NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Cardiovascular function and psychological distress in urbanised black South Africans: The SABPA study

NYIKO MASHELE

Thesis submitted in fulfilment of the requirements for the degree Magister of Scientiae in Physiology

School for Physiology, Nutrition and Consumer Sciences
North-West University, Potchefstroom campus

March 2009

Supervisor: Prof. JM. Van Rooyen
Co-supervisor: Prof. L. Malan
Assistant supervisor: Dr. J. Potgieter

THE ROAD NOT TAKEN

Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

Then took the other, as just as fair,
And having perhaps the better claim,
Because it was grassy and wanted wear;
Though as for that the passing there
Had worn them really about the same,

And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way,
I doubted if I should ever come back.

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and

I took the one less traveled by,
And that has made all the difference!

Robert Frost

ACKNOWLEDGEMENTS

The Author of this book would like to thank the following who without whom the completion of this dissertation would have not been possible:

- The Heavenly Father for all the blessing He has granted me throughout my studies.
- My mother and father for their love and support. Their dedication to my success has motivated and made me the person I am today.
- My supervisor, Professor J.M. Van Rooyen for the motivation and emotional and academic support.
- My co-supervisors: Professor L. Malan for the driving force and the motivation behind this study.
- Assistant supervisor: Dr. J. Potgieter, without whom the understanding of the psychological data would have been impossible.
- Contributors to the SABPA project: students, participants, data sampling, analysis and interpretation of data.
- My Brothers for their constant emotional support.
- Professor L.A. Greyvenstien for the language editing.
- The sponsors of the SABPA project: the North-West University: AUTHER (African Unit for Transdisiplinary Health Research); National Research Foundation (NRF); Medical Research Council (MRC). Metabolic Syndrome Institute (France).

TABLE OF CONTENTS

DECLARATION BY AUTHORS

The contribution of each of the researchers involved in this study is given in the following table:

Name	*Role in this study*
Me N Mashele (Physiologist)	Responsible for literature searches, statistical analyses, processing of data, design and planning of manuscript, interpretation of results and writing of the manuscript
Prof JM van Rooyen (Physiologist)	Supervisor. Supervised the writing of the manuscript, initial planning and design of manuscript, technical advice regarding literature, statistical analyses and interpretation of results.
Prof L Malan (Physiologist)	Co-supervisor. Supervised the writing of the manuscript, initial planning and design of manuscript, technical advice regarding literature, statistical analyses and interpretation of results.
Dr. JC Potgieter (Psychologist)	Co-supervisor. Supervised the writing of the manuscript, technical advice regarding literature, statistical analyses, and interpretation of results.

The following is a statement from the co-authors confirming their individual roles in the study and giving their permission that the article may form part of this dissertation.

I declare that I have approved the above-mentioned manuscript, that my role in the study, as indicated above, is representative of my actual contribution and that I hereby give consent that it may be published as part of the M.Sc. dissertation of Me N Mashele.

Prof. JM. van Rooyen Prof. L. Malan Dr. JC. Potgieter

AFRIKAANSE TITEL: Kardiovaskulêre funksie en psigologiese distres in verstedelikte swart Suid Afrikaners: Die SABPA studie

OPSOMMING

Motivering: Kardiovaskulêre siektes(KVS) is een van die vernaamste oorsake van wêreldwye sterftes, met die hoogste mortaliteitstempo in lande met lae en middel inkomste. Die verhoogde voorkoms van risiko faktore soos hipertensie, obesiteit en diabetes in Sub-Sahara Afrika, het verhoogde voorkoms van KVS tot gevolg. Dit is egter nog onduidelik of stres en meer spesifiek, die ervaring van psigologiese angs (distres), 'n bydrae lewer tot die verhoogde voorkoms van kardiovaskulêre siektes in hierdie populasie groep.

Volgens ons kennis is daar nog geen navorsing in 'n Afrika konteks gedoen oor die assosiasie tussen depressie, as 'n nagevolg van psigologiese angs, en kardiovaskulêre wanfunksie by Afrikane nie. Verdere navorsing op hierdie populasie groep kan dus as baanbrekerswerk beskou word.

Doel: Die doel van hierdie studie was om die assosiasie tussen psigologiese angs en kardiovaskulêre funksie in verstedelikte swart Suid-Afrikaners te ondersoek. Dit het 'n teiken populasie van 200 Afrikane, mans (n=101) en vrouens(n=99) ingesluit. Die deelnemers is ingedeel in 'n hipertensiewe (NT) groep.

Metadologie: Die manuskrip wat in Hoofstuk 2 voorgelê word, is afkomstig van die SABPA (Simpatiese aktiwiteit en Ambulatoriese Bloeddruk in Afrikane)projek. 'n Groep van 200 swart Afrikane is vanuit regeringsinstansie van die Noord-Wes Provinsie van Suid-Afrika, gewerf. Alle prosedures wat tydens die studie uitgevoer is, is deur die Noord-Wes Universiteit Etiek Komitee goedgekeur en die deelnemers het vooraf ingeligte toestemming gegee. Antropometriese metings is geneem met die bystand van 'n geregistreerde Biokinetikus. Rustende kardiovaskulêre, veranderlikes soos harttempo (HT), arteriële kompliansie (C_w), totale perifere weerstand (TPR) en gemiddelde arteriële druk (GAP) is geneem deur gebruik te maak van 'n Finometer apparaat. Die polsgolfsnelheid is verkry deur gebruik te maak van die Complior apparaat. Die 24 uur ambulatoriese bloeddruk (BD) metings is geneem deur gebruik te maak van 'n Cardiotens apparaat. Met behulp van die rustende EKG NORAV PL-1200 data is linker ventrikulêre hipertrofie gevind, deur gebruik te maak van die Cornell product ($RaVL + SV_3$) * QRS. Met behulp van gesondheidsvraelyste is die persepsie van gesondheid (General Health Questionnaire; GHQ-28) en die graad van depressie (Patient Health Questionnaire; PHQ-9) geassesseer. Die deelnemers is op grond van die "European Society of Hypertension (ESH)" 2007 se riglyne, in 'n hipertensiewe en normotensiewe groep verdeel, deur gebruik te maal van die 24 uur AMBP as 'n norm. Resultate verkry vanuit statistiese analises is aangepas vir uitskieters (ouderdom, liggaamsmassa indeks, alkohol inname en fisieke aktiwiteit). Statistiese analises is gedoen om die betekenisvolle verskille tussen ouderdom, liggaamsmassa indeks leefstyl, faktore en kardiovaskulêre veranderlikes en psigologiese parameters te bepaal. Die leser word na Hoofstuk 2 verwys, vir 'n meer

gedetailleerde beskrywing van die proefpersone, studie ontwerp en analitiese metodes gebruik.

Resultate en Gevolgtrekking: Die hipertensiewe (HPT) mans en vrouens was meer obees (p>0.01) met 'n groter middel omtrek (MO) (p=0.05) in vergelyking met hul normotensiewe(NT) teenvoeters. Die HPT groep (mans alleen) het ook 'n hoër Cornell produk waarde (p=0.06) opgelewer vergelyking met die normtensiewe groep. By die HPT mans daar 'n positiewe assosiasie ten opsigte van persepsie van fisieke gesondheid en bloeddruk (SBP en DBP), terwyl dit by die HPT vrouens geassosieer word met harttempo(HT). Erge depressie is geassosieer met linker ventrikulêre hipertrofie by HPT mans en met GAP by die HPT dames. Na 'n logistiese regressie analise om die verhouding tussen depressie en persepsie van gesondheid tot HPT te bepaal, is gevind dat depressie die grooste by bydraende faktor tot hipertensie in Afrikane is. Dit is aangetoon dat depressiewe vrouens se kans om hipertensie te ontwikkel 1.13 keer groter is as mans.

Hierdie resultate stel dus 'n moontlike assosiasie tussen depressie, as 'n uitkoms van psigologiese distres en kardiovaskulêre wanfunksie in verstedelikte Afrikane vaar en dat depressie 'n prominente bydrae lewer tot hipertensie in Afrika vroue.

Sleutelwoorde: depressie; persepsie van gesondheid; kardiovaskulêre funksie; verstedelikte Afrikane; hipertensie

TITLE: Cardiovascular function and Psychological distress in Urbanised black South Africans: the SABPA Study

SUMMARY

Motivation: Cardiovascular disease (CVD) is one of the leading causes of death worldwide, with the greatest mortality rates occurring in low and middle income countries. The increase in the prevalence of risk factors such as hypertension, obesity and diabetes in Sub-Saharan Africa has led in an increase of the prevalence of CVD. It remains largely unclear whether psychological distress and more specifically the perception of own health and / depression may contribute to this observed increase in the prevalence of CVD in this population group.

To our knowledge investigations exploring these aspects have not been done in the African context, thus the association between depression as an outcome of psychological distress and cardiovascular dysfunction in Africans is a new frontier that requires further exploration in the population group.

Objective: The aim of this study was to investigate the association between psychological distress and cardiovascular function in urbanized black South Africans which included a target population of 200 Africans, men (n=101) and women (n=99). The participants were stratified into a hypertensive (HT) and normotensive (NT) group.

Methodology: the manuscript presented in chapter 2 made use of the data obtained from the SABPA (Sympathetic activity and Ambulatory Blood Pressure in Africans) project. A group of 200 black Africans from governmental institutions of the North West Province

of South Africa were recruited. All procedures conducted were approved by the North-West University Ethics Committee and written informed consent was given by all the participants prior to the study. Anthropometric measurements were taken with the assistance of registered biokinetisists. Resting cardiovascular variables such as heart rate (HR), arterial compliance (C_w), total peripheral resistance (TPR) and the mean arterial pressure (MAP) were obtained with the use of a Finometer device. The 24 hours ambulatory blood pressure (BP) (AMBP) measurements were obtained with a Cardiotens apparatus. The resting ECG NORAV PL-1200 data determined left ventricular hypertrophy (LVH) by making use of the Cornell product ($RaVL + SV_3$) * QRS. Psychological distress questionnaire assessed the perception of health (General Health Questionnaire; GHQ-28) and depression severity (Patient Health Questionnaire; PHQ-9). Participants were stratified into hypertensive and normotensive groups based on the European Society of Hypertension (ESH) 2007 guidelines using the 24hr AMBP as a norm.

Results were adjusted for confounders (age, body mass index, smoking, alcohol consumption and physical activity). One way Analysis of Covariance (ANCOVA) was done to determine significant differences between age, body mass index, lifestyle factors cardiovascular variables and psychological parameters.

For more detailed description of the subjects, study design and analytical procedures used in this study the reader is referred to the Methods section in Chapter 2.

Results and Conclusion: The hypertensive (HT) men and women were more obese ($p<0.01$) with a larger waist circumference (WC) ($p=0.05$) and a lower compliance

($p \leq 0.05$) compared to their normotensive (NT) counterparts. Only the HT men revealed a higher Cornell product value ($p=0.06$) compared to NT counterparts. In HT men, somatisation was positively associated with blood pressure (SBP & DBP), while in HT women it was associated with heart rate (HR). Major depression was associated with a left ventricular hypertrophy in HT men and MAP in HT women. Logistic regression analysis followed to predict the strongest contributor to HT in Africans. It was indicated that depressed women are 1.13 times more likely to develop hypertension than men.

In conclusion, these results suggest a possible association between depression as an outcome of psychological distress and cardiovascular dysfunction in urbanised Africans. Depression has also been identified as a contributor to HT in African women.

Keywords: depression; perception of health; cardiovascular function; urbanized Africans; hypertension.

PREFACE

The structure and layout of this study is in manuscript format. The script is divided into three chapters: Chapter 1 serves as the foundation, background and motivation for this study. Chapter 2 includes instructions for authors from a peer reviewed journal aimed for publication (*Ethnicity and Disease Journal*). Chapter 3 is a general summary of the results, findings and recommendations for future studies in this field. At the end of each chapter is a detailed list of the relevant references used within that chapter. Style of referencing in Chapters 1 and 3 is according to the mandatory style indicated by the relevant journal for which the manuscript is intended for publication.

* Manuscript (Chapter 2): Journal for submission – *Ethnicity and Disease.*

OUTLINE OF STUDY

The outline of this study is as follows:

- Chapter 1: General introduction, literature overview, research question, aim, hypothesis.
- Chapter 2: Cardiovascular function and psychological distress in urbanized black South Africans: The SABPA study.
- Chapter 3: Introduction, summary and main findings, discussion of main findings, comparison with relevant literature, chance and confounding, weakness of study, final conclusion, recommendations.
- Addendums: General Health Questionnaire (GHQ-28) and Patient Health Questionnaire (PHQ-9).

LIST OF TABLES

Chapter 2:

LIST OF FIGURES

Chapter 1:

LIST OF ABBREVIATIONS

BP	-Blood Pressure
DBP	-Diastolic Blood Pressure
SBP	-Systolic Blood Pressure
PWV	-Pulse Wave Velocity
MAP	-Mean Arterial Pressure
C_w	-Arterial ('Windkessel') compliance
BMI	-Body Mass Index
HR	-Heart Rate
HRV	- Heart Rate Variability
SD	-Standard Deviation
LVH	-Left Ventricular Hypertrophy
CVD	-Cardiovascular Diseases
GHQ-28	-28-item version of the General Health Questionnaire
PHQ-9	-9-item version of the Patient Health Questionnaire
HPA	-Hypothalamic-Pituitary-Adrenal system
ANCOVA	- Analysis of Covariance
WHO	-World Health Organization
SAM	-Sympathetic-Adrenal-Medullary system

GAS	-General Adaptation Syndrome
DSM-IV	-Diagnostic and Statistical Manual of Mental Disorders
ACTH	-Corticotrophin
CRF	-Corticotrophin Releasing Factor
SNS	-Sympathetic Nervous System
SA	-Sympathoadrenal
SABPA	-Sympathetic Activity and Ambulatory Blood Pressure in Africans
CHD	-Coronary Heart Disease
GHQ-SS	-General Health Questionnaire: Somatic Symptoms
GHQ-AS	-General Health Questionnaire: Anxiety Symptoms
GHQ-SD	-General Health Questionnaire: Social Dysfunction
GHQ-DS	-General Health Questionnaire: Depression Symptoms
HT	-Hypertension / Hypertensive
NT	-Normotention / Normotensive

CHAPTER 1

INTRODUCTION AND LITERATURE STUDY

General Introduction

Cardiovascular disease (CVD) is one of the leading causes of death worldwide, with the greatest mortality rates occurring in low and middle income countries. [1] CVD is often termed as multi-factorial, as it can be caused by a combination of interwoven factors such as hypertension, diabetes, obesity, smoking, alcohol consumption and physical inactivity.[2,3] According to Benjamin *et al.*, [2] the burden of risk factors in a specified geographical region closely correlates with the prevalence patterns of that disease in that given area. With this in mind it is clear that there has been an increase in the prevalence of risk factors such as hypertension, obesity and diabetes in Sub-Saharan Africa and accordingly, an increase in the prevalence of CVD.[4,5,6] It still remains largely unclear whether stress and more specifically the experience of psychological distress may contribute to this observed increase in the prevalence in CVD in these populations.

There are many different definitions of what stress is, depending whether the term is used by psychologists, medical professionals, management consultants or others. In general the term refers to the perceptions and responses of humans trying to adapt to the challenges of everyday life.[7] The most commonly accepted definition is that stress is a condition or feeling experienced when a person perceives that emotional and physical demands exceed the personal and social resources the individual is able to mobilise.[8,9,10] Stress may be experienced either positively or negatively, depending on a number of factors. The term "eustress" refers to an adaptive response promoting the activation of internal resources to meet emotional and environmental demands and achieve goals. [11]

Psychological distress, on the other hand, occurs when the demands of a situation exceed the individual's adaptive resources and the person can, therefore, not adapt or cope with persistent stress.[12, 13] Psychological distress is a concept that is often embedded and discussed in the context of strain, stress and distress and is seldom defined as a distinct concept.[14] In this study, however, the term psychological distress will be used to refer to persistent stress that is not resolved through coping or adaptation. With increasing environmental demands this inability to adapt or cope may manifest as behavioural (e.g. absenteeism, accident proneness and drug abuse), psychological (e.g. depression, burnout and psychosomatic complaints) and medical (heart disease and other physical illnesses) consequences.[13, 15, 16, 17] In this study psychological stress will be operationalised through a number of the so-called psychological consequences or outcomes of long-term exposure to stress to which an individual is unable to adapt. These outcomes, which include individual's self-reported experience of anxiety, social dysfunction, somatic complaints and depression, will be taken as representative of the level of psychological distress that an individual has been experiencing.

One of the environmental demands that has recently received increased research attention as a source of psychological distress in an African context is urbanisation.[17, 18, 19] With rapid urbanisation, the loss of social and cultural support may lead to psychosocial disruption and one of the main psychological consequences of distress namely depression sets in.[17] The WHO defines depression as a common mental disorder that presents as a depressed mood, lack of interest, feelings of guilt or low self-worth, disturbed sleep or appetite, low energy and poor concentration. When these problems become chronic it

may lead to substantial impairments in an individual's ability to take care of his or her everyday responsibilities.[20] In addition to the onset of depression researchers have found that urbanisation may result in an elevation in vascular reactivity in Africans.[17, 19, 21]

Depression has become a major interest in psychosomatic research as one of the psychological outcomes of distress. Physiologically depression may affect the cardiovascular system through direct and indirect mechanisms. Direct mechanisms include the nervous system activation, systemic and localized inflammation, cardiac rhythm disturbances and hypercoagulability which negatively influence the cardiovascular system.[22] Indirectly, depression may affect the cardiovascular system through behavioural adaptation to unhealthy lifestyle changes such as an increase in alcohol and tobacco consumption, physical inactivity and high fatty acid intake, all of which are cardiovascular risk factors.[23]

Studies in the past have shown a relationship between depression and CVD such as coronary heart disease and coronary artery disease.[23, 24]Unfortunately these studies focused on depression and CVD post-cardiac event. Conflicting results were found with regards to depression and the development of hypertension in the African-American population. Shinn *et al.*[25] found that their results did not support the role of depressive symptoms in the development of hypertension in normotensive adults.[25] Other researchers, on the other hand, found that the association between depression and the risk of hypertension compares favourably with better established predictors of hypertension such as obesity.[26] To our knowledge investigations exploring these aspects have not been done in the African context. Thus, more research on the relationship between depression

as an outcome of psychological distress and cardiovascular dysfunction in an African context may be warranted.

The aim of this study was, therefore, to investigate whether there is a relationship between psychological distress, as operationalised through the self-reported experience of anxiety, social dysfunction, somatic complaints, depression and cardiovascular dysfunction in urbanised black Africans of the North West Province.

STRESS

Defining stress

Stress is a concept that has been developed over the past decades from Selye's physiological definition, which is widely accepted as a definition in research, to a more cognitive approach focusing on the relationship between the individual and the environment.[7,27] Irrespective of the definition used, fundamentally stress is a condition or feeling experienced when a person perceives that emotional and physical demands exceed the personal and social resources the individual is able to mobilise and this is linked to the onset of distress and disorders.[8, 9, 10, 28,29]

THE STRESS RESPONSE

The stress response begins with a stressor, the perceived threat, or stimulus that causes some form of effect on the organism instigating the onset of human stress response process within an individual.[7, 30] Stressors may differ in duration and intensity. *Chronic stressors* are persistent events or stimuli that an individual is exposed to on an unchanging continuous basis.[31, 32] These stressors are constant in nature but may vary in intensity. *Acute stressors* are events or stimuli of a short duration and high intensity which have a specified time of onset.[31, 32, 33] Traumatic life events such as environmental disasters and sudden death of a family member are examples of acute stressors.[32]

It is evident from the literature that individuals experience events differently. An event that may be classified as a chronic stressor to one individual may be experienced as part of daily life for another.[32] Thus perceptions or appraisals of the events, situations or stimuli are important elements in the determination of one's safety in relation to one's environment.[27] Lazarus [27] described two types of appraisals, *primary* and *secondary appraisal*. *Primary appraisal* is influenced by individual characteristics and environmental factors. This type of appraisal involves the interpretation of how stressful the potential problem may be. *Secondary appraisal* involves the evaluation of whether an individual's coping resources are adequate to deal with the potential stressor when the situation is deemed as stressful.[27, 28] Secondary appraisal occurs in relation (and not necessarily after) to the primary appraisal of a situation, in other words the evaluation is dependent on the subjective interpretation of whether an event or situation poses a threat

to the individuals well-being. Therefore, secondary appraisal can be influenced by a number of factors such as demands, constraints and opportunities resulting in the generation of emotions attributed to a particular event or situation.[27,28]

According to Selye, stress may be experienced positively (eustress) or negatively (distress) depending on a number of factors. As previously mentioned the term "eustress" refers to an adaptive response promoting the activation of internal resources to meet emotional and environmental demands and achieve goals.[11] Selye considered the relation between eustress and distress fundamental in the attainment of a greater a well-being.[30] When the experience of stress reaches a threshold level (which may be different for each individual), any additional stress, situation or event can promote the onset of distress which is characterised by behavioural and physiological responses that can lead to disorder or disease.[7,30] It is thus clear from Selye's theory of stress that stress can be experienced in a beneficial or in a harmful way.

In addition to these early designations, McEwen [34] formulated two new terms to describe the body's responses to stress, 'allostasis' and 'allostatic load'. 'Allostasis' literally means maintaining stability through change and the term 'allostatic load' refers to the wear and tear the body experiences due to repeated cycles of allostasis. When the brain perceives any situation as stressful, physiological and behavioural responses are initiated leading to allostasis and adaptation according to McEwen.[34] Persistent stress results in repeated cycles of allostasis and the accumulation of allostatic load. During persistent environmental demands stress may manifest as diverse behavioural (e.g. poor diet and

substance abuse), psychological (e.g. depression and psychosomatic complaints) and medical symptoms (e.g. cardiovascular dysfunction and physical illnesses).[34,35]

It is clear from the above-mentioned models that the experience of stress, whether mental or physical, over time can be cumulative and detrimental. A stressful event becomes detrimental when the individual fails to adapt or cope with the persistent stress. This may manifest as behavioural, psychological and medical symptoms that are harmful to the individual and are linked to the onset of distress and cardiovascular disorders.

DISTRESS

'Distress' is a term first used by Selye to describe the negative experience of stress and the failure to resolve persistent stress through coping or adaptation.[11] Psychological distress occurs when the demands of a situation exceed the individual's adaptive resources and the person can, therefore, not adapt or cope with persistent stress.[12,13] The concept of psychological distress is often embedded in the context of strain, stress and distress and is seldom defined as a distinct concept.[14] Ambiguity exists in the literature in terms of the context in which stress and distress are used. In this study the term 'psychological distress' refers to persistent stress that is not resolved through adaptation.

Outcomes of psychological distress

As an outcome of psychological distress, depression is a psychiatric condition that has received attention in most lines of research.[36] Depression is a common mental disorder that is characterised by depressed mood, sadness, loss of interest and pleasure, poor concentration, decreased energy, feelings of guilt and low self-worth and disturbance in sleeping and eating patterns.[20, 37] The extent, severity and duration of the depressive symptoms can help differentiate between depression from normal mood changes.[20] A clear distinction can be made between chronic depressive symptoms which result from persistent depressed mood over a period of months or years and acute symptoms occurring in response to everyday life events.[37]

Other outcomes of psychological distress include the experience of anxiety and insomnia, social dysfunction and somatic symptoms.[38] A variety of psychological instruments have been developed and implemented in measuring psychological distress and its outcomes.[38]

Measuring psychological distress

Psychological distress and its consequences can be measured by making use a variety of psychological instruments.[39] The ones that will be utilised in this study are the General Health Questionnaire and the Patient Health Questionnaire.[40, 41]

1. The General Health Questionnaire (GHQ)[38]

The General Health Questionnaire (GHQ-28) is a self-report questionnaire that assesses psychological well-being by detecting those likely to have or are at risk for developing

psychiatric disorders.[38, 39, 40] The questionnaire is useful in the understanding of various sources of distress in occupational research.[39]

The questionnaire consists of four (4) subscales that measure the common mental health symptoms/domains of depression, anxiety, somatic symptoms and social withdrawal.[39]

1.1 Somatic Symptoms

Perceived stress is associated with decreased psychological well-being and increased somatic symptoms.[42, 43] Somatic manifestations of depression occur across all cultures and have been variously described as functional, medically unexplained somatic symptoms, somatic preoccupation or worry about illness, or undue emphasis on the somatic manifestations of psychiatric disorders.[44, 45] In African-Americans, severity of somatic symptoms was found to be higher than in the Caucasian group.[46] In an African context, somatic symptoms in depression are extremely common features.[44] Somatic depressive symptoms are associated with poor health status and predicted cardiovascular mortality and cardiac mortality.[47]

1.2 Anxiety

Anxiety is one of the most common symptoms of psychological distress and is associated with a variety of somatic symptom patterns. Varied anxiety states have been linked to autonomic nervous system activity such as rapid heart rate, shortness of breath and sweating.[48] These symptoms are frequently viewed as signs of increased sympathetic activity.[48] Long-term sympathetic activation has been associated with cardiovascular

dysfunction. Both depression and anxiety have been shown to be associated with increased risk for cardiovascular diseases such as CAD.[49]

1.3 Social dysfunction

Substantial amounts of literature from epidemiological, sociological and health psychology research have demonstrated the association between social support and morbidity and mortality risks.[50] Social dysfunction is an indication of the disintegration of a person's social support network and the loss of both given and received support.[51] As the importance of the social support network is an important characteristic of collectivistic cultures, the lack of social support may result in psychosocial dysfunction and the onset of depression.[17] Social support is increasingly being recognised as a predictor of CHD etiology and prognosis.[52] In Africans the loss in social support resulting from rapid urbanisation is associated with increased vascular reactivity.[6, 17, 18]

1.4 Symptoms of Depression

Depressive symptoms, that result from chronic exposure to stress over a substantial period of time, have deleterious effects on cardiovascular functioning.[53] Symptoms of depression have been related to future incidences of hypertension.[54] In addition to the etiological link to heart disease, depression may be a risk factor for mortality following a cardiac event.[53, 55] Symptoms of depression appear to be related to exaggerated heart rate (HR), blood pressure (BP) and vascular resistance response.[56]

Items

Multiple versions of the GHQ are available using 12, 28, 30, 60 items, but the 28-item version is used most widely.[39]

An example of items used in this questionnaire include 'Have you found everything getting on top of you'; 'Have you been getting scared or panicking for no reason?' and 'Have you been getting edgy and bad tempered'. Each of the above are then accompanied by 4 possible responses; 'not at all', 'no more than usual', 'rather more then usual' and 'much more than usual'. The GHQ may be evaluated in a variety of ways. In this study each item was evaluated using the binary scoring method.[57] The two least symptomatic answers are given a score of nil (0) whilst the two most symptomatic answers are given value of one (1). Total scores exceeding the threshold of 4 are classified as achieving 'psychiatric caseness'. In general practice, individuals classified as achieving 'psychiatry caseness' would be likely to receive further attention.[39]

Validity

The reliability coefficients reported in various studies ranged from 0.78 to 0.95. Wissing and Van Eeden [58] reported a reliability coefficient of 0.91 in a South African sample. An acceptable reliability and validity indices for use in the Setswana-speaking group has also been shown.[59]

2. Patient Health Questionnaire (PHQ) [41]

The Patient Health Questionnaire (PHQ) is a 9-item instrument for making criteria-based diagnoses of depressive disorders and it is also a reliable and valid measure of depression

severity. [41] Being half the length of other depression measurements, the PHQ-9 is ideal as it has both sensitivity and reliability. The scale is based on the actual 9 criteria of diagnosis of the DSM-IV depressive disorders. The PHQ assesses 8 diagnoses divided into threshold disorders (disorders that correspond to specific DSM-IV diagnoses i.e. major depressive disorder) and sub-threshold disorders (disorders whose criteria include fewer symptoms than required for any specific DSM-IV diagnoses i.e. other depressive *disorders*). The questionnaire scores each of the nine (9) DSM-IV criteria as "0" (not at all) to "3" (nearly every day). For analysis the PHQ-9 scores are divided into the following categories of increasing severity: 0-4, 5-9, 10-14, 15-19 and 20 or greater which represent minimal, mild, moderate, moderately severe, and severe depression respectively. Scores less then five (5) signify the absence of depressive disorders; scores of 5-9 predominately represent no depression or sub-threshold depression; scores of 10-14 represent a spectrum of individuals who may or may not display depression. Scores of 15 or higher usually are indicative of major depression.[41]

Items

At 9 items, the PHQ-9 has comparable sensitivity and specificity to many other larger depression measures. The PHQ-9 is based directly on the diagnostic criteria for major depressive disorder in the Diagnostic and Statistical Manual Fourth Edition (DSM-IV). There are two components of the PHQ-9; assessing symptoms and functional impairment to make a tentative depression diagnosis, and deriving a severity score to help select and monitor treatment.[41]

Validity

Both construct and criterion validity have been established in primary health care settings rendering the PHQ-9 a reliable and valid measure of depression in this sample. The combination of brevity, construct and criterion validity makes the PHQ-9 a useful, dual-purpose diagnostic tool for assessing severity of depressive disorders. [41]

Physiological outcomes of distress: The General Adaptation Syndrome

Failure to adapt or cope with persistent stress may generate continual physiological stimulation characterised by incessant activation of two primary systems associated with the physiological stress response, the sympathetic-adrenal-medullary system (SAM) and the hypothalamic-pituitary-adrenocortical (HPA), that can produce a cascade of negative pathological consequences.[60] The resultant dysregulation of these systems may lead to high catecholamine levels, autonomic dysfunction and other peripheral effects such as increased peripheral resistance .[10, 22, 60-62]

Selye[7] researched the physiological outcomes of stress and characterised them into a three (3) stage response model known as the general adaptation syndrome (GAS). According to GAS, the stress response may be broken into 3 stages, namely alarm (stage 1), resistance (stage 2) and finally, exhaustion (stage 3). The identification or realisation of a threat results in a state of alarm and this leads to a production of epinephrine in order to elicit a fight or flight response. Included in this stage is the activation of the HPA axis, thus leading to the production of cortisol.[63] Persistence of the stress results in the activation of various physiological coping mechanisms (stage 2). The body tries to adapt

to the strains or demands of the environment, but the body cannot keep up with this indefinitely. Depletion of the body's recourses (stage 3) and the inability to maintain normal function will lead to the reappearance of the initial autonomic nervous system (ANS) symptoms. Extensions of this stage will lead to long-term damage, thus resulting in illnesses such as depression and cardiovascular dysfunction.[7]

Chronic activation of the SNS and HPA will result in an elevated secretion of catecholamines and other vasoactive substances such as angiotensin II and ACTH.[63] Elevated plasma levels of catecholamines may lead to Na^+ retention and volume overload [64] whilst vasoactive substances will contribute to increased vascular resistance.[63] Both volume overload and exaggerated vascular resistance will contribute to an elevation in BP and future incidences of hypertension.[65,66] This persistent elevation of BP will result in pressure overload and the sustained pressure and volume overload will progressively lead to morphological changes in left ventricular geometry and subsequently to an increase in ventricular mass.[67] In a population in transition, chronic exposure to stress will lead to an increase in sympathetic reactivity and an elevated normal BP. [6,17-19,21] Repeat exposures to this wear and tear may be detrimental (pressure and volume overload) to vascular health (morphological changes in arterial vasculature), subsequently leading to the increase in ventricular mass and development of left ventricular hypertrophy.[34, 35, 65] The physiological response of the body to persistent stress by making use of Selye's General adaptation syndrome model, is briefly described in Figure 1.[7]

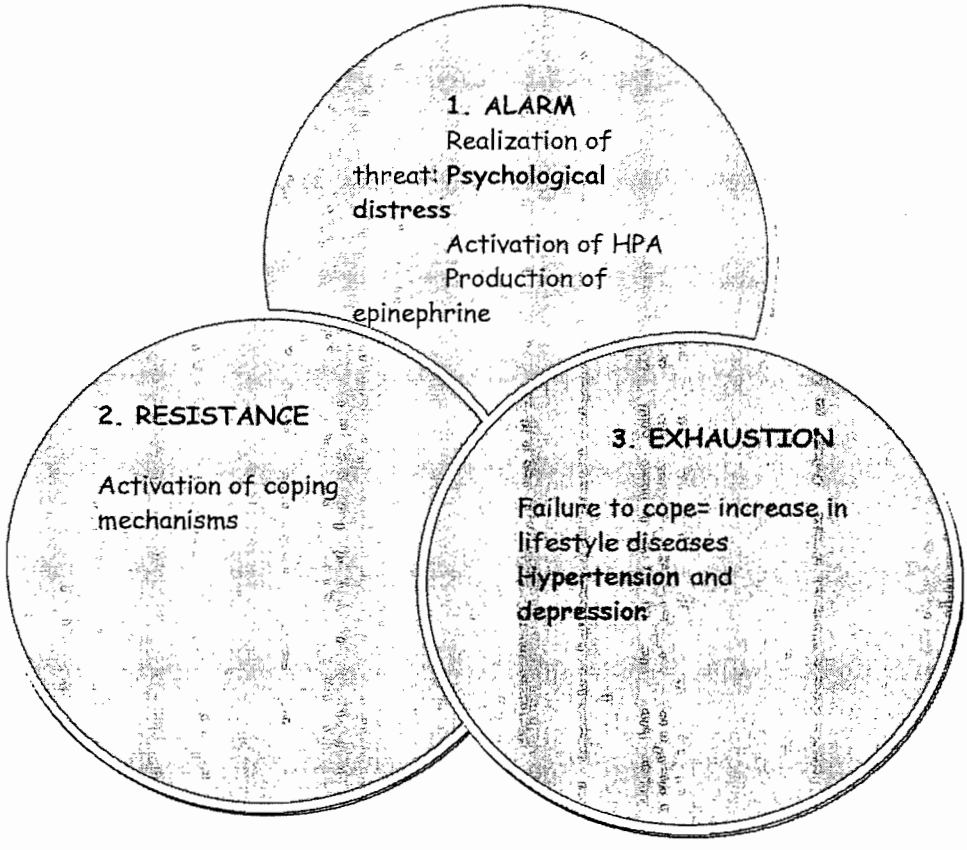

Figure 1.A brief description of Hans Selyes General Adaptation Syndrome.[7]

Urbanisation, Distress and Hypertension

With rapid urbanisation, the loss of social and cultural support may lead to psychosocial disruption and psychological distress may set in.[17]As a source of psychological distress, urbanisation is an environmental demand that has received increased research attention in an African context in the past decade.[17, 18, 19] The process of rapid urbanisation has led to

social and cultural disruption leading to increased levels of stress.[17] Urbanisation has also been associated with a significant increase in lifestyle-related diseases such as hypertension, coronary heart disease, diabetes and cerebrovascular disease.[19] Epidemiological studies have established that the prevalence of hypertension is increasing in the African population [6, 17-19,21,25] The causative factors for hypertension in the African population may vary from abnormalities in the renin-angiotensin-aldosterone system, putative role of the sodium channel and environmental influences.[5] Increased salt sensitivity and low rennin activity have been identified as important contributors to hypertension in Africans.[68, 69] Therefore, these genetic factors further predispose Africans to an exaggerated vascular reactivity in response to environmental stressors compared to other ethnic groups.

Environmental stressors, such as those brought about by urbanisation, are likely to enhance sympathetic activity and contribute to the early development and severe progression of hypertension in blacks.[65, 66] Malan [6] and colleagues found an association between stress experienced during urbanisation and an increase in BP and high prevalence of hypertension.[6, 17] Figure 2 is a simplified schematic presentation that describes the process by which chronic exposure to environmental stressors contributes to the development and progression of hypertension.

There is ample evidence that sympathetic hyperactivity is a characteristic feature of some forms of hypertension, especially in the early stages of essential hypertension. [64-66] Studies done on HT have shown that subjects with hypertension exhibit excessive cardiovascular risk factors like left ventricular and arteriolar hypertrophy.[67] In addition to

a raise in BP, adrenergic stimulation may induce target end organ damage by both hemodynamic and non hemodynamic mechanisms.[69] Adrenergic stimulation has been associated with left ventricular hypertrophy as well as vascular hypertrophy and stiffening.[70] As the hypertensive state escalates, hemodynamic pattern changes from a high cardiac output mediated by the stimulation of β_1-adrenergic pathways to a high vascular resistance pattern mediated by α-adrenergic pathways.[5, 17, 18] The maintenance of BP shifts from the central mechanisms to the vascular mechanisms which promote an increase in vascular resistance that lead to hypertension-related morbidity and mortality.[17, 67, 70] An α-adrenergic vascular reactivity has been found in Africans. This resulted in higher vasoconstriction and decreased vascular compliance.[5, 64]

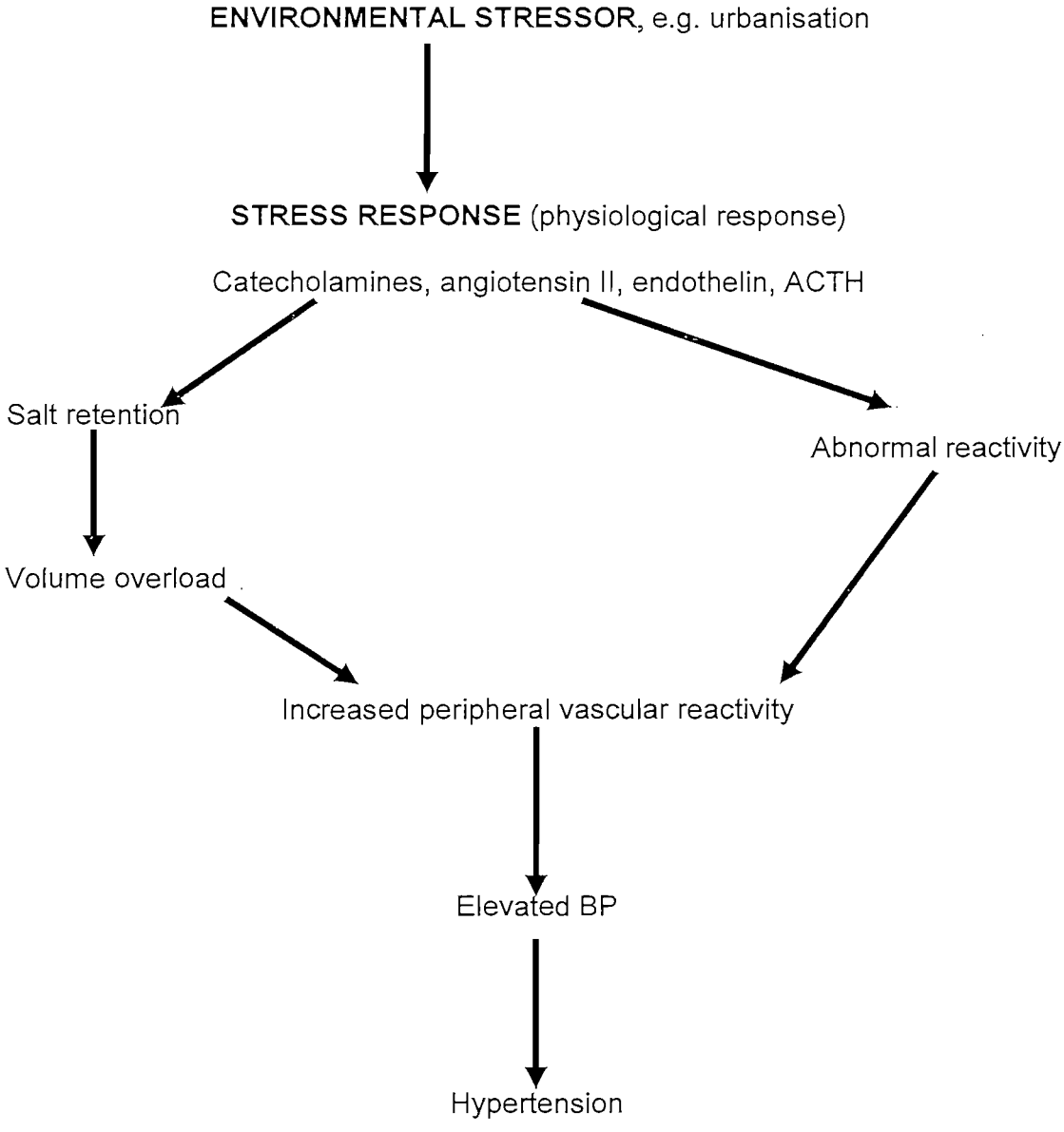

Figure 2.Schematic representation of the interaction between environmental stressors and the development of hypertension in Africans.[66]

Distress, Depression and Cardiovascular disease

The presence of psychological distress has been associated with incidences of CVD in several prospective cohort studies. In Caucasian subjects with high levels of distress, it was found that distress was a predictor of all-cause mortality in that population group.[71] In a follow-up multicultural study in African-American subjects their experience of psychological distress was associated with a higher mortality rate in comparison to other ethnic groups.[72] Studies done on the African population have provided an association between psychological distress experienced from urbanisation, and the prevalence of hypertension.[6, 17, 18, 19] Limited literature exist on distress and CVD in the African population. Although ample literature exist linking psychological distress and CVD risk, the intermediate mechanisms are yet to be fully elucidated in the African population. Behavioural mechanisms such as smoking, alcohol consumption and physical inactivity maybe an adaptation or coping response to psychological distress, and may thus be an important intermediate factor in the disease processes.[60, 62, 67, 70]

Psychological distress may lead to CVD via several different mechanisms. Firstly, it maybe indirectly associated with CVD through its associations with adoption of unhealthy behaviours such as excessive alcohol consumption, physical inactivity and eating fatty foods which are also well known risk factors for CVD.[73,74] Secondly, psychological distress maybe a product of exposure to situations of low perceived control.[73] It is well documented in the literature that Africans experience elevated vascular reactivity in response to environmental stressors.[6, 17, 65, 66] For instance, Van Rooyen [65] and colleagues found that children who were exposed to a violent environment

had higher vascular activity compared to those exposed to situations of low violence.[65]

Finally, psychological distress may lead to unhealthy coping behaviour that especially in the context of low perceived control may indirectly lead to increased CVD risk. Malan *et al.*[17] for example noted that Africans with active coping styles had an exaggerated vascular reactivity compared to individuals who have adapted to a more passive coping style, therefore, it seems that Africans who felt they had some control over their situation (AC) experienced exaggerated vascular reactivity compared to those who have low perceived control. Behaviourally they cope better but physiologically the cost of coping leads to more adverse CV responses and HT.[17]

Psychological distress primarily activates the sympathetic or hypothalamic pituitary-adrenal axis systems which trigger pathophysiological mechanisms that include inflammation, haemostasis and altered metabolic and cardiac autonomic control.[23] For example, Africans who are exposed to high levels of environmental stress have been found to exhibit heightened sympathetic activity.[21] This enhanced sympathetic activity may contribute to the early development and severe progression of hypertension in Africans, which in itself is a CVD risk factor in this population .[66]

As an outcome of long-term exposure to psychological distress, depression has received ample attention in most lines of clinical research. It is estimated that at any given time 5-10% of the population suffer from depression.[20] In the African context, the prevalence of depression has not been recorded. With the use of the Mental Health Continuum, which is a mental well-being measure, an estimated prevalence of individuals with low levels of psychological well-being (languishing) in the African population can be deduced as these

individuals who are more likely to suffer from psychiatry disorders like depression.[75] In a study done by Van Rooy [75] *et al.*, 6% of their subjects were languishing and these subjects had low levels of emotional, social and psychological well-being, and may represent individuals who are at high risk of developing psychiatric disorders such as depression.[75]

Depression has been associated with the hyperactivity of the HPA system and the sympathetic nervous system (SNS). Both these systems result in the release of glucocorticoids and catecholamines respectively.[10] These two systems are interconnected, the activation of one of these systems influences changes in the other. The HPA system augments the sympthoadrenal system via central regulatory pathways and the development of CVD. [22] The heightened levels of glucocorticoids, particularly cortisol, have a number of effects on the physiological system. The resulting increase in plasma catecholamine leads to vasoconstriction, platelet activation and elevated heart rate (HR).[10, 22] Researchers have found that in addition to the elevated circulating plasma levels of epinephrine, depressed patients manifest elevated resting HR and decreased HRV compared to non-depressed controls.[61] According to Carney *et al.*,[61] these conditions are a result of autonomic dysregulation (reduction in parasympathetic activity and an increase in sympathetic activity) that have been associated with sudden cardiac death in patients with CHD.[66] Additionally, elevated catecholamine levels may promote pro-thrombotic processes by potentiating platelet activation and increasing hemodynamic stress on vascular walls, or by inhibiting vascular eicosanoid synthesis.[76, 77] The cost of the increased hemodynamic stress is changes in structural and functional properties of the large arteries and an increase in LV mass. Increased levels of coagulating-promoting

factors have been shown to predict coronary syndromes such as myocardial infarctions (MI) and sudden cardiac death in healthy individuals and in patients with CVD.[78]

SUMMARY

Figure 3 summarises the main ideas discussed so far. Persistent stress elicits both behavioural and physiological responses. It is clear from the figure that if a stressor is perceived negatively, both behavioural and physiological mechanisms are initiated resulting in the increased risk for both physical and psychiatric disease.

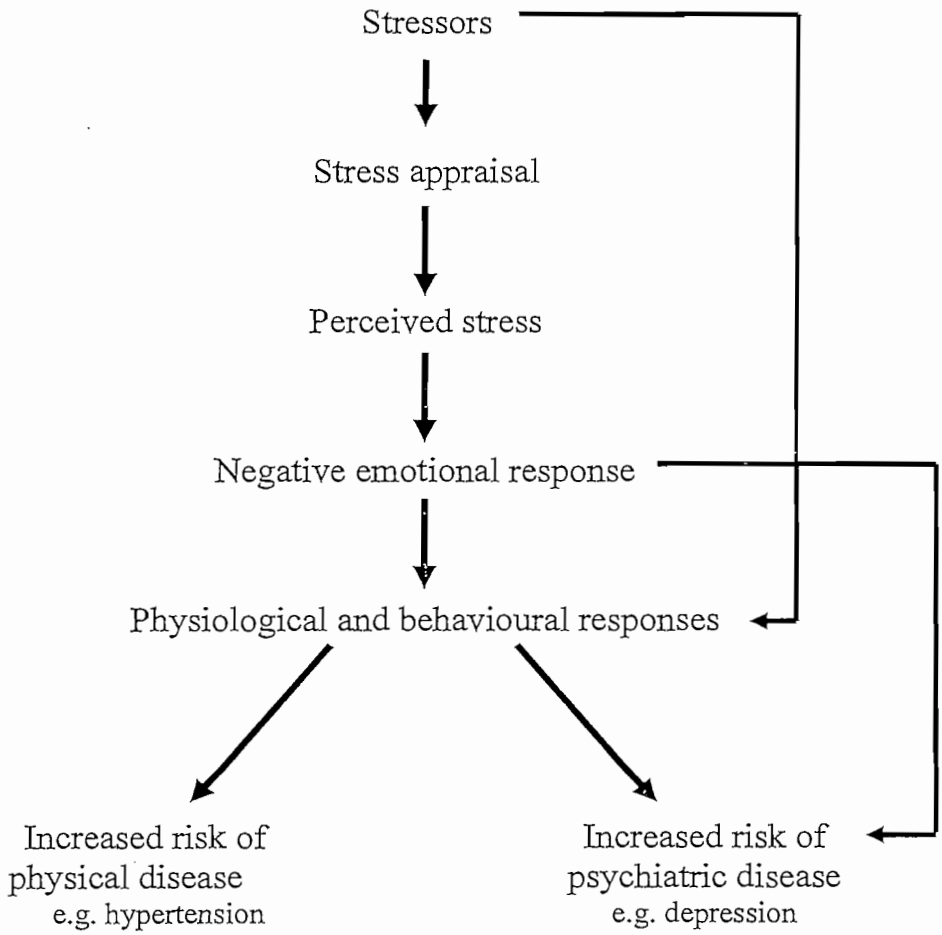

Figure 3.Physiological and behavioral response to environmental stressors and their subsequent consequences in the development of pathological conditions.

RESEARCH QUESTION

Although a number of studies have investigated depression and the pathology of CVD, only a limited number focuses on psychological distress and cardiovascular function pre-hypertension. From that limited percentage, none focused on depression and cardiovascular function in Africans. Therefore, an investigation focusing on psychological distress and cardiovascular function in the African population is warranted.

AIM

The aim of this study was, therefore, to investigate whether there is a relationship between psychological distress and the development of cardiovascular dysfunction in urbanised black Africans of the North West Province.

HYPOTHESIS

1. There is a relationship between perception of poorer health (GHQ) and cardiovascular dysfunction in Africans
2. An association exists between depression, perception of health, hypertension and cardiovascular function in Africans.

REFERENCES:

1. WHO (World Health Organization). Cardiovascular disease: prevention and control. Available at: http://www.who.int/mediacentre/factsheets/fs317/en/index.html. Accessed November 7, 2008.
2. Benjamin EJ, Smith SC, Cooper RS *et al.* Task Force #1—magnitude of the prevention problem: opportunities and challenges. *J Am Coll Cardiol,* 2002; 40:588-603.
3. Reddy KS, Yusuf S. Emerging epidemic of cardiovascular disease in developing countries. *Circulation.*1998; 97:596-601.
4. SADHS: Department of Health, Medical Research Council & Measure DHS+. South Africa Demographic and Health Survey 1998, Available at: http://www.hst.org.za/indicators/SADHS_1998_Full.pdf . Accessed November 2, 2008.
5. Opie LH, Seedat YK. Hypertension in Sub-Saharan African populations. *Circulation.* 2005; 112:3562-3568.
6. Malan L, Malan NT, Wissing MP *et al.*, Coping with urbanisation: A cardiometabolic risk? *Biol Psychol.* 2008; 323-328.
7. Selyes H. *The Stress of life.* New York: McGraw-Hill; 1956.
8. McEwen BS. Stress, adaptation, and disease: Allostasis and allostatic load. *Ann N Y Acad Sci.*1998; 840: 33-44.
9. Lazarus RS. From psychological stress to the emotions: A history of changing outlooks. *Annu Rev Psychol.* 1993; 44: 1-21.

10. Vale S. Psychological stress and cardiovascular diseases. *J Postgrad Med.* 2005; 81: 429-435.

11. Selye H. Confusion and controversy in the stress field. *J Hum Stress.* 1975; 1:37-44.

12. Folkman S, Lazarus RS, Dunkel-Schetter C *et al.*, Dynamics of stressful encounter, cognitive appraisal, and coping and encounter outcomes. *Journal of personality and Social psychology.*1986;50(5):992-1003.

13. De Kloet RE, Joels M, Holsboer F. Stress and the brain: from adaptation to disease. *Nat Rev Neurosci.* 2005; 6(6):463-475.

14. Ridner SH. Psychological distress: concept analysis. *J Advan Nurs.* 2004; 45(5): 536-545.

15. Quick JC, Quick JD, Nelson DL *et al.*, *Preventative stress management in organizations.* Washington DC: American Psychology Association; 1997.

16. Voster HH, Wissing MP, Venter CS *et al.*, The impact of urbanization on physical and mental health of Africans in the North-West Province of South Africa: The THUSA study. *S Afr J Sci.* 2000; 96: 505-514.

17. Malan L, Schutte AE, Malan NT *et al*, Coping mechanisms, perception of health and cardiovascular dysfunction in Africans. *Int J Psychophysiol.* 2006; 61:158-166.

18. Van Rooyen JM, Kruger HS, Huisman HH *et al.*, An epidemiological study of hypertension and its determinants in a population in transition: the THUSA study. *J Hum.* Hypertens. 2000; 14:779-787.

19. Malan NT, Van De Merwe JS, Huisman HW *et al.*, A comparison of cardiovascular reactivity of rural blacks, urban blacks and whites. *Stress Med.* 1992; 8:241-246.

20. WHO (World Health Organization). Depression. Available at: http://www.who.int/mental_health/management/depression/definition/enAccessed November 7, 2008.

21. Van Rooyen JM, Nienaber AW, Huisman HW *et al.*, Differences in resting cardiovascular parameters in 10-to-15 year old children of different ethnicity: the contribution of physiological and psychological factors. *Ann Behav Med.* 2004; 28(3)163-170.

22. Joynt KE, Whellan DJ, O'Connor CM. Depression and cardiovascular disease: mechanisms of interaction. *Biol Psychiatry.* 2003; 54(3): 248-261.

23. Stansfeld SA, Fuhrer R, Shipley MJ *et al.*, Psychological distress a risk factor for coronary heart disease in the Whitehall II Study. *Int J Epidemiol.* 2002; 31:248-255.

24. Lett HS, Blumenthal JA, Babyak MA *et al.*, Depression as a Risk factor for coronary artery disease: Evidence, mechanisms, and treatment. *Psychosom Med.* 2004; 66:305-315.

25. Shinn EH, Poston WSC, Kimball KT *et al.*, Blood pressure and symptoms of depression and anxiety: a prospective study. *Am J Hypertens.* 2001; 14:660-664.

26. Kabir AA, Whelton PK, Khan MM *et al.*, Association of symptoms of depression and Obesity with hypertension: the Bogalusa Heart study. *Am J Hypertens.* 2005; 19(6):639-645.

27. Lazarus R.S. *Stress and emotion: New synthesis*. San Francisco: Springer Publishing Company; 1999.

28. Carver CS, Scheier MF, Weintraub JK. Assessing coping strategies: theoretically base approach. *J Pers Soc Psychol*.1989; 57:267-283.

29. Matthieu MM, Ivanoff A. Using stress, appraisal, and coping theories in clinical practice: Assessments of coping strategies after disasters. *Brief Treat Crisis Interven.* 2006; 6(4):337-348.

30. Everly GS, Lating JM. *A clinical guide to the treatment of the human stress response*. New York: Kluwer Academic; 2002.

31. Day AL, Livingstone HA. Chronic and acute stressors amongst military personal: do coping styles buffer their negative impact on health? *J Occup Health Psychol.* 2001; 6:348-360.

32. Hahn SE, Smith CS. Daily hassels and chronic stressors: conceptual and measurement issues. *Stress Med.*1999;15(2):89-101.

33. Dimsdale JE. Psychological stress and cardiovascular function. *J Am Coll Cardiol.* 2008; 51(13):1237-1246.

34. Stewart A. The detrimental effects of allostasis: Allostatic load as a measure of cumulative stress. *J Physiol Anthropol.* 2006; 25(1): 133-145.

35. McEwen BS, Seeman T. Protective and damaging effects of mediators of stress-Elaborating and testing the concepts of allostasis and allostatic load. In Alder NE, Marmot M, McEwen BS, Stewart J eds. *Socioeconomic Status and Health in industrialised nations*. New York Academy of Science, New York,.1999:30-47.

36. Carney RM, Freedland KE, Miller GE *et al.,* Depression as a risk factor for cardiac mortality and morbidity: a review of potential mechanisms. *J Psychosom Res.* 2002; 53: 897–902.

37. Hamer M, Tanaka G, Okamura H *et al.*, The effects of depressive symptoms on cardiovascular and catecholamine responses to induction of depressive mood. *Biol Psychol.* 2007; 74(1):20-25.

38. Goldberg DP, Hiller VF. A scaled version of the General health Questionnaire. *Psychol Med.* 1979; 9: 139-145.

39. Jackson G. The General Health Questionnaire. *Occup Med.* 2007; 57(1):79.

40. Goldberg DP, Hiller. *Manual of General Health Questionnaire.* England NFER Publishing; 1978.

41. Kroenke K, Spitzer RL, Williams. The PHQ-9: Validity of a brief depression Severity Measure. *J Gen Intern Med.* 2001; 16:606-613.

42. Begley TM. Coping strategies as a predictor of employee distress and turnover after an organisation consolidation: a longitudinal analysis. *Occup Organizational Psychol.*1998; 38(5):477-500.

43. Cooper CL, Kelly M. Occupational stress in head teachers: a national UK study. *Br J Educ Psychol.* 1993; 63 (1): 130-143.

44. Okulate GT, Olayinka MO, Jones OBE *et al.*, Somatic symptoms in depression: evalution of their diagnostic weight in an African setting. *Br J Psychiatry.* 2004;184:422-427.

45. Kirmayer LJ, Robbins JM, Dworkind M *et al.*, Somatization and the recognition of depression and anxiety in primary care. *Am J Psychiatry.* 1993; 150:734-741.

46. Brown C, Schulberg HC, Madonia MJ *et al.*, Clinical presentations of major depression by African Americans and Whites in the primary medical care practice. *J Affect disord.* 1996; 41:181-191.

47. de Jonge P, Ormel J, Van den Brink RHS. Symptom dimensions of depression following myocardial infarction and their relation with somatic health status and cardiovascular prognosis. *Am J Psychiatry.*2006; 163:138-144.

48. Friedman BH, Thayer JF. Autonomic balance revisited: panic anxiety, and heart rate variability. *J Psychosom Res.* 1998; 44(1):133-151.

49. Zoeller RF. Physical activity: Depression, anxiety, physical activity and cardiovascular disease: what's the connection? *Am J lifestyle Med.* 2007;1:175.

50. Seeman TE, Singer BH, Ryff CD *et al.*, Social relationships, gender, and allostatic load across two age cohorts. *Psychosom Med.* 2002, 64:395-406.

51. Lawler KA, Piferi RL, Younger JW *et al.*, A change of heart: cardiovascular correlates of forgiveness in response to interpersonal conflict. *J Behav Med.* 2003; 26:373-393.

52. Rozanski A, Blumenthal JA, Kaplan J. Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. *Circulation.* 1999; 99: 2192-2217.

53. Strik JJMH, Denollet J, Lousberg R *et al.,* Comparing symptoms of depression and anxiety as predictors of cardiac events and increased health care consumption after myocardial infarction. *J Am Coll Cardiol.*2003; 42(10):1801-1807.

54. Jonas BS, Lando JF. Negative affect as a prospective risk factor for hypertension. *Psychosom Med.* 2000; 62: 188–196.

55. Lane D, Carrol D, Lip GYH. Anxiety, depression and the prognosis after myocardial infarction: is there a causal association. *J Am Coll Cardiol.* 2003; 42(10):1808-1810.

56. Hamer M, Williams E, Vuonovirta R *et al.*, The effects of effort-reward imbalance on inflammatory and cardiovascular responses to mental stress. *Psychosom Med.* 2006; 68: 408-413.

57. Goldberg DP, Gater R, Sartorius TB *et al.,* The validity of two of the GHQ in the WHO study of mental illness in general health care. *Psychol Med.* 1997; 27:191-197.

58. Wissing MP, Van Eeden C. Empirical clarification of the nature of psychological well-being. *S Afr J Psychol.* 2002; 32(1):32-44.

59. Wissing MP, Thekiso S, Stapelberg R *et al.*, *The psychometric properties of scales measuring psychological well-being in an African group: the THUSA study*. Paper presented at the International Africa Psychology Congress. Durban, South Africa; 1999.

60. Rozanski A, Kubzansky LD. Psychologic functioning and physical health: A paradigm of flexibility. *Psychosom Med.* 2005; 67:47-53.

61. Carney RM, Freedland KE, Veith RC. Depression, the autonomic nervous system, and coronary heart disease. *Psychosom Med.* 2005; 67:29-33.

62. Lovallo W, Gerin W. Psychophysiological reactivity: mechanisms and pathways to cardiovascular disease. *Psychosom Med.* 2003; 65:36-45.

63. Light KC, Kothandapani RV, Allen MT. Enhanced vascular and catecholamine responses in women with depressive symptoms. *Int J Psychophysiol.* 1998; 28:157-166.

64. Fray JCS and Douglas JG. Pathophysiology of hypertension in blacks. Oxford University press. New York. 1993: 219-232.

65. Van Rooyen JM, Husiman HW, Eloff FC *et al.*, Cardiovascular reactivity in black South African male of different age groups: the influence of urbanisation. *Ethn & Dis.* 2002; 12(1):69-75.

66. Ergul A. Hypertension in black patients: An emerging role of the endothelin system in salt-sensitive hypertension. *Hypertension.* 2000; 36:62-67.

67. Kizer R, Arnett DK, Bella JN *et al.*, Differences in Left ventricular structure between black and white hypertensive adults. *Hypertension.* 2004; 43:1182-1188.

68. Jr Wright JT, Rahman M, Scarpa A *et al.*, Determinants of salt sensitivity in black and white normotensive and hypertensive women. *Hypertension.*2003; 42:1087.

69. Johnson RJ, Gordon KL, Suga S. Renal injury and salt sensitive hypertension after exposure to catecholamines. *Hypertension.* 1999; 34:151-159.

70. Meeus F, Kourilsky O, Guerin AP. Pathophysiology of cardiovascular disease in hemodialysis patients. *Kidney Int.* 2000; 58:140-147.

71. Robinson KL, Mcbeth J, Macfarlane G. Psychological distress and premature mortality in the general population: a prospective study. *Ann Epidemiol.* 2004; 14(7):467-472.

72. Fiscella K and Franks P. Does psychological distress contribute to racial and socioeconomic disparities in mortality? *Soc Sci Med.*1997; 45(12): 1805-1809.

73. Hamer M, Molloy G, Stamatakis E. Psychological distress as risk factor for cardiovascular events. *J Am Col Cardiol.* 2008; 52(25); 2157-2162.

74. Ruuskanen JM, Ruoppila I. Physical activity and psychological well-being among people aged 65-84 years. *Age Aging.* 1995; 24:292-296.

75. Van Rooy SG, Wissing MP, Potgieter JC *et al.*, *Validation of a scale to measure psychosocial well-being in an African context.* M.A. Dissertation- North West University, Potchefstroom campus.2007: 17-37.

76. Bosma H, Marmot MG, Hemingway H *et al.*, Low job control and the risk of coronary heart disease in the Whitehall II (prospective cohort) study. *Br Med J.* 1997; 314:558-565.

77. Anfossi G, Tovati M. Role of catecholamines in platelet function: pathophysiological and clinical significance. *Eur J Clin Invest.* 1996; 32:353-370.

78. Tousoulis D, Davies G, Stefanadis C. Inflammatory and thrombotic mechanisms in coronary atherosclerosis. *Heart.* 2003; 89:993-997.

CHAPTER 2:
CARDIOVASCULAR FUNCTION AND PSYCHOLOGICAL DISTRESS IN URBANIZED BLACK SOUTH AFRICANS: THE SABPA STUDY

INSTRUCTIONS FOR AUTHORS:

Ethnicity & Disease
MANUSCRIPT SUBMITTAL INFORMATION

Introduction

Ethnicity & Disease (*Ethn Dis*) is an international, peer-reviewed journal that provides information on causal relationships in the etiology of common illnesses through the study of ethnic patterns of disease. It is distributed to readers in more than 15 countries and reaches healthcare professionals interested in improving health outcomes for ethnic minority populations. *Ethn Dis* publishes original reports, reviews, editorials, special articles, reviews and commentaries, book and other media reviews, and letters on such topics as ethnic differentials in disease rates, the impact of migration on health status, social and ethnic factors related to healthcare access, and metabolic epidemiology. The journal also provides information in special sections dedicated to legislative and regulatory issues, grants and funding resources, clinical trials, and agency updates. Authors wishing to submit a manuscript for consideration should follow the guidelines herein.

Review Process

Each manuscript submitted to *Ethn Dis* enters the journal's peer-review process, which is governed by an editorial board. Authors can expect to receive a letter acknowledging receipt of manuscript within two weeks of submittal. Once received in the *Ethn Dis* editorial office, an article is submitted to a minimum of two reviewers who rate each article on merit of: content; scientific validity and integrity of data; appropriateness to *Ethn Dis* subject matter; and general presentation and readability of information. The first review is generally completed within one month from original submittal. Once reviewers' comments are collected, the author receives feedback and will be asked to make revisions as recommended by the reviewers and resubmit within three weeks (or earlier, as determined by the editorial calendar). The revised manuscript is then returned to the reviewers to ensure compliance with suggested changes (a process that generally takes two-three weeks); subsequent revisions may be necessary. Upon acceptance, the author is invited to submit the final version of the manuscript, adhering strictly to the guidelines listed herein.

Authors submitting articles not appropriate for publication in *Ethn Dis* will receive notification within two weeks of submittal.

Types of Submittals Accepted

Original Reports: Original works describing results of clinical trials, investigations, community-based research, or epidemiologic study. Manuscripts are evaluated and accepted through the peer-review process. Guidelines for Original Reports are provided herein.

Commentary/Review: Original works providing comment on existing policies, procedures, or observation of clinical approaches. This category also includes reviews of scientific literature. Manuscripts are evaluated and accepted through the peer-review process. Guidelines for Commentary/Review are the same as those for Original Reports.

Guest Editorials (invited only): Letter of invitations are issued to individuals with expertise related to an issue's scientific focus. Editorials are accepted by the editor-in-chief.

Letters to the Editor: Ethn Dis prints letters to the editor regarding issues important to health care in ethnic minority populations or letters related to manuscripts published in the journal. Guidelines for content can be found herein.

Book and Media Reviews: Individuals may submit reviews on books and other media related to the subject matter of *Ethn Dis*. Guidelines for content can be found in herein.

Manuscript Criteria and Preparation

Researchers and authors who would like to submit an article for publication in *Ethn Dis* must abide by the following guidelines when preparing and presenting their article for consideration by the journal's scientific and editorial review board. Authors should carefully refer to each section before final preparation and submittal of a manuscript.

Content Requirements of Manuscript: When preparing a manuscript for submittal to *Ethn Dis*, an author should develop text in the following sequence and as described below: title page, introduction, methods, results, discussion, acknowledgments, references, figure legends, tables. *Ethn Dis* adheres to strict word or page limit. Submissions must not exceed 5,000 words, including ALL text found in the sections noted above and inclusive of all text found in tables. If figures are used, authors should count each figure as 500 words of the total count.

Example:
Manuscript, title page, all text, references and text in tables = 3,500
Two figures (500x2) = 1,000
Total word count = 4,500

Title page: The title page should carry in this order:
1) a short running head of no more than 40 characters (count letters and spaces);
2) the title of the article, which should be concise but informative;
3) the full name of each author with his or her highest academic degree (see Authorship below);

4) the abstract (see Abstract below);
5) keywords (see Keywords below);
6) the name of the department and the institution to which the work should be attributed followed by the initials of the lead author(s) in parenthesis;
7) the department(s) and institution(s) of each additional author, followed by the initials of related author;
8) the name, address, phone, fax and email address of the author for correspondence and requests for reprints of the manuscript. If reprints will not be available, provide a statement that reprints will not be available from the authors;
9) word count (as described above) number of figures, number of tables, number of references;
10) date of submittal (include date of revision submittal if also applicable).

Authorship: Each author listed should have participated sufficiently in the work to take public responsibility for appropriate portions of the content. The lead author should take responsibility for the integrity of the work as a whole, from inception to published article. Authors are required to identify each author's contribution to the manuscript. The Author Responsibility, Contributions and Financial Disclosure Form must be submitted with each manuscript.

Group Authorship: Increasingly, authorship of multi-center trials is attributed to a group. All members of the group who are named as authors should fully meet the criteria set forward on the Author Responsibility and Contributions Form. Group members who do not meet these criteria should be listed, with their permission, in the Acknowledgments.

Abstract and Key Words
Abstract: The abstract should appear on the title page and should be no more than 250 words for structured abstracts. The abstract should state the purposes of the study or investigation, basic procedures (selection of study subjects, observational or analytical methods), main findings (giving specific data and their statistical significance, if possible) and the principal conclusions. It should emphasize new and important aspects of the study or observations. A structured abstract will include the following headings: Object-ive(s); Design; Setting; Patients or Participants; Interventions; Main Outcome Measures; Results; Conclusions.

Key Words: Below the abstract, authors should provide 3 to 10 key words or short phrases that will assist indexers in cross-indexing the article. Key words are published with the article. Terms from the medical subject headings (MeSH) list of Index Medicus should be used, if at all possible.

Introduction
State the purpose of the article and summarize the rationale for the study or observation. Give only strictly pertinent references and do not include data or conclusions from the work being reported.

Methods
Describe your selection of the observational or experimental subjects (patients or laboratory animals, including controls) clearly. Identify the age, sex, and other important characteristics of the subjects.

Identify the methods, apparatus (give the manufacturer's name, city, and state in parentheses), and procedures in sufficient detail to allow other workers to reproduce the results. Give references to established methods, including statistical methods; provide references and brief descriptions for methods that have been published but are not well known; describe new or substantially modified methods, give reasons for using them, and evaluate their limitations. Precisely identify all drugs and chemicals used, including generic name, dose, and route of administration.

Reports of randomized clinical trials should present information on all major study elements including the protocol (study population, interventions or exposures, outcomes, and the rationale for statistical analysis), assignment of interventions (methods of randomization, concealment of allocation to treatment groups), and the method of masking (blinding).

Statistics
Describe statistical methods with enough detail to enable a knowledgeable reader with access to the original data to verify the reported results. When possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty (such as confidence intervals). Avoid relying solely on statistical hypothesis testing, such as the use of *P* values, which fails to convey important quantitative information. Discuss the eligibility of experimental subjects. Give details about randomization. Describe the methods for, and success of, any blinding of observations. Report complications of treatment. Give numbers of observations. Report losses to observation (such as dropouts from a clinical trial). References for the design of the study and statistical methods should be to standard works when possible (with pages stated) rather than to papers in which the designs of methods were originally reported. Specify computer programs and software used.

Restrict tables and figures to those needed to explain the argument of the paper and to assess its support. Use graphs as an alternative to tables with many entries; do not duplicate data in graphs and tables. Avoid non-technical uses of technical terms in statistics, such as "random", "normal," "significant," "correlations," and "sample." Define statistical terms, abbreviations, and most symbols. For requirements on figure/chart submittals, please see Illustrations/Figures.

Results
Present your results in a logical sequence in the text, tables, and illustrations. Do not repeat in the text all the data in the tables or illustrations; emphasize or summarize only important observations.

Discussion
Emphasize the new and important aspects of the study and the conclusions that follow from them. Do not repeat data or other material given in the Introduction or the Results section. Include in the Discussion section the implications for future research. Relate the observations to other relevant studies.

Link the conclusions with the goals of the study, but avoid unqualified statements and conclusions not completely supported by the data. In particular, authors should avoid making statements on economic benefits and costs unless their manuscript includes economic data and analyses. Avoid claiming priority and alluding to work that has not been completed. State new hypotheses when warranted, but clearly identify them as such. Recommendations, if appropriate, may be included.

Acknowledgments
List all contributors who do not meet the criteria for authorship, such as a person who provided only technical help (eg, writing assistance, data input, or general support). Authors must have written permission from each person listed in the Acknowledgment section. Financial and material support should also be acknowledged.

References
References should be numbered consecutively in the order in which they are first mentioned in the text. Identify references in text, tables, and legends by Arabic numerals (in superscript font, outside of punctuation marks including periods and commas). References cited only in tables or in legends to figures should be numbered in accordance with the sequence established by the first identification in the text of the particular table or figure.

Do not use the Footnote, End-mark, or Citation command in software.

References should be prepared according to style guidelines based on Uniform Requirements style and presented in the *American Medical Association Manual of Style*, 9th edition (1997). Two examples of the most commonly used citations follow; please note and precisely employ text enhancements, capitalization, spacing, and punctuation.

Standard journal article.

Vega KJ, Pina I, Krevsky B. Heart transplantation is associated with an increased risk for pancreatic disease. Ann Intern Med. 1996;124(11):980-983.

If more than 6 authors, present the first 3 authors followed by ", et al."

Chapter or article in book.

Philips SJ, Whisnant JP. Hypertension and stroke. In: Laragh JH, Brenner BM, eds. *Hypertension: Pathophysiology, Diagnosis, and Management*. 2nd ed. New York: Raven Press; 1995: 465-478.

The titles of journals should be abbreviated according to style used in Index Medicus. This list of journals can be obtained through the National Library of Medicine's website (http://www.nlm.nih.gov/).

Figure Legends
Type legends for figures starting on a separate page, with Arabic numerals corresponding to the figures. When symbols, arrows, numbers, or letters are used to identify parts of the illustrations, identify and explain each one clearly in the legend.

Tables
See Tables, found in "Technical Requirements of Manuscripts."

Technical Requirements of Manuscript

General

- Double-space all parts of the manuscript (except tables, which may need to be single-spaced).
- Review the sequence and make sure the manuscript is presented in this order: 1) title page (including abstract and key words), text, acknowledgments, references, tables, legends.
- Illustrations and figures should be no larger than 8 x 10 in. (203 x 254 mm) and should be submitted as a ready-to-be published glossy print (see Illustrations/Figures for more details).
- Include permission to reproduce previously published material or to use illustrations that may identify human subjects.
- Submit the original manuscript and electronic file in required format.
- Use only standard 10- or 12-point font size.

Format of manuscript

- The text of original reports is usually divided into sections as described under "Content of Manuscripts."
- Submit the typed manuscript on white bond paper 81/2 x11 in (216 x 279 mm) or ISO A4 (212 x 297 mm), with margins of at least 1 in (25 mm). Print on only one side of the paper. Also submit electronic file of the manuscript.
- Use double-spacing throughout, including the title page, abstract, text, acknowledgments, refer-ences, and legends.
- Number pages consecutively, beginning with the title page. Put the page number in the lower right-hand corner of the page.
- Leave right margins unjustified (jagged edge).

Tables

- Prepare each table on its own page in an electronic file separate from the main text file.
- Do not submit tables as photographs.
- Number tables consecutively in the order of their first citation in the text, and supply a brief title for each.
- Give each column a short or abbreviated heading.
- Place explanatory matter in footnotes, not in the heading or body of the table.
- Explain in footnotes all nonstandard abbreviations that are used in each table. For footnotes, use the following symbols, in this sequence: *, single dagger, double dagger, section marker, parallel bars, paragraph marker, **, 2 single daggers, 2 double daggers, etc.
- Identify statistical measures of variations such as standard deviation and standard error of the mean.
- Be sure that each table is cited in the text.
- If you use data from another published or unpublished source, obtain permission and acknowledge them fully.

Illustrations/Figures

- Submit 2 complete sets of figures.
- Figures should be professionally drawn and photographed; freehand or typewritten lettering is unacceptable.
- Instead of original drawings, x-ray films, and other material, send sharp, glossy, black and white photographic prints, usually 5 x 7 in (127 x 173 mm) but no larger than 8 x 10 (203 x 254 mm).
- Illustrations prepared in PowerPoint must be submitted as a sharp, glossy, black and white photographic print. Electronic files of PowerPoint figures are not acceptable.
- Background color for all figures should be white.
- Do NOT send figures embedded in other word-processing software. If figure is sent as an electronic file, it must be submitted in one of the following formats: *.tif or *.eps, with file resolution of 350 dpi for grayscale. Files of lower resolution will be rejected. Please check with your institution's audiovisual or graphics department to ensure the correct file format and print. A printout of the electronic file must accompany the file.
- Letters, numbers, and symbols should be clear and of sufficient size that, when reduced for publication, each item will still be legible.
- Titles and detailed explanations belong in the legends for illustrations, not on the illustrations.
- Each figure should have a label pasted on its back indicating the number of the figure, author's name, and top of the figure.
- Do not write directly on the back of figures or scratch or mar them by using paper clips.
- Do not bend figures or mount them on cardboard.
- Figures should be numbered consecutively according to the order in which they have been first cited in the text.
- If a figure has been published, acknowledge the original source and submit written permission from the copyright holder to reproduce the material. Permission is required irrespective of authorship or publisher, except for documents in the public domain.
- *Ethn Dis* publishes only black and white illustrations/figures.

Units of Measurement

- Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, liter, or their decimal multiples).
- Temperatures should be given in degrees Celsius, followed by Farenheit equivalents in parentheses. Blood pressures should be given in millimeters of mercury (mm Hg-*note the proper spacing and capitalization*).
- All hematologic and clinical chemistry measurements should be reported in the metric system in terms of the International System of Units (SI).

Abbreviations and Symbols

- Use only standard abbreviations.
- Avoid abbreviations in the title and abstract.
- The full term for which an abbreviation stands should precede its first use in the text unless it is a standard unit of measurement.

Style

Writing style should follow guidelines outlined in the *American Medical Association Manual of Style*, 9th edition (1997).

Submittal Requirements

Where to submit

Manuscripts and supporting documents as described herein can be submitted:

1) Via USPS mail or courier delivery service. Include the original electronic file(s) on disk. Disk must contain the full manuscript in one file; tables in another file; and other supporting files. Files should be prepared in PC-compatible word-processing software, preferably MS Word. Name each file with the lead author's last name, followed by an abbreviation of a key word (eg, smith-cvd.doc or for tables, smith-cvd-tables.doc).

2) Via *Ethnicity & Disease* web site. Visit http://www.ishib.org/ethndis/ and follow submittal instructions.

What else to submit

Cover letter: All manuscripts should be submitted with a cover letter that identifies the individual responsible for correspondence with the editors. Provide an exact postal address, telephone and fax numbers, and email address.

Responsibility, Contributions, and Financial Disclosure Forms: Each listed author must complete and submit an Author Responsibility, Contribution,

Title: Cardiovascular function and psychological distress in urbanised black South Africans: The SABPA study

Authors: *Mashele N[1] (BSc Hons.), Van Rooyen JM[1] (DSc), Malan L[1] (PhD), Potgieter JC[2] (PhD)

Affiliations: [1]School for Physiology, Nutrition and Consumer Sciences and [2]School for Psychosocial Behavioural Sciences, North-West University, Potchefstroom Campus, Private Bag X6001, Potchefstroom, 2520, South Africa

Keywords: depression; perception of health; cardiovascular function; urbanised Africans; hypertension

Number of text pages: 21

Number of tables: 3

Corresponding author and recipient of reprint requests:

*Prof JM. Van Rooyen

School for Physiology, Nutrition and Consumer Sciences

North-West University, Potchefstroom Campus

Private Bag X6001

Potchefstroom

2520

South Africa.

E-mail: johannes.vanrooyen@nwu.ac.za

ABSTRACT

The increased prevalence of cardiovascular risk factors in Sub-Saharan Africa has led to an increase in the prevalence of CVD in this region. Whether the experience of psychological distress may contribute to this observed increase as risk factor remains largely unclear.

Objective: The aim of this study was to investigate the association between psychological distress and cardiovascular function in urbanised black South Africans which included African men (n=101) and women (n=99). The participants were stratified into a hypertensive (HT) and normotensive (NT) group.

Measures: Resting cardiovascular variables were obtained with the use of a Finometer device and 24 hour blood pressure (BP) measurements with the Cardiotens apparatus. Pulse wave velocity (PWV) was obtained with the use of a Complior® device. Psychological questionnaires assessed the perception of health (General Health Questionnaire; GHQ-28) and depression status (Patient Health Questionnaire; PHQ-9). The resting ECG NORAV PL-1200 data determined left ventricular hypertrophy (LVH) by making use of the Cornell product ((RaVL + SV_3)*QRS)). Results from the statistical analysis were adjusted for confounders (age, body mass index, smoking, alcohol consumption and physical activity).

Results: The HT groups were more overweight, had a lower compliance (C_W) and higher LVH (only men) compared to the NT group. In HT men perception of health (somatic symptoms) was positively associated with blood pressure (BP), while in HT women it was associated with heart rate (HR). Major depression was associated with LVH in HT

men and MAP in HT women. Depressed women are 1.13 times more likely to develop hypertension than men

Conclusion: Psychological distress was associated with higher BP and development of LVH in HT African men and women.

Keywords: depression; perception of health; cardiovascular function; urbanised Africans; hypertension.

Word count: 253

INTRODUCTION

Cardiovascular disease (CVD) is one of the leading causes of death worldwide, with the greatest mortality rates occurring in low and middle income countries.[1] It still remains largely unclear whether stress and more specifically the experience of psychological distress may contribute to this observed increase in the prevalence of CVD in these population groups. The term stress refers to the perceptions and responses of humans trying to adapt to the challenges of everyday life.[2]

Stress may be experienced either positively or negatively, depending on a number of factors. The term "eustress" refers to an adaptive response promoting the activation of internal resources to meet emotional and environmental demands and achieve goals.[3] Psychological distress, on the other hand, occurs when the demands of a situation exceed the individual's adaptive resources and the person can, therefore, not adapt or cope with persistent stress.[4,5] Psychological distress is a concept that is often embedded in the context of strain, stress and distress and is seldom defined as a distinct concept.[6]

In this study, however, the term psychological distress will be used to refer to persistent stress that is not resolved through coping or adaptation. With increasing environmental demands this inability to adapt or cope may manifest as behavioural (e.g. substance abuse), psychological (e.g. depression and psychosomatic complaints) and medical (heart disease and other physical illnesses) consequences. [5,7-9]

One of the environmental demands that has recently received increased research attention as a source of psychological distress in a South African context is urbanisation.[10-13] With rapid urbanisation as found in the North West Province of South Africa, the loss of social and cultural support may lead to psychosocial disruption and an associated increase in psychological distress which may contribute to the high incidence of hypertension in the urbanised black Africans.[11, 13] In this study, psychological distress will be measured through the presence of a number of signs and symptoms of psychological disorder, including depression, anxiety and social dysfunction.

Studies in the past have shown a relationship between depression and CVD such as coronary heart disease (CHD) and coronary artery disease.[14, 15] Unfortunately, these studies focused on the role of depression in CVD post-cardiac event. Conflicting results were found with regards to depression and the development of hypertension in the African-American population. Shinn *et al.* [16] found that their results did not support the role of depressive symptoms in the development of hypertension in normotensive adults.[16] Other researchers found that the association between depression and the risk of hypertension compares favourably with better established predictors of hypertension such as obesity.[17] To our knowledge investigations exploring the association between psychological functioning and CVD have not been done in the African context. Therefore, more research on the relationship between psychological distress and the development of CVD like hypertension is warranted.

The aim of this study was, therefore, to investigate whether there is a relationship between psychological distress and the development of cardiovascular dysfunction in urbanised black Africans of the North West Province of South Africa.

METHODS

Design

The methods for this study have been adapted and curtailed from the Sympathetic activity and Ambulatory Blood Pressure in Africans (SABPA) study. The SABPA study is a multidisciplinary target population study which was conducted in 2008. The study involved the recruitment of urbanised black Africans who were involved in data collection, from governmental organizations in the North West Province.

Subjects

During recruitment, two (2) months prior to data collection, the protocol was explained to each and every participant and they were given an opportunity to ask questions. Informed consent was obtained afterwards.

Black urbanised African individuals (101 men and 99 women) who complied with the inclusion criteria of having the same socioeconomic status (SES) and work environment, and being between 25 and 60 years of age were included. The exclusion criteria were: pregnancy, lactation, high temperature (>37°C), users of α and β blocking agents, psychotropic agents, blood donors or vaccination in the past three (3) months before taking part in the study.

The participants were stratified into 2 groups: (a) Hypertensive (HT) and (b) Normotensive (NT) men and women. This stratification was done according to the European Society of Hypertension (ESH) 2007 guidelines where 24hr ambulatory hypertensive status is defined as systolic and/or diastolic blood pressure (≥125-130/ ≥80 mmHg).[18]

Ethical considerations

The study was approved by the Ethics Committee of the North-West University, Potchefstroom Campus, in accordance with ethical guidelines of the WMA Declaration of Helsinki.[19]

Experimental procedure

The experimental procedure for each participant followed a two day period.

On the first day the Cardiotens device (Meditech CE0120®) was installed and programmed to record the 24 hour BP of 4 participants. The physical activity meter was fitted around the waist and a physical activity (GPAIQ) questionnaire was completed at school. Thereafter, the 4 participants left to resume their normal daily activities. The Cardiotens device recorded BP measurements in 30 minute intervals during the daytime and in 60 minute intervals during the night.

At the end of day one (~16:40, South African time) the 4 participants were transported to the Metabolic Unit Research Facility of the North-West University (research unit for human studies) where they stayed overnight. The unit is well equipped with 10 furnished

bedrooms, a kitchen, two bathrooms and a dining area. The procedures for the evening included a brief introduction to the apparatus to minimise the 'white coat effect' and a tour of the facilities. [20] Completion of the psychosocial battery questionnaires followed under supervision of registered psychologists and fieldworkers. The questionnaires were arranged in such a way as to reduce the effects of participant fatigue, with half the questionnaires completed before dinner, and the remaining half thereafter. The participants had dinner at 18.00 and enjoyed their last beverage at 20:00 (tea/coffee and biscuits) before going to bed between the hours of 21:00-22:00.

The procedure of day 2 included the disconnection of the Cardiotens apparatus at 06:00. After obtaining the anthropometric measurements, the participants were brought to the blood pressure station where the cardiovascular measurements were taken whilst the participants were in a semi-Fowlers position.

Measuring instruments and apparatus

1. Demographic questionnaire

Included in the demographic questionnaire were questions on smoking and alcohol consumption. These are self-reporting questions with a 'yes' or 'no' answer which were obtained and assessed. Information on physical activity levels was obtained with the Global Physical Activity Questionnaire.[21] The questionnaire measures the total physical activity participation in 3 domains: (a) activity at work, (b) travel to and from places and (c) recreational activities. The sum of these domains are then evaluated and summated in calories per week. Physical activity is classified as high (vigorous intensity activity on at

least 3 days achieving a minimum of 1,500 METS-minutes /wk OR seven (7) or more days of any activity accruing at least 3,000 METS-minutes/wk) or low (not meeting any of the above criteria).[21]

2. Psychological questionnaires

The 28-item GHQ [22] is used for the assessment of signs and symptoms of psychological dysfunction and is useful in the understanding of various sources of distress in occupational research.[23] The GHQ is a measure of the common mental health/domains of depression, anxiety, somatic symptoms and social withdrawal [23] and was validated for the Tswana speaking population.[24] An example of items used in this questionnaire include: 'Have you found everything getting on top of you'; 'Have you been getting scared or panicking for no reason?' and 'Have you been getting edgy and bad tempered'. Each of the above are then accompanied by 4 possible responses; 'not at all', 'no more than usual', 'rather more than usual' and 'much more than usual'. In this study each item was evaluated using the binary scoring method.[25] The 2 least symptomatic answers are given a score of nil (0) whilst the 2 most symptomatic answers are given a value of one (1). Total scores exceeding the threshold of 4 are classified as achieving 'psychiatric caseness'. In general practice individuals classified as achieving 'psychiatric caseness' would be likely to receive further attention.[23] The reliability coefficients of the subscales for this questionnaire varied between 0.77 and 0.83.

The Patient Health Questionnaire (PHQ) is a sensitive 9-item instrument for making criteria-based diagnosis of depressive disorders and it is also a reliable and valid measure of depression severity.[26] This scale can ideally establish depressive disorder diagnosis and

grade depressive symptom severity. The scale is based on the actual nine (9) criteria of diagnosis of the DSM-IV depressive disorders. The PHQ assesses eight (8) diagnoses divided into threshold disorders (disorders that correspond to specific DSM-IV diagnoses i.e. major depressive disorder) and sub-threshold disorders (disorders whose criteria include fewer symptoms than required for any specific DSM-IV diagnoses i.e. other depressive disorders). The questionnaire scores each of the 9 DSM-IV as "0" (not at all) to "3" (nearly every day). For analysis the PHQ-9 scores are divided into the following categories of increasing severity: 0-4, 5-9, 10-14, 15-19 and 20 or greater which represent minimal, mild, moderate, moderately severe, and severe depression respectively. Scores less then five (5) signify the absence of depressive disorders; scores of 5-9 predominately represent no depression or sub-threshold depression; scores of 10-14 represent a spectrum of individuals who may or may not display depression. Scores of 15 or greater usually are indicative of major depression.[26] In this study scores of ≤ 10 are considered as the absence of depression (MDD=0), and values ≥ 10 are considered as the presence of major depression (MDD=1).[26] The Cronbach alpha-reliability index for this sample was 0.81.

3. Anthropometric measurements

All measurements were standardised and taken in triplicate to the nearest 0.1 cm by registered biokineticists. Height was measured by making use of a stadiometer while the participants head was in the Frankfurt plane.[27] Weight was measured to the nearest 0.1kg using a KRUPS scale with the participants wearing minimal clothing. The above mentioned measurements were used for the calculation of Body Mass Index [body mass/height^2].[28] Physical activity was measured using an Actical® accelerometer

(Montréal, Québec).[29] Waist circumferences were measured at the midpoint between the lower costal border and the iliac crest perpendicular to the long axis of the trunk with a metal tape.[27]

4. Cardiovascular measurements

A Cardiotens apparatus (Meditech CE0120®) was used for the 24 hour blood pressure measurement and a 12-lead ECG (NORAV PC 1200) was applied to obtain six resting cardiac cycles. Non-invasive continuous arterial blood pressure recordings were obtained using the Finometer device (Finapres Medical Systems, Amsterdam, The Netherlands). The Fast Modelflo computer software programme analysed the results to provide: mean arterial pressure (MAP) and total peripheral resistance (TPR), compliance (Cw) and heart rate (HR). Pulse wave velocity was calculated using a Complior®. Left ventricular hypertrophy (LVH) was calculated from the 12-lead ECG device using the following gender-specific formula: Cornell product (Sum of all the leads, RaVL+SV3 $\geq$ 2.8 mV in men and; $\geq$2.0 mV in women)* QRS>244 ms. [30]

Statistical Analysis

All data was analysed by means of the computer software package STATISTICA 8 (StatSoft, Inc., Tulsa, OK, USA, 2008). All data were normally distributed, hence parametric methods were used. A single 2×2×2 (hypertension×depression×gender) analysis of covariance (ANCOVA) was done to evaluate the main effects interactions for cardiovascular and psychological distress data. The prevalence of smoking, alcohol consumption, hypertension, HT medication, physical activity (PAI) and depression were computed using the 2-way Pearson Chi-square analysis. ANCOVA was used to compare

the psychological and cardiovascular parameters between the hypertensive and normotensive gender groups while adjusting for confounders (age, BMI, PAI, smoking and alcohol consumption). Partial correlations followed to indicate associations between cardiovascular variables (BMI, WC, Cw, MAP, 24hr SBP and the Cornell product), depression (PHQ-9) and the common mental health domains of depression (GHQ_DS), anxiety (GHQ_AS), somatic symptoms (GHQ_SS) and social dysfunction (GHQ_SD), GHQ_Total score (GHQ_T) separately in the hypertensive men and women. Partial correlations were done whilst adjusting for confounders such as age, BMI, PAI and smoking and alcohol consumption. Logistic regression analysis was done using HT as dependent variable and SS, Cornell product, GHQ and depression as the preditor variables. ODD ratio was determined the measure of effect size. The reliability of the GHQ-28 and the PHQ-9 were determined by the Cronbach alpha (α) reliability coefficient which was between 0.77 and 0.83 for the GHQ-28 and 0.81 for PHQ-9. Data were considered statistically significant if $p \leq 0.05$.

RESULTS

The 2 X 2 X 2 (24h HT X depression X gender) interactions were not significant for any of the cardiovascular parameters, depression and perception of health data. For exploratory reasons we evaluated cardiovascular parameters were evaluated in subsequent 2-way ANCOVA's, (24h HT X depression) in men and women which showed significance for own perception of health (GHQ-T ($F(1, 91) = 3.98$; $p = 0.05$), GHQ-AS ($F(1, 91) = 4.02$, $p = 0.05$) and GHQ-DS ($F(1, 91) = 4.17$, $p = 0.05$)). The 2 X 2 (gender X

depression) interaction showed a significant interaction between depression (PHQ) and LVH (>244 mV) (F (1, 163) =7.30; p=0.01).

Table 1 showed that more men were hypertensive (79%) than women (57%). The hypertensive men and women were older (p=0.01), more obese (p<0.01) with larger waist circumference (WC) (p=0.05) compared to their normotensive counterparts. The hypertensive groups also revealed a higher Cornell product value, marginally significant only in HT men (p=0.06), and lower arterial compliance (p=0.05) compared to the normotensive groups.

Table 2 revealed that in HT men blood pressure, SBP (r =0.24) and DBP (r =0.30) correlated positively with perceived health (GHQ_SS) and target end organ damage (LVH). LVH (r=0.32) was positively correlated with depression (PHQ_ Major depression) in HT men. A negative (r=-0.26) correlation was found between target end organ damage (LVH) and compliance, whilst a positive correlation was found between MAP and LVH. In the hypertensive women HR correlated positively with GHQ_SS (r=0.30), whilst MAP had a correlation with depression (r=0.23; p=0.05). Additionally a marginally significant correlation was found MAP and LVH (r=0.20, p= 0.08).

To support these results, a logistic regression analysis was performed (Table 3). Using logistic regression analysis in the HT gender groups, with HT as the dependent variable, depression showed an ODD ratio of 1.13.

Table 1: Descriptive statistics of the hypertensive and normotensive men and women. Mean (CI)

	Hypertensive Men (N=79)	Normotensive Men (N=21)	p-value	Hypertensive Women (N=57)	Normotensive Women (N=42)	p-value
*Age (years)	**44.39 (42.61;42.17)**	**39.10(35.64;42.55)**	**0.01**	46.61(44.58;48.65)	43.74(41.37;46.11)	0.07
*BMI (Kg/m^2)	**28.48 (27.24;29.73)**	**23.10(20.65;25.48)**	**<0.01**	**34.63(32.71;36.54)**	**30.38(28.16;32.61)**	**<0.01**
*Waist Av (cm)	**100.6 (92.15;109.07)**	**82.13(65.74;98.53)**	**0.05**	**99.59(95.90;103.27)**	**85.52(81.23;89.81)**	**<0.01**
*Smoking n (%)	26 (34.21)	5 (23.80)	0.42	3 (5.26)	0 (0)	0.13
*Alcohol n (%)	34 (43.04)	6 (28.57)	0.23	7 (12.28)	5 (11.90)	0.95
*PAI n (%)	56 (70.88)	15 (71.43)	0.80	41 (71.93)	34 (80.95)	0.27
AIDS n (%)	12 (15.19)	2 (9.53)	0.20	4 (7.02)	1 (2.38)	0.30
D_HYPT n (%)	14 (17.72)	1(4.76)	0.14	15 (26.31)	6 (14.29)	0.15
TPR(mmHg/ml/s)	1.07 (0.04; 1.00)	1.05 (0.895; 1.21)	0.80	0.99(0.90;1.09)	0.92(0.80;1.03)	0.29
MAP(mmHg)	**113.34 (110.12; 115.85)**	**101.53(95.48;107.58)**	**<0.01**	**105.68(103.41;107.95)**	**95.60(92.88;98.31)**	**<0.01**
C_W (ml/mmHg)	**1.84 (1.77;1.92)**	**2.03 (1.87;2.19)**	**0.05**	**1.74 (1.66;1.81)**	**2.01 (1.92;2.10)**	**<0.01**
HR(b/m)	68.20 (65.73;70.68)	63.90 (58.67;69.12)	0.16	70.39(67.10;73.69)	68.82(64.87;72.78)	0.56
**PWV (m/s)	9.10 (8.55;9.65)	8.28 (7.11;9.45)	0.16	8.63(8.19;9.07)	8.31(7.79;8.84)	0.39
Cornell product(mV)	**89.65 (78.29; 101.02)**	**60.02 (32.44; 87.61)**	**0.06**	60.53(53.36;67.71)	49.58(40.98;5820)	0.65
24hr DBP(mmHg)	**91.48 (88.68;92.63)**	**76.92 (72.80;81.04)**	**<0.01**	**84.25(82.47;86.03)**	**72.38(70.28;74.48)**	**<0.01**
24hr SBP(mmHg)	**142 (138.84;144.56)**	**122.61 (116.65;128.58)**	**<0.01**	**137.10(134.21;139.91)**	**117.37(114.01;120.73)**	**<0.01**
PHQ_TT	8.33 (7.07; 9.6)	8.31 (5.72;10.90)	0.99	10.48 (8.92;12.02)	10.12(8.30;11.95)	0.80
GHQ_T	7.21 (5.74; 8.68)	8.20 (5.13; 11.25)	0.58	9.23(7.41;11.04)	9.10(6.93;11.21)	0.91
GHQ_SS	2.38 (1.91;2.84)	2.35 (1.38;3.32)	0.97	2.60 (1.95;3.25)	2.74 (1.97;3.51)	0.79
GHQ_AS	2.31 (1.77;2.86)	2.60 (1.46;3.72)	0.67	2.77 (2.10;3.50)	3.10 (2.28;3.90)	0.57
GHQ_SD	1.70 (1.20;2.20)	2.21 (1.18;3.23)	0.39	2.44 (1.85;3.01)	1.94 (1.25;2.62)	0.29
GHQ_DS	0.82 (0.48;1.17)	1.03 (0.31;1.76)	0.62	1.43 (0.84;2.01)	1.30 (0.60;1.97)	0.75

CI, 95% confidence intervals; n, number of participants; (%), percentage; BMI, body mass index; waist Av, waist average; PAI, physical activity index; D_HYPT, hypertensive medication; TPR; total peripheral resistance, MAP; mean arterial pressure; C_W; arterial compliance; HR, heart rate; PWV, pulse wave velocity; 24hr SBP, 24 hour systolic blood pressure; 24hr DBP, 24 hour diastolic blood pressure; PHQ_TT, patient health questionnaire total score; GHQ_T, general health questionnaire total score; GHQ-SS, somatic symptoms; GHQ-AS, anxiety symptoms; GHQ-SD, social dysfunction; GHQ-DS, depressive symptoms.

Statistical significance is considered when, $p \leq 0.05$. Significant values are highlighted in **bold**.

*covariants age, smoking, alcohol consumption, physical activity and BMI. **Value adjusted for age, BMI, smoking, alcohol consumption and MAP

Table 2: Partial correlations in hypertensive African men and women: cardiovascular variables with depression (PHQ-9), Perception of health (GHQ_SS) and target end organ damage (LVH)

	Hypertensive men:			*Hypertensive women:*		
	Target end organ damage (LVH)	Perception of health (GHQ_SS)	PHQ_Major depression	Target end organ damage (LVH)	Perception of health (GHQ_SS)	PHQ_Major depression
	r-value p-value	r-value p-value	r-value p-value	r-value p-value	r-value p-value	r-value p-value
Waist Av	-0.02; 0.86	0.13; 0.30	-0.18; 0.13	**0.22; 0.06**	0.04; 0.73	-0.16; 0.18
***PWV**	0.15; 0.19	-0.07; 0.54	-0.04; 0.77	-0.13; 0.26	-0.04; 0.72	0.01; 0.91
MAP	**0.44;<0.01**	0.18; 0.12	0.15; 0.21	0.20; 0.08	-0.14; 0.22	**0.23; 0.05**
HR	0.03; 0.81	0.15; 0.22	-0.05; 0.69	-0.13; 0.27	**0.30; 0.01**	-0.03; 0.83
TPR	0.13; 0.26	0.10; 0.41	0.10; 0.38	0.18; 0.11	-0.20; 0.08	0.05; 0.69
C_W	**-0.26; 0.03**	-0.15; 0.20	-0.12; 0.32	-0.10; 0.37	0.11; 0.35	-0.18; 0.13
SBP	**0.43;<0.01**	**0.24; 0.04**	-0.00; 1.00	0.21; 0.06	-0.07; 0.55	0.05; 0.69
DBP	**0.32; 0.01**	**0.30; 0.01**	-0.01; 0.97	0.12; 0.31	-0.11; 0.34	0.11; 0.35
Cornell product	-	-0.07; 0.56	**0.35;<0.01**	-	0.03; 0.83	-0.10; 0.40

Waist Av, waist average; PWV, pulse wave velocity; MAP, mean arterial pressure; HR, heart rate; TPR, total peripheral resistance; C_W, arterial compliance; SBP, systolic blood pressure; DBP, diastolic blood pressure; Cornell product (>2.44.0 mV). GHQ-SS, somatic symptoms; PHQ_major depression, scores of <10 are considered as showing no depressive disorders; whilst a score >10 are considered to be major depressed.
*PWV is adjusted for age, BMI, PAI, smoking, alcohol consumption and MAP
All cardiovascular parameters were adjusted for age, BMI, PAI, smoking and alcohol consumption
Significant correlations are highlighted in **bold.**

Table 3: Logistic regression analysis, estimates and ODD ratio of the hypertensive gender groups

		Men:		*Women:*	
Dependent variable	**Predictor**	**Estimates**	**ODD ratio**	**Estimates**	**ODD ratio**
HT	HR	0.05	1.05	0.02	1.02
	Cw	-1.12	0.33	-1.71	0.18
	Cornell product	0.01	1.01	0.03	1.03
	GHQ_SS	0.06	1.06	-0.22	0.80
	PHQ_TT	0.02	1.02	0.12	**1.13**

HT, hypertension; HR, heart rate; Cw, arterial compliance; GHQ_SS, General health questionnaire (somatic symptoms), PHQ_TT, patient health questionnaire total score

DISCUSSION

The main aim of this study was to investigate the interaction between cardiovascular function and psychological distress in urbanised black South Africans. The main findings of this study were that in HT men mean arterial pressure (MAP) and BP where associated with poorer well-being (GHQ_SS) and LVH was associated with depression (p=0.001). In HT women a similar trend followed where HR and MAP were associated with perception of health (GHQ_SS) and depression (PHQ) respectively. Additionally this study showed that overall in HT African men MAP, and BP was associated with target end organ damage while compliance was negatively associated with LVH. In HT women, waist average was weakly associated with target end organ damage.

African men had a higher prevalence of hypertension (79%) compared to women which was consistent with other studies done on this population group. [9-12] Generally the women were more depressed which is consistent with African-American women who are more

likely to be depressed than men.[31] This seems to suggest that although women are more prone to suffer from minimal to moderately severe depression, substantially more men seem to suffer from severe depression. These differences may be due to the discrepancies in the expression of depression by men and women. The expression of emotions, constrained by traditional notions of masculinity, may explain why the prevalence of depression was high in men even though they did not report symptoms of depression [32]

When participants in this study were stratified into hypertensive and normotensive groups, significant correlations were found between the experience of somatic symptoms and 24hr BP. This finding suggests that individuals who suffer from high BP have a negative experience of their physical health, and that they are aware of being physically not well. It has previously been found that increased BP manifests among individuals with negative perceptions of their well-being.[13] This is also consistent with findings from other studies that showed that Africans experience chronic sympathetic system activation when exposed to social and environmental stressors.[9, 11] The same authors illustrated that in African men, an exaggerated peripheral resistance response can be seen.[11, 12] The perception of daily events as stressful might result in a negative experience of physical health, psychological distress and poor perceived health, which may elicit itself as subjective stress resulting in an exaggerated vascular response and subsequently the increase in BP.[33]

In HT men, there were associations between major depression, LVH and compliance. These findings suggest that individuals who are hypertensive are more likely to develop depression and LVH with lower compliance. It has been previously found that

hypertension has been associated with lower vascular compliance, development of LVH and end organ damage as a result of vascular resistance and elevation in BP.[34, 35] Additionally hypertensive individuals have a greater risk of developing depression.[36] In accordance with both of these findings, the results of this study showed that the HT groups, depression was associated with LVH and especially vascular blood pressure values. HPA hyperactivity has been associated with both hypertension and depression. Whether HPA hyperactivity is a possible mechanism for the above-mentioned associations in this population remains an unsubstantiated speculation that will require further investigation.[37-39]

Other studies have shown that in men, depression has been significantly associated with a variety of vascular disorders, particularly the elevation of MAP.[16, 40, 41] In this study only an association between depression and MAP in hypertensive women was found. The possible reasons for this discrepancy in findings may lie in the difference in the populations under study. The above-mentioned studies included African-Americans and other ethnicities, therefore, rendering a comparison between the studies more complex. Different backgrounds, socio-economic status, living conditions and levels of stress and depression can additionally be confounders for comparing studies in different settings. Additionally, the use of different psychological models in diagnosing depression may result in an incongruity in the sensitivity of the instruments.

A logistic regression analysis was performed to show the size of the effect depression, perception of health to hypertension and cardiovascular parameter have on HT. Depressed women are 1.13 times more likely to develop hypertension than women, indicating that depression has a greater effect on HT in women than the other measured

predictors. Therefore, individuals who are depressed have a greater chance of developing hypertension. As was found in the African-Americans, depression was predictive of later incidence of hypertension.[42]

In this study the population of African men had BP (138/89 mmHg) which is higher than the ESH recommendations (>125-130/ >80 mmHg), suggesting a possible need for new cut off values (24hr AMBP) for Africans. Other possible limitations of the study include the small size of the study sample when subjects were divided in HT and NT. Future research should also incorporate the measure of psychological well-being in addition to the measure of psychopathology, as it will give a better spectrum of mental wellness of those individuals lying within the threshold category. In other words, the lack of depression symptoms in a certain part of the current sample should not be interpreted as the presence of mental wellness.

In conclusion, this study showed that depression was significantly associated with certain measured cardiovascular parameters and that depression was the most prominent contributor to HT. Major depression was associated with the development of pathological conditions such as the development of LVH, lower vascular compliance and elevated MAP, possibly through autonomic dysfunction. Perception of poorer health, in particular somatisation could contribute to autonomic dysfunction in both men and women. The limited number of similar studies in an African population serves as motivation for more research in this area.

ACKNOWLEDGEMENTS

The authors acknowledge the contributions of the following SABPA team members: the anthropometric measurements done by biokineticists supervised by Prof. J.H de Ridder, cardiovascular measurements supervised by cardiovascular physiologists and the psychological data supervised by psychologists. This study was financially supported by the North-West-University: AUTHER (African Unit for Transdisiplinary Health Research); National Research Foundation (NRF). Metabolic Syndrome Institute (France).

REFERENCES:

1. WHO (World Health Organization). Cardiovascular disease: prevention and control. Available at: http://www.who.int/mediacentre/factsheets/fs317/en/index.html. Accessed November 7, 2008.
2. Seyle H. *The Stress of life*. New York: McGraw-Hill, 1956.
3. Seyle H. Confusion and controversy in the stress field. *J Hum Stress*. 1975; 1:37-44.
4. Folkman S, Lazarus RS. An analysis of coping in a middle-aged community sample. *J Health and Soc Behav*. 1980; 21:219-239.
5. de Kloet RE, Joels M, Holsboer F. Stress and the brain: from adaptation to disease. *Nat Rev Neurosci*. 2005; 6(6):463-475.
6. Ridner SH. Psychological distress: concept analysis. *J Advan Nurs*. 2004; 45(5): 536-545.
7. Quick JC, Quick JD, Nelson DL *et al., Preventative stress management in organizations*. Washington DC: American Psychological Association; 1997.
8. Voster HH, Wissing MP, Venter CS *et al*., The impact of urbanization on physical and mental health of Africans in the North-West Province of South Africa: The THUSA study. *S Afr J Sci*. 2000; 96: 505-514.
9. Malan L, Malan NT, Wissing MP *et al*., Coping with urbanisation: A cardiometabolic risk? *Biol Psychol* . 2008; 323-328.
10. Malan NT, Van De Merwe JS, Huisman HW *et al.,* A comparison of cardiovascular reactivity of rural blacks, urban blacks and whites. *Stress Med.* 1992; 8:241-246.

11. Van Rooyen JM, Kruger HS, Huisman HH *et al.*, An epidemiological study of hypertension and its determinants in a population in transition: the THUSA study. *J Hum Hypertens*. 2000; 14:779-787.
12. Van Rooyen JM, Husiman HW, Eloff FC *et al.*, Cardiovascular reactivity in black South African males of different age groups: the influence of urbanisation. *Ethn & Dis*. 2002; 12(1):69-75.
13. Malan L, Schutte AE, Malan NT *et al.,* Coping mechanisms, perception of health and cardiovascular dysfunction in Africans. *Int J Psychophysiol*. 2006; 61:158-166.
14. Stansfeld SA, Fuhrer R, Shipley MJ *et al.*, Psychological distress a risk factor for coronary heart disease in the Whitehall II Study. *Int J Epidemiol*. 2002; 31:248-255.
15. Lett HS, Blumenthal JA, Babyak MA *et al.*, Depression as a Risk factor for coronary artery disease: Evidence, mechanisms, and treatment. *Psychosom Med*. 2004; 66:305-315.
16. Shinn EH, Poston WSC, Kimball KT *et al.*, Blood pressure and symptoms of depression and anxiety: a prospective study. *Am J Hypertens*. 2001; 14:660-664.
17. Kabir AA, Whelton PK, Khan MM *et al.*, Association of symptoms of depression and Obesity with hypertension: the Bogalusa Heart study. *Am J Hypertens*. 2005; 19(6):639-645.
18. Giuseppe M, De Backer G, Dominiczak A *et al.*, 2007 Guidelines for the management of arterial hypertension. *Eur Heart J*. 2007; 28:1462-1532.
19. WMA (World Medical Association). Declaration of Helsinki: Ethical principles for medical research involving human subjects. World Medical Association online 2005 Available at: http://www.wma.net/e/policy/b3.htm. Accessed November 9, 2008.

20. Obrist PA. *Cardiovascular Psychophysiology: A perspective*. London: Plenum Press; 1981.

21. World Health Organization. 2003. The Global Physical Activity Questionnaire (GPAQ). Available at: http://www.who.int/entitty/chp/steps/resources/GPAQ.htm Accessed: November 7, 2008.

22. Goldberg DP and Hiller VF. *Manual of General Health Questionnaire*. England: NFER Publishing Windsor; 1978.

23. Jackson G. The General Health Questionnaire. *Occup Med*. 2007;57(1):79.

24. Stapelberg R. *Psigometriese eienskappe van die Cope en SACS by 'n groep Setswana-sprekende Suid-Afrikaners/ Psychometric characteristic s of the cope and SACS in the Setswana-speaking South African group* (MA). Potchefstroom University, Potchefstroom.1999; p 200.

25. Goldberg DP, Gater R, Sartorius TB *et al.,* The validity of two of the GHQ in the WHO study of mental illness in general health care. *Psychol Med*. 1997; 27:191-197.

26. Kroenke K, Spitzer RL, Williams. The PHQ-9: Validity of a brief depression Severity Measure. *J Gen Intern Med*. 2001; 16:606-613.

27. Marfell-Jones M, Olds T, Stewart A *et al.*, International Standards for anthropometric assessment. ISAK: Potchefstroom. South Africa. 2002:58-87.

28. American College of Sports Medicine (ACSM). *Guidelines for Exercise Testing and Prescription*. 7th. Philadelphia: Lippincott Williams & Wilkins; 2006.

29. Heil DP. Predicting Activity Energy Expenditure Using the Actical® Activity Monitor. *Res Q Exercise Sport*. 2006; 77(1):64-80.

30. Ang DSC, Lang CC. The prognostic value of the ECG in hypertension: where are you now? *J Hum Hyperyens*. 2008; 22:460-467.

31. Riolo SA, Nguyen TA, Greden JF *et al.*, Prevalence of depression by race/ethnicity: findings from the National Health & Nutrition Examination study III. *Am J Public Health*.2005; 95(6):998-1000.

32. Brownhill S, Wilhelm K, Barclay L *et al.*, 'Big build': hidden depression in men. *Aust N Z J Psychiatry*.2005;39(10):921-931.

33. Appels A. Mental precursors of myocardial infarction. *Br J Psychiatry*.1990; 156:465-471.

34. Verdecchia P, Schillaci G, Borgioni C *et al.*, Prognostic values of a new electrocardiographic method for the diagnosis of left ventricular hypertrophy in essential hypertension. *J Am Coll Cardiol*.1998; 31:383-390.

35. Sundström J, Lind L, Arnlöv J *et al.*, Echocardiographic and echocardiographic diagnoses of left ventricular hypertrophy predict mortality independently of each other in a population of elderly men. *Circulation*. 2001; 103:2346-2351.

36. Farmer A. Medical disorders in people with recurrent depression. *Br J Psychol.* 2008; 192:351-355.

37. Remme WJ. The sympathetic nervous system and ischemic heart disease. *Eur Heart J*.1998; 19(F): 62–71.

38. Reynolds RM, Walker BR, Syddall HE *et al.*, Altered control of cortisol levels and impaired cognition in human aging: implication for depression and dementia in later life. *Rev Neurosci*. 1999;10:117-139.

39. Gold SM, Dziobek I, Rogers K. Hypertension and Hypothalamo-Pituitary-Adrenal axis hyperactivity affect frontal lope integrity. *J Clin Endocrinol Metab.* 2005; 90(6):3262-3267.

40. Rieff M, Schwartz S, Northridge M. relationship of depressive symptoms to hypertension in a household survey in Harlem. *Psychosom Med.* 2001; 63:711-721.

41. Dimsdale JE. Symptoms of anxiety and depression as a precursor to hypertension. *J Am Med Assoc.*1997; 277:574-575.

42. Jonas BS, Frank P, Ingram DD. Are symptoms of anxiety and depression risk factor for hypertension? *Arch Fam Med.*1997;6(1): 43-49.

CHAPTER 3:
GENERAL FINDINGS AND CONCLUSIONS

INTRODUCTION

This chapter will present the main findings that were reported in this dissertation. Results will be discussed, interpreted, elucidated and compared to the relevant literature in Chapter 1. Conclusions will be drawn and recommendations will be made regarding further research on psychological distress, its prevalence, physiological mechanisms, associations with hypertension and target organ damage.

SUMMARY OF MAIN FINDINGS

The significant findings of the article reported in this dissertation were:

The prevalence of hypertension in urbanised black South Africans was associated with psychological distress (depression and somatisation) and cardiovascular dysfunction (target end organ damage).

The main aim of the study was to investigate the relationship between psychological distress and cardiovascular function amongst urbanised black South Africans. It was hypothesised that (a) an association exists between depression, perception of health, hypertension and cardiovascular function in Africans, and (b) perception of health, hypertension and depression prevalence is associated with cardiovascular dysfunction in Africans. From the results, left ventricular hypertrophy (LVH), heart rate (HR), blood pressure (BP) and mean arterial pressure (MAP) were associated with perception of health and depression respectively. Based on these findings both parts of the hypothesis can be accepted as the prevalence of severe depression was more prominent in men who also had a higher hypertension prevalence and greater LVH with lower compliance.

DISCUSSION OF MAIN FINDINGS

Depression is associated with hypertension and development of cardiovascular diseases (CVD).[1,2] Both hypertension and CVD are becoming more prevalent in Sub-Saharan Africa, but the role of depression as an outcome of psychological distress on cardiovascular function has not yet been investigated in Africans.[3]

The aim of this study was to investigate the association between psychological distress, depression and cardiovascular dysfunction in urbanised black South Africans. Although the findings of this study cannot be generalised to the whole African population of South Africa, it serves as a foundation for future in-depth studies.

In HT men, systolic blood pressure (SBP) (r =0.24) and diastolic blood pressure (DBP) (r =0.30) correlated positively with perception of health (GHQ_SS), while the LVH (r=0.35) was positively correlated with depression (PHQ). In the hypertensive women, heart rate (HR) correlated positively with perceived somatic symptoms (r=0.30), whilst MAP had a weak positive correlation with depression (r=0.23; p=0.05). It seems that hypertension in Africans is associated with LVH, lower arterial compliance (C_W) and negative perception of physical health and symptoms of depression. These results are linking hypertension to LVH in urbanised Africans in this population group.

COMPARISON WITH RELEVANT LITERATURE

When comparing the results of this study with existing literature, it is evident that some findings confirmed those of other research. It has previously been found that urbanised African men show higher hypertension prevalence and that persistent psychological stress associated with increased BP. A negative perception of health is associated with increased vascular sympathetic activity.[4, 5, 6] The literature indicated that African-American women are more likely to report symptoms of depression than men.[7] Consistent with these findings this study showed that women reported more symptoms of depression but the prevalence of severe depression was higher in men. This maybe attributed to differences in the expression of depression by men and women. The expression of emotions, constrained by traditional notions of masculinity, may explain why the prevalence of depression was high in men, even though they did not report symptoms of depression.[8] Emphasis should be drawn to the fact that the literature regarding depression amongst urbanised Africans is to a large extent limited.

CHANCE AND CONFOUNDING

Chance: A number of methodological factors may have influenced the outcomes of this study.

The size of the study population may be questioned. When the participants were stratified into hypertensive and normotensive groups the number of participants made it inadequate to identify trends in the greater population. Due to the small number of subjects in each hypertensive gender group, the prevalence of severe depression may be a

misrepresentation of the true situation in the general population.

Confounding factors: Other confounding factors such as HIV status may have influenced the results. Age, body mass index, smoking, alcohol consumption, physical activity and the use of hypertensive drugs were addressed by statistically adjusting for possible bias interaction.

Furthermore, it was necessary to interpret all the statistical results in a physiological perspective; the lack of statistical significance does not necessarily indicate a lack of physiological significance.

WEAKNESS OF STUDY

Weaknesses of this study include:

1. In this study population, the African men had a higher BP (138/89 mmHg) than that recommended by the ESH (≥125-130/ ≥80 mmHg) guidelines for 24hr ambulatory blood pressure (24hr AMBP) measurements, suggesting a possible need for new cut off values for African men.[9]
2. The psychological questionnaires only measure psychopathology and do not give an indication of the mental well-being of individuals. As these are not mutually exclusive states of functioning. Questionnaires that provide a more holistic view of mental health should be considered in future as this will give a better view of individuals that lie in the threshold spectrum for depression.

FINAL CONCLUSIONS

In conclusion, this study showed that depression was significantly associated with certain measured cardiovascular parameters and that depression was the most prominent contributor to HT prevalence in urbanised Africans. Major depression was associated with the development of pathological conditions such as the development of LVH and elevated MAP, possibly through autonomic dysfunction. Perception of poorer health, in particular negative perception of physical health as represented by the experience of somatic symptoms, could contribute to the activation of HPA axis and sympathetic desensitisation in both men and women.

RECOMMENDATIONS

The following recommendations are proposed for future studies:

1. A study with a larger population will give a clearer picture of the prevalence of depression amongst urbanised black South Africans.
2. Depression has both behavioural and direct pathophysiological effects. Further investigation into the pathophysiological effects of depression will give a clearer view of their effects on cardiovascular function.
3. Direct pathophysiological effects of depression involve 3 mechanisms; hypercortisolaemia (increased cortisol levels), impairment in platelet function and finally, reduction in heart rate variability and vagal control. A study of all three mechanisms will be valuable in isolating mechanisms contributing to the high

prevalence of CVD in Africans

4. The levels of cortisol should be analysed in conjunction with the cardiovascular and psychological variables. Levels of cortisol may change and contribute to the development of hypertension.[10] The analysis of cortisol will provide a link between depression which is characterised by hypercortisolaemia and hypertension.
5. Impaired platelet function has been thought to contribute to the development of CVD such as ischemic heart disease.[11] Depression has been associated with enhanced platelet reactivity and release of platelet products such as platelet factor 4 and ß– thromboglobulin. Therefore, the use of enzyme-linked immunosorbent assay (ELISA) to measure plasma concentrations of the platelet-specific proteins in these individuals may provide a better understanding of the physiological mechanisms associated with depression .[12]
6. Control of the heart rate is mainly via the autonomic nervous system. Therefore, fluctuations in heart rate may provide a sensitive measure of the rapidly reacting autonomic systems which are altered in depressed individuals. Measuring heart rate variability will give clarity on the autonomic nervous system functioning.[13]
7. Investigating baroreflex sensitivity may add value in the understanding of psychological distress and its effects on hemodynamic reactivity, in other words individuals who are depressed or experiencing symptoms of depression will fail to make appropriate adjustments in HR with increases in BP.[14]
8. Major depression is associated with memory and learning deficits due to the persistent hypercortisolaemia. Therefore, accessing learning and memory

function may be an additional method in validating depression in these individuals.[15]

9. Future research should incorporate the measure of psychological well-being in addition to the measure of psychopathology, as it will give a better indication of the physiological functioning especially of those individuals lying within the threshold category of mental illness.
10. Further research in target organ damage may have both health and economic relevance.

REFERENCES:

1. Jonas BS, Lando JF. Negative affect as a prospective risk factor in hypertension. *Psychosom Med.* 2000; 62:188-196.
2. Kuper M, Marmot M, Hemingway H. Systematic review of prospective cohort studies of psychosocial factors in the etiology and prognosis of coronary heart disease. *Semin in Vasc Med 2.* 2002:267-314.
3. Seedat YK, Opie LH. Hypertension in Sub-Saharan African populations. *Circulation.* 2005; 112:3562-3568.
4. Malan L, Malan NT, Wissing MP *et al.*, Coping with urbanisation: A cardiometabolic risk? *Biol Psychol.* 2008; 323-328.
5. Van Rooyen JM, Kruger HS, Huisman HH *et al.,* An epidemiological study of hypertension and its determinants in a population in transition: the THUSA study. *J Hum Hypertens.* 2000; 14:779-787.
6. Malan L, Schutte AE, Malan NT *et al.,* Coping mechanisms, perception of health and cardiovascular dysfunction in Africans. *Int J Psychophysiol.* 2006; 61:158-166.
7. Riolo SA, Nguyen TA, Greden JF *et al.,* Prevalence of depression by race/ethnicity: findings from the National Health & Nutrition Examination study III. *Am J Public Health.* 2005; 95(6):998-1000.
8. Brownhill S, Wilhelm K, Barclay L *et al.,* 'Big build': hidden depression in men. *Aust N Z J Psychiatry.* 2005;39(10):921-931.
9. Giuseppe M, De Backer G, Dominiczak A *et al.*, 2007 Guidelines for the management of arterial hypertension. *Eur Heart J.* 2007; 28:1462-1532.

10. Malan NT, Van De Merwe JS, Huisman HW *et al.,* A comparison of cardiovascular reactivity of rural blacks, urban blacks and whites. *Stress Med.* 1992; 8:241-246.

11. Bruce EC, Musselman DL. Depression, alteration in platelet function and ischemic heart disease. *Psychosom Med.* 2005; 65:34-36.

12. Files JC, Malpass TW, Yee EK *et al.,* Studies of human platelet alpha granule release *in vivo*. *Blood.* 1981; 58:607–618.

13. Musselman DL, Evans DL, Nemeroff CB. The Relationship of depression to cardiovascular disease. *Arch Gen Psychiatry.* 1998; 55:580-59.

14. Lipman RD, Grossman P, Bridges SE *et al.,* Mental stress response, arterial stiffness and baroreflex sensitivity the healthy aging. *J Geronotol A: Biol Sci Med Sci.* 2002; 57:279-284.

15. Rozanski A, Blumenthal JA, Kaplan J. Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. *Circulation.* 1999; 99; 2192-2217.

CHAPTER 4:

ADDENDUMS

PATIENT HEALTH QUESTIONNAIRE (PHQ-9)

(Kroenke, Spitzer & Williams, 2001)

Instructions:

Please indicate how often over the last 2 weeks you have been bothered by any of the following problems by ticking the appropriate box.

		not at all	several days	more than half the days	nearly every day
1.	Little interest/pleasure in doing things	0	1	2	3
2.	Feeling down/depressed/hopeless.	0	1	2	3
	Trouble falling or staying asleep/ *OR* sleeping too much	0	1	2	3
4.	Feeling tired/ having little energy	0	1	2	3
5.	Poor appetite *OR* overeating	0	1	2	3
	Feeling bad about yourself *OR* that you are a failure/ that you have let yourself or your family down	0	1	2	3
	Trouble concentrating on things, such as reading the newspaper/ watching television	0	1	2	3
	Moving or speaking so slowly that other people could have noticed *OR* being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
	Thoughts that you would be better off dead/ of hurting yourself in some way	0	1	2	3
If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home or get along with other people?		**not difficult at all**	**somewhat difficult**	**very difficult**	**extremely difficult**
		☐	☐	☐	☐

GENERAL HEALTH QUESTIONNAIRE (GHQ)

(Goldberg & Hiller, 1979)

Instructions:

We would like to know if you have had any medical complaints, and how your health has been in general over the past few weeks. Please answer ALL the questions simply by ticking the answer which you think most nearly applies to you. Remember that we want to know about present and recent complaints, and not those that you had in the past. It is important that you try to answer ALL the questions. Thank you very much for your cooperation.

HAVE YOU RECENTLY

		1	2	3	4
A1	Been feeling perfectly well and in good health?	Better than usual	Same as usual	Worse than usual	Much worse than usual
A2	Been feeling in need of a good tonic?	Not at all	No more than usual	Rather more than usual	Much more than usual
A3	Been feeling run down and out of sorts?	Not at all	No more than usual	Rather more than usual	Much more than usual
A4	Felt that you are ill?	Not at all	No more than usual	Rather more than usual	Much more than usual
A5	Been getting pains in your head?	Not at all	No more than usual	Rather more than usual	Much more than usual
A6	Been getting a feeling of tightness or pressure in your head?	Not at all	No more than usual	Rather more than usual	Much more than usual
A7	Been having hot or cold spells?	Not at all	No more than usual	Rather more than usual	Much more than usual

B1	Lost much sleep over worry?	Not at all	No more than usual	Rather more than usual	Much more than usual
B2	Had difficulty in staying asleep?	Not at all	No more than usual	Rather more than usual	Much more than usual
B3	Felt constantly under strain?	Not at all	No more than usual	Rather more than usual	Much more than usual
B4	Been getting edgy and bad-tempered?	Not at all	No more than usual	Rather more than usual	Much more than usual
B5	Been getting scared or panicky for no good reason?	Not at all	No more than usual	Rather more than usual	Much more than usual

B6	Found everything getting on top of you?	Not at all	No more than usual	Rather more than usual	Much more than usual
B7	Been feeling nervous and strung-up all the time?	Not at all	No more than usual	Rather more than usual	Much less than usual

C1	Been managing to keep yourself busy and occupied?	More so than usual	Same as usual	Rather less than usual	Much less than usual
C2	Been taking longer over the things you do?	Quicker than usual	Same as usual	Longer than usual	Much more than usual
C3	Felt on the whole you were doing things well?	Better than usual	About the same	Less well than usual	Much less well
C4	Been satisfied with the way you've carried out your task?	More satisfied	About same as usual	Less satisfied than usual	Much less satisfied
C5	Felt that you are playing a useful part in things?	More so than usual	Same as usual	Less useful than usual	Much less useful
C6	Felt capable of making decisions about things?	More so than usual	Same as usual	Less so than usual	Much less capable
C7	Been able to enjoy your normal day-to-day activities?	More so than usual	Same as usual	Less so than usual	Much less than usual

D1	Been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
D2	Felt that life is entirely hopeless?	Not at all	No more than usual	Rather more than usual	Much more than usual
D3	Felt that life isn't worth living?	Not at all	No more than usual	Rather more than usual	Much more than usual
D4	Thought of the possibility that you might make away with yourself?	Definitely not	I don't think so	Has crossed my mind	Definitely has
D5	Found at times you couldn't do anything because your nerves were too bad?	Not at all	No more than usual	Rather more than usual	Much more than usual
D6	Found yourself wishing you were dead and away from it all?	Not at all	No more than usual	Rather more than usual	Much more than usual
D7	Found that the idea of taking your own life kept coming into your head?	Definitely not	I don't think so	Has crossed my mind	Definitely has