation (539). Other recommendations include controlling meals served to the workforce (e.g. in the army), to children during school hours, and to banning junk food advertisements to children during key television programmes. Numerous studies have demonstrated the effectiveness of such interventions (553). The plan is to engage with relevant government departments including agriculture, trade and industry, and treasury to increase the accessibility and availability of healthy foods as well as to improve eating habits through public awareness campaigns. The aim is to decrease overweight/obesity by 3% by 2016 and by 10% by 2020 (539). This may be difficult to achieve in light of the high and rising levels of overweight/obesity prevalent in women in this study.

Evidence from other countries such as Finland, the US and Poland have demonstrated the health benefits that accrue in populations following the implementation of population-based interventions; there are rapid wide-ranging improvements in diet and decreased calorie intake (51, 236, 311, 536). In accord with WHO recommendations to phase out industrially produced trans-fats (156), the South African government in February 2011 introduced legislation restricting the trans-fatty acid content to a maximum of 2 grams per 100 grams of oil or fat (554). Evidence from Denmark, which similarly banned the use of oils and fats containing more than 2% of industrially produced trans-fatty acids in foods, showed that this method was effective in reducing trans-fat intake. Furthermore, this intervention was cost saving as it required no consumer education (156, 536).

Considering that trans-fats adversely affect lipid profiles and increase the risk for diabetes and CVD (156), this legislation in South Africa is likely to have an important

positive impact on health. The Disease Control Priorities (DCP) project report indicated that substituting 2% energy from trans-fat with polyunsaturated fat led to a reduction of CVD risk ranging between 7-8% and 25-40%, without considering the additional beneficial effects on diabetes (156).

A front-of-pack food labelling with respect to levels of salt, fat, saturated fat, sugar and other nutrients would enable consumers to make informed healthier choices as well as stimulate product reformulation. A recommended suggestion that is easy to understand is the 'traffic light system' where red indicates bad/unhealthy and green good/healthy choices (with amber between the two) (216, 222, 536). This type of labelling enables consumers to make choices easily and has already been found to dramatically influence the purchase of foods, particularly those in the red category (216). Additionally, the cheaper pricing of healthy compared to unhealthy alternatives requires attention in order to increase affordability and to encourage the uptake of the healthier option.

Interventions also include reducing salt intake, which has been associated with a drop in BP and a lower risk of CVD event. Notably, Charlton and colleagues demonstrated the BP-lowering effect for systolic BP in a local hypertensive population on treatment following the dietary manipulation of seven commonly consumed processed foods. The BP lowering effect of this dietary intervention was estimated to contribute to a 20-% reduction in the number of deaths attributed to high BP (555).

In South Africa, salt ingestion at approximately 8.1grams/day (556) exceeds the recommended maximum 4-6 grams/day with almost 50% of intake from non-discretionary sources (536, 555, 556). In light of the high hypertension prevalence in this population, it is crucial that CVD prevention strategies in South Africa include a component that attempts to lower BP across the whole population. Even modest decreases in BP, if experienced across an entire population, have the potential to yield substantial reductions in CVD morbidity and mortality (216, 285, 293, 307, 309).

In accord with WHO recommendations that governments implement policies regarding food labelling, legislation and product reformulation (217), South Africa has announced the need to legally control the salt content in most processed food (37) and has commenced discussions with the appropriate consumer and industry groups to initiate a process of voluntary reductions in food sodium levels (556). Such an initiative would have a significant impact on BP levels as the black population has been found to be particularly salt-sensitive (37). Randomised trials have

demonstrated that, for a given reduction in salt intake, the declines in BP were larger in individuals of African origin compared to whites (216, 285). Moderating salt intake would also correspond with international recommendations that advocate for salt reduction as a key cost-effective intervention to target the burden of NCDs (80). The aim is to reduce salt consumption in South Africa to 7 grams/day by 2016 and to <5 grams/day by 2020 (539).

In addition, measures to improve food labelling of products recognised as significant sources of salt intake need to be implemented (311). Government legislation to introduce effective cost-saving initiatives such as the New Zealand and Australian 'Tick' programme locally, whereby the salt content of selected processed foods is decreased could greatly benefit population health, particularly in view of the high prevalence of hypertension (309, 536).

Further, for effective salt reduction at the population level, it is important for policy development and implementation to target the main source of dietary sodium in the population (308). Worthy of investigation, therefore, are policies to reduce the salt content of bread, which comprises 25-40% of sodium intake, and is the single greatest contributor to non-discretionary salt intake in South Africa (536, 556, 557). In a milieu of rising hypertension prevalence and the known profound effect of salt intake, reducing salt intake to achieve the WHO recommended salt consumption target of <5 grams/day would be one of the most cost-effective strategies to combat the epidemic of hypertension and CVD, and to improve population health in South Africa (309, 556). Potentially, 8% of strokes, 6.5% of IHD and 11% of hypertensive heart disease could be prevented if recommended reductions in the salt content of bread and some other commonly consumed food products in South Africa were introduced (556). In addition to major beneficial effects on health, there will also be significant cost savings such as reduced healthcare costs (285). Direct healthcare cost savings from a decline in stroke incidence would amount to an estimated R300 million (US$40 million) annually (556).

Opposition from food manufacturers and their shareholders with vested interests is likely to be encountered because of the potential negative impact on lucrative sales from junk food and ready meals (often laden with cheaper sugar, salt and fat laden ingredients) (216, 536, 553). Furthermore, with regards to salt, it is also a major determinant of thirst and a reduction in intake will reduce fluid consumption with a subsequent reduction in caloric-laden soft drink. The other benefit of added salt in food products for manufacturers is that salt enhances cheap and unpalatable food making it edible at no cost (216).

Such nutrition-related policies therefore require political will for implementation. Despite challenges South Africa urgently needs to develop and implement evidence-based policies and strategies to effectively address the daunting CVD epidemic. About 40% of deaths from CVD and other NCDs have been reported to be caused by the consumption of foods high in saturated and industrially produced trans-fats, salt and sugar (80). Therefore, if South Africa is to seriously tackle the growing epidemic of these diseases, it is essential that such dietary measures be introduced.

5.2.4. PROMOTING PHYSICAL ACTIVITY

In addition to population-based strategies that encourage healthier food patterns (limiting tobacco and alcohol use, and reducing salt and trans-fat intake), interventions need to create an enabling environment for physical activity. In response to the WHO's recommendations in its Global Strategy on Diet, Physical Activity and Health, various South African government departments promoted physical activity. The DOH introduced the 'Vuka! South Africa – Move for Your Health' campaign and the Department of Education and Department of Sport and Recreation developed a policy framework on physical activity, reflected in the White Paper 'Getting the Nation to Play', which supported the initiatives undertaken by the DOH (200). These initiatives have, however, not been met with any notable success.

Even though individual behaviour determines physical activity levels, there are multiple influences on health-related behaviours and conditions, including individual, community and public policy factors (200). Therefore, physical activity is not simply a personal choice; it is influenced by the built environment, infrastructures for public transport, urbanisation patterns, safety issues, education on physical activity in childhood, and many other systemic factors that are not addressed in strategies focusing on individuals (29). Environmental factors that prevent South Africans from participating in optimal physical activity include a lack of safety and high crime rates, and a lack of green areas and recreation facilities. Cultural beliefs and attitudes towards thin people also seem to contribute to low levels of physical activity among South Africans (200, 238). Additionally, the poor have fewer opportunities for physical activity and recreation (539).

The WHO Global Strategy stressed that inter-sectoral planning and collaboration is required across government departments to create safe and 'walkable' communities, schools and neighbourhoods, and to increase awareness of the importance of physical activity for health (200). In addition to the involvement of the government departments mentioned above, there is a clear need to mobilise other government

departments to create safe and attractive opportunities for physical activity, particularly within urban environments. Evidence demonstrates that cities which encourage walking and cycling above car use have better health statistics (401). Developing and implementing policies to create enabling environments for physical activity are in accord with the WHO Action Plan endorsed by the World Health Assembly in 2008 (198).

Currently, there are undertakings to develop a national strategy to increase population-wide physical activity in South Africa (Dr Kolbe-Alexander, personal communication). The government plans to encourage physical activity by improving awareness of the importance of regular physical activity, by promoting inter-sectoral collaboration to increase opportunities for activity and by implementing programmes and interventions to promote activity. The aim is a 10-% increase in moderate-intensity physical activity per week by 2020 (539).

A life-course approach that instils a culture of regular physical activity and other healthy lifestyle behaviours from childhood to older age is also needed (200). The complex interplay of personal, political, cultural and environmental factors reinforces the need for health to become an explicit objective in all policies if the prevention and control of CVD and other NCDs are to be achieved (29).

5.3. INDIVIDUAL HIGH-RISK APPROACHES

5.3.1. HEALTHCARE DELIVERY IN SOUTH AFRICA

According to World Bank figures from World Development Indicators 2008, South Africa spends 8.7% of its gross domestic product (GDP) on health; more than any other African country and just slightly less than Sweden (8.9%) (544, 558). However, the largest proportion of healthcare spending occurs in the private sector; most of the population, who lack health insurance, receive care in the overburdened and underfunded public health system, which spends 3.5% of GDP on healthcare (558, 559).

The country's healthcare services are struggling to cope with the quadruple burden of disease, comprising HIV/AIDS, CVD and other NCDs, poverty-related diseases, and violence and injuries (381, 549). The focus of care is currently on infectious diseases, particularly HIV/AIDS and TB, and overburdened healthcare services and health professionals in South Africa perceive diabetes, dyslipidaemia, hypertension and their associated consequences as less urgent (382). In stark contrast to the poor treatment illustrated by the data presented in the previous chapter, effective combination ART has resulted in the overall mortality associated with HIV decreasing

significantly and life expectancy increasing to the extent that CVD-related deaths now represent a rising proportion of mortality in HIV-infected individuals (470). The risk of CVD has now emerged as an important consideration in HIV-infected individuals and is likely to increase as they live longer (560).

Notwithstanding the growing burden of CVDs with their potential catastrophic costs, the health system response has been limited (536). These chronic conditions are marginalised and have received little priority from healthcare services and professionals alike (382). Therefore, it is not surprising that the management of diabetes and hypertension in South Africa is far from optimal, as demonstrated in this and other studies (465, 480, 498, 550, 558, 561, 562). Furthermore, studies conducted over a decade or more ago reported poor control of diabetes and hypertension and attest to the longstanding nature of this problem (465).

The almost non-existent management of dyslipidaemia prevailing in this study is also inexcusable. Although statins have been available only since 2004 in the Western Cape public healthcare sector, there are now more cost-effective generics universally available. These have been included in the national Essential Drug List (389) albeit with a maximum dosage of only 10 mg of simvastatin. With the advent of generic medication to offset the high cost of treatment for dyslipidaemia, and the rising prevalence of IHD in the black population, it has become imperative to screen for and manage individuals with dyslipidaemia using the total cardiovascular risk assessment approach.

Several reasons exist for the poor management of diabetes, hypertension and dyslipidaemia and include healthcare system, healthcare provider and individual barriers (53, 492). In South Africa, the lack of sufficient healthcare providers, facilities and resources including time, space, equipment and medication contribute to the scant attention paid to CVDs. Healthcare providers work under increasingly difficult circumstances with staff shortages a major barrier to effectively managing patients with diabetes and hypertension (465, 550, 563). This results in prolonged queuing for patients and a reduced quality of care provided (563). Resources to cater for the greater load of diabetic and hypertensive patients referred from secondary and tertiary healthcare facilities are inadequate with no provisions made for the larger patient volumes (465).

5.3.2. REORIENTATION OF HEALTHCARE SERVICES

For the successful management of these conditions, changes are required in the health system at the levels of policy, organisation, training and facilities. The WHO

emphasises that the treatment and control of CVD risk factors do not require massive resources. A well-organised and focused strategy by healthcare systems, in a supportive political milieu, can achieve acceptable control in a setting of modest resources (53).

Healthcare systems can maximise their returns from scarce resources through innovative means by shifting services to incorporate care for chronic conditions (564). In many developing countries, resources are inappropriately directed to tertiary healthcare, while lower-level healthcare facilities are often not equipped with basic facilities (53). Similarly, in South Africa healthcare expenditure is currently dominated by tertiary-level hospitals, with 30% of total public health expenditure spent on super-tertiary hospitals based in Johannesburg, Cape Town and Durban (565). In light of the expanding demand for chronic care of CVD and other NCDs this needs to be rectified with a redistribution of resources to PHC services. These services play a key role in the provision of preventive and care interventions and are usually the foremost access point for healthcare (53, 56).

An optimally functioning PHC system is vital for the effective execution of prevention strategies and identification of individuals at high-risk for CVD (536), and needs to be reinforced to deliver better chronic disease care (564). The challenge in providing effective CVD risk management within PHC systems is that these services have been developed for treating acute, time-limited episodic conditions that cater for urgent patient needs. They are thus not geared to support the continuity of care required for patient follow-up in CVD risk management (53, 564). Nursing staff at PHC clinics in Cape Town rotate through different departments, in line with an acute care model but inappropriate for chronic care management, despite the fact that at least 50% of patients attending PHC clinics have chronic needs (550, 566).

An evolution in PHC is necessary with improvements in the design and organisation of the healthcare system to optimise the care provided for CVD and other NCDs (563, 564, 566). On-going care provided by a well-functioning team is the basis for optimal control of chronic diseases (566). Continuity of care in the management of chronic diseases, in terms of specific healthcare providers as well as information flow, is vital and can also save time and money with the elimination of investigations that may be unnecessarily repeated by new healthcare providers (567, 568).

Furthermore, the referral process from PHC facilities to more specialised centres is currently flawed (563, 566). There needs to be greater cohesion and better links between primary and specialist care services to ensure shared information across

settings and healthcare providers (539, 564, 566). This will result in improved health, reduced waste, fewer inefficiencies and a less frustrating experience for the patient (564).

5.3.3. TASK SHIFTING TO LOWER-LEVEL HEALTHCARE WORKERS

The major challenges for the delivery of CVD care are the shortage of healthcare providers with the appropriate training and skills, and an already overburdened workforce (53), as evident in South Africa (465, 550). For efficient and effective chronic care delivery, specialised training in chronic care management and dedicated chronic care teams are required (550). However, with human resources already accounting for 50-70% of healthcare expenditure in South Africa (559), there is an urgent need to find feasible and cost-effective solutions for improving delivery of CVD care.

One long-term strategy to address the issue of human resources is to train and allow less specialised healthcare providers, such as nurses and community healthcare workers (CHWs), to reliably and effectively assess and manage CVD in PHC settings (536). At the clinic level, CHWs could provide education, check BP and glucose levels, and administer basic urine tests while specifically trained nurses could prescribe medication and refer patients with complications or severe disease to physicians. The reallocation of such CVD risk-factor care, typically from a physician to a healthcare provider with a lower education and training level, or to an individual specifically trained to execute a limited task only, without having the formal health education, is referred to as task shifting (569).

South Africa has developed extensive experience of task shifting with the successful treatment and care of HIV/AIDS patients. Assigning the care of uncomplicated HIV/AIDS to lower-level healthcare workers such as specially trained nurses and adherence counsellors in clinics has been demonstrated to improve the quality and access to care, and adherence to medication. Drawing on this expertise and success, and in view of budgetary constraints, a task shifting model for CVD management warrants consideration (536, 568).

The introduction of CHWs as part of a PHC outreach programme has the potential to strengthen health system effectiveness and reduce the pressure experienced at PHC facilities. Furthermore, utilising trained CHWs to conduct support groups for individuals with chronic conditions could potentially improve the care for CVD risk factors (465). Such a strategy requires a well-designed training programme that

imparts an appropriate skill and knowledge base to CHWs with close monitoring and evaluation by managers at district and sub-district levels (53, 465).

5.3.4. INTEGRATION OF HIV/AIDS AND CARDIOVASCULAR DISEASE CARE

The key principles in the care of patients with chronic illnesses have been incorporated by the National DOH in the management of HIV/AIDS (567). Seeing that the requirements for effective decentralised provision of therapy for HIV/AIDS and for CVDs are closely aligned (570), the care of chronic conditions such as diabetes and hypertension in South Africa could be integrated with HIV/AIDS care. This may improve patient outcomes for CVD, seeing that adherence levels and patient management are usually better within the HIV clinics (346, 536, 559). The effort, services and resources which are directed at individuals and communities affected by HIV/AIDS can be harnessed to strengthen the delivery for CVD and other NCDs (570). Furthermore, positioning integrated chronic care for both infectious and NCDs at the heart of the PHC system is likely to garner a greater response for CVD risk-factor management (536). Also, with the ageing of the HIV population and the reduction in premature mortality owing to ART, the same individuals will likely develop CVD risk factors and require simultaneous treatment for HIV and CVD. Nonetheless, the efficiency, quality and acceptability to users, and the effects on health status of integrating care for chronic infectious and NCDs will need to be determined (536, 568, 570).

5.3.5. SCREENING FOR CARDIOVASCULAR DISEASE RISK FACTORS

Together with the appropriate management of individuals with known CVD risk factors and the inclusion of those at high risk in dedicated CVD programmes, the ultimate goal should encompass the early identification of those with asymptomatic and previously undiagnosed CVD risk factors, such as diabetes and hypertension. Currently, there exists no clear policy for screening of CVD risk factors in South Africa. Besides, the country lacks the staff, facilities and funds to implement population-based screening programmes, especially in view of the HIV/AIDS pandemic (558).

Targeted screening programmes to identify individuals with high-risk characteristics (such as older age, high BMI or WC, the presence of a known risk factor or a positive family history) (246) should ideally be undertaken to address the suboptimal detection of diabetes, hypertension and dyslipidaemia. To identify people at high risk for diabetes, the IDF and American Diabetes Association, among other organisations, recommend brief screening questions (571, 572). These include

varying combinations of age, BMI, WC, first-degree relative with diabetes, self-reported hypertension and physical activity. However, a screening questionnaire has not been validated for Africa. Once validated, screening programmes may be implemented by trained CHWs, who are closely monitored, at clinics, social development pay points or other government services.

Screening programmes can also potentially be easily incorporated into the current HIV Counselling and Testing campaign, which has already tested over 13 million individuals for HIV, and offers an excellent opportunity for the screening of CVD and other NCDs. In addition to HIV and TB screening, healthcare providers conducting testing could routinely offer testing for diabetes, hypertension and other NCD risk factors (539). Early detection and effective treatment for diabetes, hypertension and other CVD risk factors will result in efficient and cost-effective management because of decreased complications and hospitalisations (249).

After individuals at high-risk for diabetes are identified on the screening questions, the challenge remains regarding the appropriate biochemical test to use. This test needs to be reliable, high performance, convenient and low-cost (461). OGTT are cumbersome and inconvenient while HbA_{1C} tests are expensive. Further, both require skilled healthcare personnel and laboratory facilities for sample analyses, a major challenge in resource constrained setting such as South Africa. The most practical alternative, as recommended by the WHO, is using a point-of-care capillary glucose test which is simple and reliable for identifying undiagnosed diabetes (461, 573).

5.3.6. PATIENT-CENTRED APPROACH TO CARDIOVASCULAR DISEASE MANAGEMENT

Unlike acute illnesses where patients are treated usually without their active participation (465), comprehensive CVD care relies on individuals adhering to daily drug regimens, implementing lifestyle advice and returning for follow-up assessments (53). Therefore, the focus needs to be on patients' central role in and responsibility for their own healthcare and constitutes an important shift in current clinical practice (564, 567). Patients need to be assisted in achieving their goals by healthcare providers as well as their families, support groups and community (539, 564, 567).

For improved patient adherence to therapy and lifestyle recommendations, it is important for knowledge and advice to be imparted in a culturally relevant context. For example, when designing and implementing obesity treatment and prevention programmes, cognisance must be taken of the complex socio-cultural determinants

of obesity. These range from perceptions of what constitutes an ideal body shape and size with the preferred form being overweight, to food availability and portion sizes (574). In African cultures, being overweight is acceptable and even desired, as it is perceived to be associated with dignity, respect, wealth, strength, attractiveness, happiness and health, and with being well-treated by their husbands (224, 229, 238, 574, 575). Moreover, in the context of the high prevalence of the HIV/AIDS epidemic in South Africa, excess body weight is associated with a lack of this disease and stigmatisation (396, 447, 575). In the context of this positive attitude towards overweight/obesity, changing knowledge and awareness presents a challenge (576). Extensive education is required to alter perceptions of overweight/obesity considering the widespread ignorance of the link between obesity and increased CVD risk (442).

5.4. THE NATIONAL DEPARTMENT OF HEALTH'S STRATEGY FOR CARDIOVASCULAR DISEASE IN SOUTH AFRICA

In accordance with the recent UN resolution that seeks to halt the increasing trends in premature deaths from NCDs, the South African DOH has prioritised the management of NCDs, which is a significant step for the control of CVDs (552). The DOH stated that it was committed to developing a full and comprehensive NCD strategic plan with the aim of introducing multi-sectorial public policies that created sustainable health promoting environments (552).

That the healthcare for individuals with NCDs, including CVD, needed to be fully integrated into the re-engineering of PHC in South Africa is also stated in the NCD strategic plan. In addition, population-based prevention, screening and better self-management with increased adherence is needed to achieve good NCD care which is in line with the WHO innovative model for chronic care (552). As a result, healthcare in South Africa is undergoing a process of reformation. The strengthening of health systems is regarded as a prevention and control mechanism for reducing CVD and other NCDs. An essential component of the re-engineering of the PHC services will be the establishment of PHC outreach teams in all community wards in the country. The plan is for CHWs to visit households directly, and identify and refer those at high risk for assessment at local clinics, among other duties (539). The focus for improving health outcomes will be on health promotion and disease prevention (577).

Goals for NCDs with targets to be achieved by 2020 were set at the South African Summit on the Prevention and Control of NCDs in 2011 and included the following which are applicable to CVD (578):

- Reduce the relative premature mortality (under age 60 years) from NCDs by at least 25%
- Reduce tobacco use by 20%
- Reduce the per capita consumption of alcohol by 20%
- Reduce the mean population salt intake to <5 grams per day
- Reduce the percentage overweight/obese by 10%
- Reduce the prevalence of raised BP by 20%
- Increase the prevalence of physical activity by 10%

Realising the targets for tobacco use, alcohol consumption, diet and physical activity have been discussed under Section 5.2. with the South African strategy advocating the 'best buys' in terms of implementation costs, health impact and cost-effectiveness. Additional aims, in conjunction with the population-based interventions and lifestyle measures, include reducing the prevalence of raised BP through medication and improving control of hypertension and diabetes by 30%, thereby contributing to a reduction in premature mortality (539). These are aligned with the global NCD targets which will be incorporated into the WHO global action plan for the prevention and control of NCDs covering the period 2013-2020 (579).

These targets set by South Africa were among the first initiatives globally aimed at reducing the burden of NCDs and announced ahead of the UN High-Level Meeting in September 2011 (580). The foundation of the South African NCD strategic plan has been the numerous good legislative and policy initiatives as well as guidelines and standards for CVD and other NCDs that have been formulated by the DOH over the past two decades. These include the national programmes for the control and management of hypertension (1998) and diabetes (1998) at primary level, policy guidelines on primary prevention of chronic diseases of lifestyle (1999), national guideline on foot health at primary level (2000), national guideline on stroke and transient ischaemic attack management (2001), national guideline on the prevention and management of overweight and obesity (2003), and the updated national guidelines on the management of hypertension (2006), among other initiatives (539). However, there has been a lack of an equivalent emphasis on the implementation, monitoring and assessment of these policies throughout the healthcare system (581). In view of the re-engineering of PHC in the country and the current global focus on NCDs, it is sincerely hoped this NCD strategic plan will be translated into effective action.

5.5. CONCLUSION

This thesis aimed to determine the prevalence of CVD risk factors in 2008/09, the changes in these between 1990 and 2008/09, and the association between psychosocial stress and the other CVD risk factors in a random sample of the 25-74-year-old urban black population of Cape Town. A high prevalence with rising levels over time was reported for many CVD risk factors including diabetes, hypertension and dyslipidaemia in the studied population. The worsening profile of other risk factors, in particular overweight/obesity in women, can explain part of the observed changes. The association of psychosocial stress was found to be independently related to certain CVD risk factors, notably with diabetes in women.

Moreover, not only are most of these risk factor rates higher now compared to two decades ago, but in view of the high rates of IGT (predictive of future diabetes), hypertension and dyslipidaemia, the extremely high levels of overweight/obesity, effective treatment of HIV/AIDS, and with continuing urbanisation and ageing populations the burden of CVD in this setting is likely to increase exponentially. This highlights the importance of, as well as the expanding demand for, cost-effective chronic care of CVDs, their risk factors and related conditions such as diabetes.

Management of cardiovascular risk factors in South Africa is far from optimal, as demonstrated in this and other studies, and needs to be urgently prioritised in order to minimise CVD morbidity and mortality. The proposed re-engineering of PHC in South Africa and the strengthening of health systems with the prioritisation of NCD management will potentially improve CVD risk factor care.

In addition to optimal care for high-risk individuals, identified using a total CVD risk approach, interventions that encompass population-based strategies for primordial prevention are also required. Apart from the implementation of a comprehensive tobacco control policy and the recent legislations regulating the trans-fatty acid and sodium contents of foods, South Africa has thus far failed to adequately address the burgeoning CVD epidemic. Seeing that exposure to risk factors begins in childhood, the WHO recommends legislative and regulatory measures to protect children from the adverse impacts of marketing. The aim is to prevent the uptake of risky behaviours that predispose to CVD (582).

While the rates of diabetes, hypertension and dyslipidaemia were equally high in men and women, some lifestyle behaviours were gender-specific. Certain were prominent in women (overweight/obesity) and others in men (smoking and problematic alcohol

intake). Programmes and policies attempting to curb the rates of these lifestyle factors need to take cognisance of the influences affecting their genesis.

The positive attitudes towards overweight/obesity among women need to be explored with measures to overcome these developed in association with the communities affected. These will include realigning images of success and wealth with slimness and health, and overweight/obesity with the converse.

Despite comprehensive tobacco control legislation in South Africa, the smoking prevalence remained unchanged in women and was the highest among the youngest men. Further research is required to identify measures to curb smoking in these vulnerable groups. These may include anti-smoking campaigns or patient-centred smoking cessation programmes targeted specifically at these groups.

In conjunction with the introduction of comprehensive legislation to curb alcohol misuse, community-based research is required to investigate the culture of problematic alcohol use and encourage responsible drinking. This may include advertisements or promoting the establishment of predetermined community drivers or the use of taxi services when inebriated.

Surveillance is crucial to provide information for the development of policies and programmes, to assessment initiatives implemented and to monitor progress (38). Furthermore, on-going surveillance, currently absent in South Africa, is needed to monitor and track the burden of CVD and its risk factors in the community. The lack of reliable data for CVD risk factors and cause-specific mortality leads to the inability to accurately assess the effects of policies and programmes. A national surveillance framework should include the key risk factors, the outcomes in terms of morbidity and mortality, and the health system response and capacity (38).

The use of adult health indicators reflecting improvement, or otherwise, of healthcare provision is essential to monitor trends in the quality of care provided. The health system response regarding quality of care may be assessed, among other measures, by evaluating the implementation of clinical practice guidelines and a patient-centred style of communication which leads to greater patient satisfaction. Adequate capacity may be determined in terms of the proportion of well-trained medical and nursing staff and their effective interaction with CHWs. Logistical aspects such as drug availability/shortages or patient waiting-time at clinics also influence the quality of care delivered.

The current healthcare response may be partly responsible for the differential care of hypertension demonstrated by age and gender in this study. This and other potential reasons such as time constraints or attitudes towards drug adherence need to be examined and addressed to achieve optimal hypertension management.

Finally, the findings of this study are valuable in raising awareness about the increasing magnitude of the CVD risk-factor burden among policy makers and the public. This will place greater emphasis on these conditions in the required health policy agenda. Concerted prevention and control measures are urgently needed because, apart from unhealthy alterations in lifestyle behaviours, demographic shifts per se are estimated to contribute to a doubling of the number of CVD deaths in South Africa by 2040 (382). Failure to address this problem will otherwise impair socio-economic development and poverty alleviation in the country with 41% of CVD mortality predicted to occur in 35-64-year-olds, namely, the younger members of society, in 2030 (45).

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APPENDIX A

APPENDIX B

No 1

CRIBSA STUDY 2008 – HOUSEHOLD MEMBERS

Date: D D M M Y Y

Fieldworker:

Strata:

Block:

Address:

Number and details of people in the household

No	Name	GENDER		DOB / Month	AGE			
		M	F		25-34	35-54	55-64	65 - 74

APPENDIX C

No 2

CRIBSA STUDY 2008 – SCREENING QUESTIONNAIRE

Date: D D M M Y Y

Fieldworker:

Area:

Participant name:

Participant Address:

Telephone number(s):

	(work)
	(home)
	(cell)

Gender: Male | Female

Age: 25 - 34 | 35 - 54 | 55 - 64 | 65 - 74

	Exclusion Criteria	YES	NO
1	Bedridden		
2	Pregnant / breastfeeding		
3	Cancer treatment – in the past 1 yr		
4	TB treatment now		
5	Antiretroviral treatment now		
6	Living in Cape Town <3 months		

Agree to participate: YES | NO

Date of appointment: MON | TUES | WED | THUR | FRI | D D M M Y Y

Notes:

APPENDIX D

APPENDIX E

CARDIOVASCULAR RISK IN BLACK SOUTH AFRICANS (CRIBSA)

QUESTIONNAIRE

SECTION 1: GENERAL INFORMATION	***Office use***
STUDY NUMBER:	4
INTERVIEWER'S NAME	
AREA/TOWNSHIP	
NAME OF PARTICIPANT.....	
ADDRESS OF PARTICIPANT……..……..……	
.....	
TELEPHONE	
2ND CONTACT PERSON'S DETAILS: NAME	
ADDRESS ……..……..……..	
……..……..……..……	
TELEPHONE	
DATE OF INTERVIEW: D D M M Y Y Y Y	16
GENDER: Male 1 / Female 2	
AGE AT LAST BIRTHDAY	
DATE OF BIRTH: D D M M Y Y Y Y	27

SECTION 2: MIGRATORY HISTORY (to calculate % life spent in urban setting)	***Office use***
2A. Place of birth (village/town):	29
2B. Were you born in / on: A rural village 1 / A farm 2 / A small town 3 / A large city or town 4 / Don't know 9	
2C. Where did you spend most of your childhood (up to 10 years old)? A rural village 1 / A farm 2 / A small town 3 / A large city or town 4 / Don't know 9	
2D. When was the first time you came to a big city? (If born in city give year of birth) Y Y Y Y	
If less than 12 months tick **Yes** for new arrival: Yes 1 / No 2	36

SECTION 4: SELF-REPORTED MEDICAL HISTORY

Office use

STUDY NUMBER: [ ][ ][ ][ ] 4

4A. Would you say your health is poor, average, good, or very good/excellent?

Poor 1	Average 2	Good 3	Very good/excellent 4	[ ]

4B. Do you personally think that you are underweight, normal weight or overweight?

Underweight 1	Normal weight 2	Overweight 3	Don't know 9	[ ]

4C. Has a **doctor** or **nurse** or **health worker** at a **clinic** or **hospital told you** that you have or have had any of the following conditions?

1) High blood pressure	Yes 1	No 2	Don't know 9	[ ]
2) Heart attack or angina (chest pains)	Yes 1	No 2	Don't know 9	[ ]
3) Stroke	Yes 1	No 2	Don't know 9	[ ]
4) High blood cholesterol or fats in the blood	Yes 1	No 2	Don't know 9	[ ]
5) Diabetes or blood sugar	Yes 1	No 2	Don't know 9	[ ]
6) Diabetes during pregnancy	Yes 1	No 2	Don't know 9	[ ] 12

4D. During the past 12 months have you been tested/checked for:

1) Hypertension/high blood pressure	Yes 1	No 2	[ ]
2) Diabetes	Yes 1	No 2	[ ]

4E. During the past 12 months have you seen a traditional healer for:

1) Hypertension/high blood pressure	Yes 1	No 2	[ ]
2) Diabetes	Yes 1	No 2	[ ]

4F. Are you currently taking any herbal or traditional remedy for:

1) Hypertension/high blood pressure	Yes 1	No 2	[ ]
2) Diabetes	Yes 1	No 2	[ ] 18

SECTION 5: MEDICATION

Office use

5A. Who pays for **most** of the medication, prescribed by a doctor or nurse, that you use?

READ THE ANSWER CATEGORIES TO THE RESPONDENT

Respondent	1
Family	2
Medical aid	3
Provided at clinic or public hospital	4
Employer	5
Other (specify)	6

[ ] 19

5B. Do you use any medicine regularly or daily that a doctor or nurse has prescribed?

Yes 1	No 2	[ ]

5C. How many different medicines do you use regularly or daily?

No. of medicines:	[ ][ ] 22

SECTION 5: MEDICATION

Office use

STUDY NUMBER: | | | | | 4

5D. RECORD ALL THE DRUGS BROUGHT IN BY THE RESPONDENT:

1)		11
2)		18
3)		25
4)		32
5)		39
6)		46
7)		53
8)		60
9)		67
10)		74
11)		81

SECTION 6: FAMILY MEDICAL HISTORY

Office use

STUDY NUMBER: | | | | | 4

6A. Do you have a **close blood relative** (father, mother, brother, sister / child) who has ever been diagnosed:
by a doctor or nurse with any of the following conditions?

1) High blood pressure	Yes 1	No 2	Don't know 9	
2) Heart attack/angina/chest pain when exerting himself/herself	Yes 1	No 2	Don't know 9	
3) Stroke	Yes 1	No 2	Don't know 9	
4) Diabetes	Yes 1	No 2	Don't know 9	

6B.	Nowadays in South Africa far more young people die, or become very ill than before. Has this happened in your family?	Yes 1	No 2	
6C.	Do you have to take care of a child whose parents are ill or have died?	Yes 1	No 2	
6D.	If YES, has this made it more difficult for you to care for your own health?	Yes 1	No 2	

6E.	Does anyone in your household have HIV/AIDS?	Yes 1	No 2	Don't know 9	12

SECTION 7: PSYCHOSOCIAL

Office use

STUDY NUMBER: ☐☐☐☐ 4

A) ORIENTATION TO LIFE QUESTIONNAIRE (SOC-13)

Below are a series of questions relating to various aspects of our lives. For each question, you will first select the response which most closely resembles how you feel. Then, on a scale from 1 to 7, you will select the number closest to that response which best describes how you feel. You can choose any number between 1 and 7. Please give only one answer to each question.

1) Do you have the feeling that you don't really care about what goes on around you?

Very seldom or never						Very often
1	2	3	4	5	6	7

☐ 5

2) Has it happened in the past that you were surprised by the behaviour of people whom you thought you knew well?

Never happened						Always happened
1	2	3	4	5	6	7

☐

3) Has it happened that people whom you relied/depended on disappointed you?

Never happened						Always happened
1	2	3	4	5	6	7

☐

4) Until now your life has had:

No clear direction or purpose at all						Very clear direction and purpose
1	2	3	4	5	6	7

☐ 8

5) Do you have the feeling that you're being treated unfairly?

Very often						Very seldom or never
1	2	3	4	5	6	7

☐

6) Do you have the feeling that you are in an unfamiliar situation and don't know what to do?

Very often						Very seldom or never
1	2	3	4	5	6	7

☐

7) Doing the things you do every day is:

A source of deep pleasure and satisfaction						A source of frustration and boredom
1	2	3	4	5	6	7

☐

8) Do you feel confused or have very mixed-up feelings and ideas?

Very often						Very seldom or never
1	2	3	4	5	6	7

☐ 12

9) Does it happen that you have feelings inside that you don't like or would rather not feel?

Very often						Very seldom or never
1	2	3	4	5	6	7

☐

10) Many people—even those who are confident and successful—sometimes feel like losers in certain situations. How often have you felt this way in the past?

Never						Very often
1	2	3	4	5	6	7

☐ 14

SECTION 7: PSYCHOSOCIAL

Office use

11) When something happened, have you generally found that:

You over-estimated or underestimated its importance?						You saw things in the right perspective?	
1	2	3	4	5	6	7	15

12) How often do you have the feeling that there's little meaning in the things you do in your daily life?

Very often						Very seldom or never	
1	2	3	4	5	6	7	

13) Sometimes people have strong feelings that they cannot keep under control. How often do you have feelings that you're not sure you can keep under control?

Very often						Very seldom or never	
1	2	3	4	5	6	7	

B) LOCUS OF CONTROL

To which extent do you agree or disagree with the following statements about your own life:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree		
1) In your general work, you feel you have control over what happens in most situations	1	2	3	4	5		18
2) You feel what happens in your life is often determined by factors beyond your control	1	2	3	4	5		
3) Over the next 5-10 years, you expect to have more positive than negative experiences	1	2	3	4	5		
4) You often have the feeling you are being treated unfairly	1	2	3	4	5		
5) In the past 10 years your life has been full of changes without you knowing what will happen next	1	2	3	4	5		
6) You gave up trying to better your life a long time ago	1	2	3	4	5		23

C) LIFE EVENTS QUESTIONNAIRE

Have any of the following life events or problems happened to you during the last 6 months? What about more than 6 months ago? If so, please also rate the impact on you.

1) You yourself suffered a serious illness, injury or an assault	Yes 1	No 2 **go to next question**		
1a) Did this occur in the past 6 months?			Yes 1	No 2
If **yes**, Impact:	None 3	Some 4	Significant 5	
1b) Did this occur more than 6 months ago?			Yes 1	No 2
If **yes**, Impact:	None 3	Some 4	Significant 5	
2) A serious illness, injury or assault happened to a close relative of yours	Yes 1	No 2 **go to next question**		29
2a) Did this occur in the past 6 months?			Yes 1	No 2
If **yes**, Impact:	None 3	Some 4	Significant 5	
2b) Did this occur more than 6 months ago?			Yes 1	No 2
If **yes**, Impact:	None 3	Some 4	Significant 5	33

SECTION 7: PSYCHOSOCIAL				Office use	
3) Your parent, child or spouse died		Yes 1	No 2 **go to next question**		34
3a) Did this occur in the past 6 months?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
3b) Did this occur more than 6 months ago?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
4) A close family friend or another relative (aunt, cousin, Grandparent) died		Yes 1	No 2 **go to next question**		39
4a) Did this occur in the past 6 months?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
4b) Did this occur more than 6 months ago?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
5) You had a separation caused by marital difficulties		Yes 1	No 2 **go to next question**		44
5a) Did this occur in the past 6 months?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
5b) Did this occur more than 6 months ago?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
6) You broke off a steady relationship		Yes 1	No 2 **go to next question**		49
6a) Did this occur in the past 6 months?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
6b) Did this occur more than 6 months ago?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
7) You had a serious problem with a close friend, neighbour or relative of yours		Yes 1	No 2 **go to next question**		54
7a) Did this occur in the past 6 months?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
7b) Did this occur more than 6 months ago?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
8) You became unemployed or you were seeking work unsuccessfully for more than one month		Yes 1	No 2 **go to next question**		59
8a) Did this occur in the past 6 months?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
8b) Did this occur more than 6 months ago?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
9) You were fired from your job		Yes 1	No 2 **go to next question**		64
9a) Did this occur in the past 6 months?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		
9b) Did this occur more than 6 months ago?			Yes 1 / No 2		
If **yes**, Impact:	None 3	Some 4	Significant 5		68

SECTION 7: PSYCHOSOCIAL

Office use

10) You had a major financial crisis			Yes 1	No 2 **go to next question**	69
10a) Did this occur in the past 6 months?			Yes 1	No 2	
If **yes**, Impact:	None 3	Some 4	Significant 5		
10b) Did this occur more than 6 months ago?			Yes 1	No 2	
If **yes**, Impact:	None 3	Some 4	Significant 5		
11) You had problems with the police and a court appearance			Yes 1	No 2 **go to next question**	74
11a) Did this occur in the past 6 months?			Yes 1	No 2	
If **yes**, Impact:	None 3	Some 4	Significant 5		
11b) Did this occur more than 6 months ago?			Yes 1	No 2	
If **yes**, Impact:	None 3	Some 4	Significant 5		
12) Something you valued was lost or stolen			Yes 1	No 2 **go to next question**	79
12a) Did this occur in the past 6 months?			Yes 1	No 2	
If **yes**, Impact:	None 3	Some 4	Significant 5		
12b) Did this occur more than 6 months ago?			Yes 1	No 2	
If **yes**, Impact:	None 3	Some 4	Significant 5		83

SECTION 8: ALCOHOL USE

Office use

8A	Do you consume drinks that contain alcohol such as beer, wine, spirits or sorghum beer? Yes 1 No 2 **If No, go to Section 9**		5
8B	Have you ever felt that you should cut down on your drinking? Yes 1 No 2		
8C	Have people annoyed you by criticizing your drinking? Yes 1 No 2		
8D	Have you ever felt bad or guilty about your drinking? Yes 1 No 2		
8E	Have you ever had a drink first thing in the morning to steady your nerves or get rid of a hangover? Yes 1 No 2		9

SECTION 9: TOBACCO USE

Office use

9A	Do you **currently smoke** any tobacco products, such as cigarettes, cigars, or pipes? Yes 1 No 2 **If No, go to question 9F**		10
9B	Do you currently smoke tobacco products **daily**? Yes 1 No 2 **If No, go to question 9F**		
9C	**How old** were you when you first **started** smoking daily? Years old ____ Don't remember/not sure = 99		
9D	If you do not remember how old you were, do you remember how long ago you started smoking daily? 1 WEEKS AGO ____ 2 MONTHS AGO ____ 3 YEARS AGO ____		16
9E	On average, how many of the following items do you smoke each day? [NONE = 00] 1 Manufactured cigarettes? ____ 2 Hand-rolled cigarettes? ____ 3 Pipes full of tobacco? ____ 4 Cigars/Cheroots/Cigarillos? ____ **Go to question 9I**		24

SECTION 9: TOBACCO USE

Office use

9F **In the past,** did you ever smoke daily? Yes 1 | No 2 — **If No, go to question 9I** — Office use: 25

9G **How old** were you when you first **stopped** smoking daily? Years old — Don't remember/not sure = 99

9H If you do not remember how old you were, do you remember how long ago you stopped smoking daily?

1	WEEKS AGO	
2	MONTHS AGO	
3	YEARS AGO	30

ASSESSING USE OF SMOKELESS TOBACCO

9I Do you **currently use any** smokeless tobacco, such as snuff or chewing tobacco? Yes 1 | No 2 — **If No, go to question 9L**

9J Do you currently use smokeless tobacco **daily**? Yes 1 | No 2 — **If No, go to question 9L**

9K On average, how many times do you use each of the following items per day? [NONE = 00]

1	Snuff (by mouth)?	34
2	Snuff (by nose)?	
3	Chewing tobacco?	

Go to Section 10

9L **In the past,** did you ever use smokeless tobacco, such as snuff or chewing tobacco daily? Yes 1 | No 2 — 40

SECTION 10: PHYSICAL ACTIVITY – MODIFIED STEPS/GPAQ

Office use

STUDY NUMBER: — 4

10 The next questions are about the time you spend doing different types of physical activities. This includes activities you do **at home, at work, travelling from place to place and during your spare time**. You are requested to answer the questions even if you don't consider yourself to be an active person.

Occupation-Related Physical Activity (paid or unpaid work): When answering the following questions, think back over the **past 12 months** and consider (think of) **a usual week**.

10A Does your work involve vigorous activities, (like heavy lifting, digging, or heavy construction) for **at least 10 minutes** at a time? Yes 1 | No 2 — **If No, go to question 10D**

10B In **a usual week**, how many days do you do vigorous activities as part of your work? DAYS:

10C On **a usual day** on which you do vigorous activities, how much time do you spend doing such work?

1	HOURS:	
2	MINUTES:	

10D Does your work involve moderate-intensity activities, (like brisk walking or carrying light loads) for **at least 10 minutes** at a time? Yes 1 | No 2 — **If No, go to question 10G** — Office use: 13

SECTION 10: PHYSICAL ACTIVITY – MODIFIED STEPS/GPAQ	*Office use*
10E In **a usual week**, how many days do you do moderate-intensity activities as part of your work? DAYS:	15
10F On **a usual day** on which you do moderate-intensity activities, how much time do you spend doing such work? 1 HOURS: 2 MINUTES:	
Travel-Related Physical Activity: Other than activities that you've already mentioned, I would like to ask you about the way you travel to and from places (to work, to shopping, to market, to church, etc.).	
10G Do you walk or use a bicycle (pedal cycle) for **at least 10 minutes** at a time to get to and from places? Yes 1 No 2 **If No, go to question 10J**	
10H In **a usual week**, how many days do you walk or cycle for at least 10 minutes to get to and from places? DAYS:	
10I On **a usual day,** how much time do you spend walking or cycling for travel? 1 HOURS: 2 MINUTES:	
Non-Work Related and Leisure Time Physical Activity: The next questions ask about activities you do in your leisure or spare time, for recreation or fitness**.** Do not include the physical activities you do at work or for travel already mentioned.	
10J In your leisure or spare time, do you do any vigorous activities (like running or strenuous sports, weightlifting) for **at least 10 minutes** at a time? Yes 1 No 2 **If No, go to question 10M**	
10K In **a usual week**, how many days do you do vigorous activities as part of your leisure or spare time? DAYS:	
10L How much time do you spend doing this on **a usual day?** 1 HOURS: 2 MINUTES:	38
10M In your leisure or spare time, do you do any moderate-intensity activities (like brisk walking, cycling or swimming) for **at least 10 minutes** at a time? Yes 1 No 2 **If No, go to question 10P**	
10N In **a usual week**, how many days do you do moderate-intensity activities as part of your leisure or spare time? DAYS:	42
10O How much time do you spend doing this on **a usual day?** 1 HOURS: 2 MINUTES:	
Sitting / Resting Activity: Now I would like to ask you about the time spent sitting or resting, not including sleeping, **in the past 7 days**. This may include time sitting at a desk, visiting friends, reading, or sitting down to watch television **during working hours and leisure or spare time**.	
10P Over the **past 7 days,** how much time did you spend sitting or reclining (lying) on **a usual day (excluding sleeping)?** 1 HOURS: 2 MINUTES:	52

SECTION 11: DIETARY HISTORY	*Office use*
STUDY NUMBER:	4
24-HOUR RECALL RECORDING SHEET	
INTERVIEWER'S NAME	
DATE OF INTERVIEW: D D M M Y Y Y Y	
Tick the day of the week you are recalling	
Sunday 1 / Monday 2 / Tuesday 3 / Wednesday 4 / Thursday 5 / Friday 6 / Saturday 7	16

Steps for the Interviewer to follow when interviewing each participant

Step 1: You can start the dietary interview as follows: "I want you to think back to when you woke up yesterday morning. What time was it?
Now I want you to try to remember what you ate and drank yesterday from the moment you woke up until you went to sleep again last night. Run through the whole day in your mind and try to remember everything you ate and drank."

You must now give the participant time to remember - during this time you must not disturb them.

Now you can carry on and ask the participant to tell you what he/she ate and drank yesterday, starting in the morning after you got up. .
What was the first thing you ate after you woke up……what time was that? And then……what time was that? And then……what time was that?
You don't have to remember the exact time; tell me if it was for breakfast, lunch, supper, between breakfast and lunch, between lunch and supper or after supper.
Intervals to chose from: B = breakfast; S1 = midmorning snack; L = lunch, S2 = afternoon snack; D = dinner; AD = After dinner snack
Enter the information under STEP 1(column 1 and 2) on the following page

Step 2: To check whether the participant forgot anything, ask him / her the following questions:

- Did you have any cold drinks or other drinks yesterday?
- Did you have any sweets and or chocolate yesterday
- Did you have any cake yesterday?
- Did you have any biscuits yesterday?
- Did you have any rusks yesterday?
- Did you have any savoury snacks like chips / popcorn / salty biscuits yesterday?
- Did you have any other fruit yesterday?
- Did you have any other vegetables yesterday?
- Did you have cheese yesterday?
- Did you have any other bread or rolls yesterday?

Enter the information under STEP 2 (column 1 and 2)) on the following page.

Step 3	The **same** as usual	**More than** usual	**Less than** usual
3a What you ate or drank yesterday was it ……..?			
3b What type of **milk** is usually used in your home?			
3c What type of **butter or margarine** is usually used in your home?			
3d What type of **oil** is usually used in your home?			

Step 4: Now I am going to ask you more about each food item that you ate yesterday.
First, I want you to describe the food item and tell me how it was prepared.
Enter the information under STEP 5 (column 3) of the following page

Step 5: Now I want to know how much of each food item you ate. (portion sizes)
You will then start using the food photo manual to obtain the relevant information
Enter the information under STEP 6 (column 4) of the following page

STEP 1: Time	STEP 1: Foods eaten	STEP 4: Description of the food item	STEP 5: Description of the portion size
STEP 2: Time	**STEP 2:Forgotten foods**		

MEASUREMENTS			Official use:
		STUDY NUMBER:	4
Anthropometer's name: ……			
	Weight:	kg	10
	Height:	cm	
	Waist circumference:	cm	
	Hip circumference:	cm	22
Discard 1st blood pressure reading	1st Systolic blood pressure :	mmHg	
	1st Diastolic blood pressure :	mmHg	
	1st Heart rate :		
	2nd Systolic blood pressure :	mmHg	25
	2nd Diastolic blood pressure :	mmHg	
	2nd Heart rate :		
	3rd Systolic blood pressure :	mmHg	34
	3rd Diastolic blood pressure :	mmHg	
	3rd Heart rate :		40

CRIBSA: BLOOD RESULTS		Official use:
Name:……..	Study number	4
Oral glucose tolerance test (OGGT) (mmol/ℓ)	Fasting glucose 0 minutes	
75 g oral glucose:	Blood glucose 30 minutes	
	Blood glucose 120 minutes	13
Insulin (MIU/mℓ)	0 minutes	
Insulin (MIU/mℓ)	30 minutes	
Insulin (MIU/mℓ)	120 minutes	22
	Total cholesterol (mmol/ℓ)	
	HDL cholesterol (mmol/ℓ)	28
	Triglycerides (mmol/ℓ)	
	LDL cholesterol (mmol/ℓ)	34

APPENDIX F

CONSENT TO PARTICIPATE IN RESEARCH STUDY

Cardiovascular Risk in Black South Africans (CRIBSA) Study

Investigators: Dr N Peer, Prof NS Levitt, Prof K Steyn, Dr N Steyn, Prof VE Lambert, Dr C Lombard

STUDY NUMBER				

Dear Participant

You are being asked to participate in a research study.

You have heard and understood an explanation of the research project and have read a written explanation of what is required. Confidentiality will be adhered to at all times.

You are free to refuse to participate or can **withdraw** permission to take part at any time and you need not answer all the questions during the interview. Any questions that you may have at any time will be answered.

You may contact **Dr Nasheeta Peer** at telephone (021) **938 0811** any time you have questions about the research.

Your participation in this research is voluntary, and you will not be penalised or lose benefits if you refuse to participate or decide to stop at any stage.

If you agree to participate, you will be given a signed copy of this document and a written summary of the research.

1.) I hereby consent to participate in this research study.

..... ……..
Signature of participant Date

To my knowledge, consent was given willingly and with full understanding.

..... ……..
Signature of interviewer Date

..... ……..
Signature of Witness Date

DNA will be isolated and stored for future analyses of genes related to cardiovascular disease (CVD) and its risk factors. This is a new area of study and not all genetic aspects of CVD are currently known. These tests are done anonymously and will not be linked back to any specific person.

2.) I also give permission that my DNA may be isolated and stored for future analysis, as explained to me.

..... ……..
Signature of participant Date

To my knowledge, consent was given willingly and with full understanding.

..... ……..
Signature of interviewer Date

..... ……..
Signature of Witness Date