

CARDIOVASCULAR DYSFUNCTION AND SPECIFIC COPING MECHANISMS IN AFRICANS

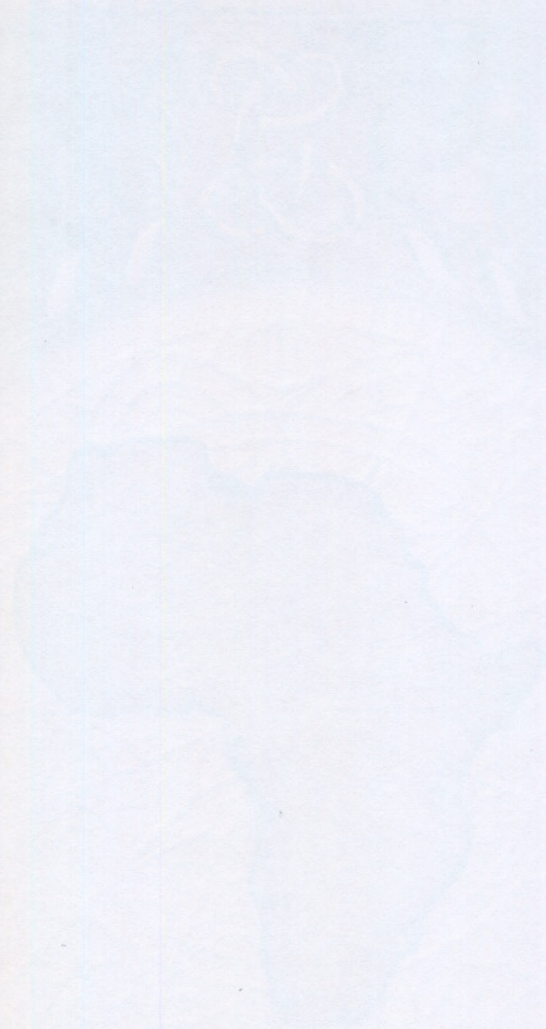
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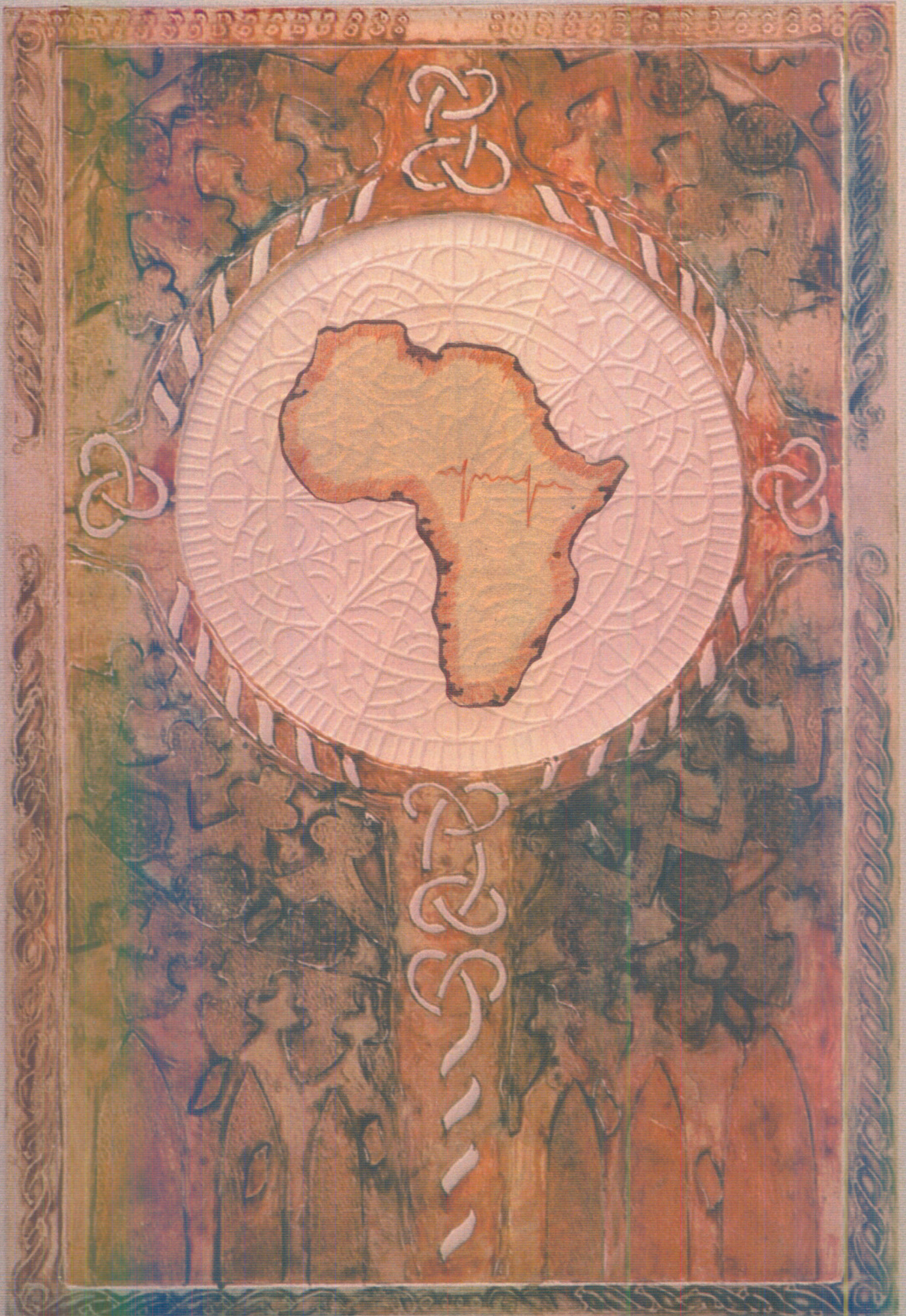
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Collagraph overleaf

The African circle of life: Interdependent group support ensures harmony and emotional health, but disintegrates during psychosocial stress or urbanisation. This manifests in specific coping mechanisms and enhanced vascular reactivity, resulting in increased morbidity and hypertension.



Cardiovascular dysfunction and specific coping mechanisms in Africans
- L. Malan

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LIST OF ABBREVIATIONS: All abbreviations are indicated and explained where they first appear in the text, whereafter only the abbreviation is used.

| | | |
|---------------------|---|--|
| ♂ | - | Men |
| ♀ | - | Women |
| $\Delta v/\Delta p$ | - | Changes in volume divided by changes in pressure |
| ≤ 40 | - | Under/or 40 years of age |
| ≥ 45 years | - | Over/or 45 years of age |
| $\mu\text{g/dl}$ | - | microgram per decilitre |
| AC | - | Active coping |
| ACE | - | Angiotensin-converting enzyme |
| α | - | Alpha |
| ANOVA | - | Analysis of variance |
| ANCOVA | - | Analysis of co-variance, adjusted for a variable |
| AS | - | Anxiety or sleeplessness |
| ANGI | - | Angiotensin I |
| ANGII | - | Angiotensin II |
| β | - | Beta |
| Ca^{2+} | - | Calcium ion |
| Ca^{2+}_i | - | Calcium intracellular |
| CI | - | Confidence intervals 95 % |
| CO | - | Cardiac output |
| Cort | - | Cortisol |
| CVR | - | Cardiovascular reactivity |
| Cw | - | Arterial compliance/Windkessel effect |
| DBP | - | Diastolic blood pressure |
| DS | - | Depression symptoms |
| e.g. | - | For example |
| F(df) | - | Degrees of freedom |
| Finapres | - | Finger arterial pressure apparatus |
| GHQ | - | General Health Questionnaire |
| GS-COPE | - | General adapted Setswana-Cope |
| HDL | - | High-density lipoprotein cholesterol |
| HPA | - | Hypothalamic-pituitary-adrenal |
| HT | - | Hypertension |
| i.e. | - | That is |
| IFG | - | Impaired fasting glucose |
| IGT | - | Impaired glucose tolerance |
| IR | - | Insulin resistance |

| | | |
|-----------------|---|---|
| ISH | - | International Society of Hypertension |
| LDL | - | Low-density lipoprotein cholesterol |
| Log | - | Logarithmically transformed |
| MS | - | Metabolic syndrome |
| mmol/l | - | milli molar per litre |
| mmHg | - | millimetre mercury |
| N | - | Number of subjects |
| Na ⁺ | - | Sodium ion |
| NS | - | Not significant |
| PAI-1 | - | Plasminogen activator inhibitor-1 |
| PC | - | Passive coping |
| Perc.correct | - | percentage correctly predicted |
| PRA | - | Plasma renin activity |
| PROL | - | Prolactin |
| PRU | - | Peripheral resistance unit |
| RAS | - | Renin-angiotensinogen system |
| SAM | - | Sympatho-adrenal-medullary system (SAM) |
| SBP | - | Systolic blood pressure |
| S-COPE | - | Adapted Setswana-translated COPE Questionnaire |
| SD | - | Social dysfunction |
| SE | - | Standard error |
| SNS | - | Sympathetic nervous system |
| SS | - | Somatic symptoms |
| SV | - | Stroke volume |
| Test | - | Testosterone |
| THUSA | - | Transition and Health during Urbanisation in South Africa |
| TG | - | Triglycerides |
| TPR | - | Total peripheral resistance |
| WHO | - | World Health Organisation |
| WHR | - | Waist-to-hip ratio |

**AFRIKAANSE TITEL : KARDIOVASKULÊRE DISFUNKSIE EN SPESIFIEKE
COPINGSTYLE IN AFRIKANE.**

Opsomming

Motivering: Kardiovaskulêre disfunksie en hipertensie is van die belangrikste oorsake van morbiditeit en mortaliteit in swart Afrikane. Volgens die Wêreldgesondheidsorganisasie neem hierdie siektetoestande in ontwikkelende lande vinnig toe. Ten spyte van die bydraende rol van genetiese invloede tot die voorkoms van hipertensie, is die bewyse van lewenstyl as merker van kardiovaskulêre siektes in hierdie groep nie bekend nie. Die interaksie van psigologiese en fisiologiese meganismes kan daarom 'n oorsigtelike bydrae lewer tot die gedragsfisiologie ten opsigte van die hoër voorkoms van hipertensie in swart Afrikane.

Doelstellings: Die hoofdoel van hierdie navorsing was om die rol van spesifieke coping-strategieë in swart Afrikane met betrekking tot kardiovaskulêre disfunksie te vergelyk.

Metodologie: Die manuskripte wat in Hoofstukke 3, 4, en 5 vervat is, het gebruik gemaak van die dwarsdeursnee vergelykende epidemiologiese "Transition and Health during Urbanisation in South Africa" projek (THUSA). Beskikbare swart Afrikane, mans en vroue, vanuit die Noordwesprovinsie van Suid-Afrika is ingesluit in hierdie studie. Antropometriese metings is geneem en demografiese vraelyste voltooi. 'n Aangepaste Setswana COPE-vraelys is gebruik om mans en vroue te klassifiseer as hoofsaaklik aktiewe (AC) of passiewe (PC) copers. Proefpersone is verder in landelike en verstedelike groepe (manuskrip twee), asook jonger (≤ 40) en ouer (≥ 45) groepe onderverdeel (manuskrip drie). In al drie manuskripte is die General Health Questionnaire (GHQ) gebruik om subjektiewe persepsie van gesondheid te meet. Die Finapres is gebruik om kontinue bloeddruk te meet voor en na die toediening van die handgreetoets. Proefpersone is as normotensief en hipertensief geklassifiseer op grond van bloeddrukmetings met die Finapres en die Riva-Rocci/Korotkoff-metode. Die klem in hierdie studie was op die kardiovaskulêre reaktiwiteitswaardes. Vastende, rustende serum renien-aktiwiteit, kortisol, prolaktien, testosteroon, hoë digtheid lipoproteïene, trigliseriedes, glukose en plasma fibrinogeenwaardes is gekorreleer met die kardiovaskulêre en psigologiese veranderlikes. Betekenisvolle verskille tussen veranderlikes is bepaal deur variansie-analises (manuskrip een en twee is gekorrigeer vir ouderdom; manuskrip een, twee en drie vir rustende bloeddrukwaardes). 'n Logistiese regressie-analise is gedoen om die mees betekenisvolle bepalers van verstedeliking te verkry. Al die THUSA proefpersone en ouers van adolessente proefpersone wat onmondig was, het ingeligte toestemming gegee. Die studie is goedgekeur deur die Etiekkomitee van die Potchefstroomse Universiteit vir Christelike Hoër Onderwys. Die leser word verwys na die afsonderlike opsommings wat aan die begin van elke manuskrip in

Hoofstukke 3, 4, en 5 voorkom vir die duidelike beskrywing van die proefpersone, studieontwerp en analitiese metodes wat gebruik is.

Resultate en gevolgtrekkings van die individuele manuskripte

- In manuskrip een het resultate van die THUSA-studie aangedui dat PC-mans en vroue meer simptome getoon het wat tipies van 'n abnormale psigologiese en fisiologiese profiel was as AC-mans en vroue. Die PC-mans, in vergelyking met die AC-mans, het 'n groter vaskulêre reaktiwiteit getoon asook groter plasma renienaktiwiteit. Teenstellend daarmee het die AC-vroue 'n groter nie-betekenisvolle vaskulêre reaktiwiteit as die PC-vroue getoon. Alle proefpersone het egter met verhoogde vaskulêre reaktiwiteit op die stressor gereageer. Mans met 'n PC-strategie het 'n versterkte vaskulêre reaktiwiteit, persepsie van swakker gesondheid en 'n groter plasma renienaktiwiteit getoon. PC-vroue het meer depressiewe simptome gerapporteer en jonger PC-vroue het 'n hoër voorkoms van hipertensie as jonger AC-vroue getoon.
 - Met 'n opvolgende studie van die eerste manuskrip was die doel hoofsaaklik daarop gestel om die omgewingseffek, naamlik verstedeliking, as moontlike verklaring vir die AC-vroue se atipiese fisiologiese AC-copingstyl te bied. Die landelike AC-proefpersone het 'n meer tipiese fisiologiese aktiewe copingstyl, naamlik 'n meer sentrale kardiaale reaksie, as die landelike PC-proefpersone getoon. Die verstedelike AC- en PC-proefpersone daarenteen het groter perifere reaksies en hipertensie voorkomswaardes getoon. Bykomend het die verstedelike AC-mans en vroue en PC-vroue meer simptome van distres getoon as die landelike proefpersone, met verhoogde waardes van prolaktien en laer waardes van testosteroon. Hierdie reaksies het ook gepaard gegaan met 'n eie persepsie van swakker gesondheid. Resultate van die tipiese fisiologiese AC-stimulasiepatroon van verstedelike proefpersone toon 'n dissosiasie van die "normale" fisiologiese AC-reaksiepatroon en is sterker in die AC-vroue. 'n Fisiologiese PC-reaksiepatroon word nou vertoon. Die groter vaskulêre reaktiwiteit, hipertensievoorkoms, persepsie van swak gesondheid en endokriene distresprofiel word geassosieer met 'n PC- en gedissosieerde AC-styl in verstedelike proefpersone. Tydens vergelyking van die verstedelike AC- versus PC-groepe is geen verskille in die rustende bloeddruk en endokriene waardes gevind nie. Met chroniese hoër stres, soos tydens verstedeliking, ontwikkel Afrikane kardiovaskulêre disfunksie/hipertensie wat dui op 'n dissosiasie/habituering van fisiologiese sisteme van Afrika-mans en -vroue. Dit gebeur ten spyte van aktiewe copingstrategieë (aktiewe coping is dus nie noodwendig "suksesvol" nie).
 - Resultate van die eerste twee manuskripte het die noodsaaklikheid van 'n verdere ondersoek vereis aangaande die invloed van ouderdom en verstedeliking op copingstyle, kardiovaskulêre disfunksie en metaboliese sindroomaanduiders tussen verskillende geslagte. Die tweede manuskrip het aangedui dat alle landelike AC proefpersone 'n meer
-

tipiese AC of sentrale kardiaale reaksie vertoon. Die landelike PC- en alle verstedelike proefpersone (AC en PC) reageer met versterkte perifere vaskulêre reaksies op die handgreetoets. Waar die perifere vaskulêre reaksies eerder by ouer proefpersone verwag is, is die voorkoms van hierdie reaksies beklemtoon in die jonger proefpersone in manuskrip drie. Die hoër vlakke van fibrinogeen in jong verstedelike vroue (AC en PC) in vergelyking met jong landelike vroue versterk verder die risiko van 'n kardiovaskulêre siektetoestand. 'n Verhoogde vaskulêre reaktiwiteit, abdominale obesiteit, verhoogde vlakke van trigliseriede asook 'n persepsie van swakker gesondheid is teenwoordig in die verstedelike jong AC-vroue, PC-mans en PC-vroue ten opsigte van dieselfde landelike groepe. Die tipiese fisiologiese stimulasiepatroon van die AC-strategie blyk gedissosieer te wees van die tipiese "normale" fisiologiese AC-stimulasiepatroon. 'n Tipiese fisiologiese PC-stimulasiepatroon word nou deur hierdie proefpersone geopenbaar. Ouer verstedelike proefpersone met 'n tipiese PC-strategie blyk wel 'n hoër voorkoms van hipertensie te hê.

Samevattend blyk dit dat jong verstedelike Afrikane, en veral vroue, 'n AC-gedragstyl met 'n gedissosieerde fisiologiese AC-stimulasiepatroon vertoon. Dit stem ooreen met 'n tipiese fisiologiese PC-kardiovaskulêre en endokriene profiel. Hierdie tipiese PC-kardiovaskulêre stimulasie patroon word versterk deur die endokriene distresprofiel, betekenisvolle metaboliese sindroomaanduiders en persepsie van swakker gesondheid. Die hipertensievoorkoms was hoër in ouer PC-styl individue. In hierdie studie blyk dit dat kardiovaskulêre veranderinge wat op 'n jonger ouderdom plaasvind moontlik beïnvloed kan word deur faktore soos verstedeliking as lewenstylfaktor asook spesifieke copingstyle. Ter afsluiting kan die voorstel gemaak word dat spesifieke copingstyle of -strategieë as 'n moontlike risikomerker gesien kan word in die ontwikkeling van die metaboliese sindroom.

Sleutelwoorde: *Afrikane, coping, vaskulêre reaktiwiteit, verstedeliking, endokriene, ouderdom, metaboliese sindroom.*

**TITLE : CARDIOVASCULAR DYSFUNCTION AND SPECIFIC COPING MECHANISMS
 IN AFRICANS.**

SUMMARY

Motivation: Cardiovascular dysfunction and hypertension are some of the leading causes of morbidity and mortality in the African population. According to the World Health Organisation the increases in these diseases are escalating in developing countries. Apart from the contributory role of genetics towards the incidence of hypertension, evidence regarding lifestyle as a determinant or marker of cardiovascular diseases in this group is not well known. The interaction of psychological and physiological mechanisms can contribute towards a broader scope of behavioural physiology in the higher prevalence of hypertension in Africans.

Objectives: The main objective of the research in this thesis was to compare specific coping mechanisms of Africans with regard to cardiovascular dysfunction.

Methodology: Manuscripts presented in Chapters 3, 4, and 5 made use of the cross-sectional comparative epidemiological "Transition and Health during Urbanisation in South Africa" (THUSA) project. The subjects included apparently healthy African men and women, which were recruited as a convenience sample from the North West Province, South Africa. Anthropometric measurements were taken and demographic questionnaires completed. An adapted Setswana COPE questionnaire was used to classify men and women as predominantly active (AC) or passive (PC) in coping style. Subjects were further subdivided into rural and urban groups (Manuscript Two), as well as younger (≤ 40) and older (≥ 45) age groups (Manuscript Three). The General Health Questionnaire (GHQ) was used to measure subjective perception of health in all three manuscripts. Blood pressure was recorded continuously before and during application of the handgrip test using the Finapres apparatus. Subjects were classified as normotensive and hypertensive after blood pressure measurement by the Finapres and the Riva-Rocci/Korotkoff method. The emphasis in this study was on the cardiovascular reactivity values. Fasting, resting serum renin activity, cortisol, prolactin, testosterone, high density lipoprotein, triglycerides, glucose and plasma fibrinogen values were correlated with cardiovascular and psychological variables. Significant differences between variables were determined by means of variance analyses (Manuscript One and Two adjusted for age; Manuscripts One, Two and Three adjusted for resting cardiovascular data). A logistic regression analysis was performed to determine the most significant determinants of urbanisation. All THUSA subjects and parents of under-aged adolescents gave informed consent and the study was approved by the Ethics Committee of the Potchefstroom University for Christian Higher Education. The reader is referred to the abstracts at the beginning of each separate manuscript

in Chapters 3 – 5 for a description of the subjects, study design and analytical methods used in each paper.

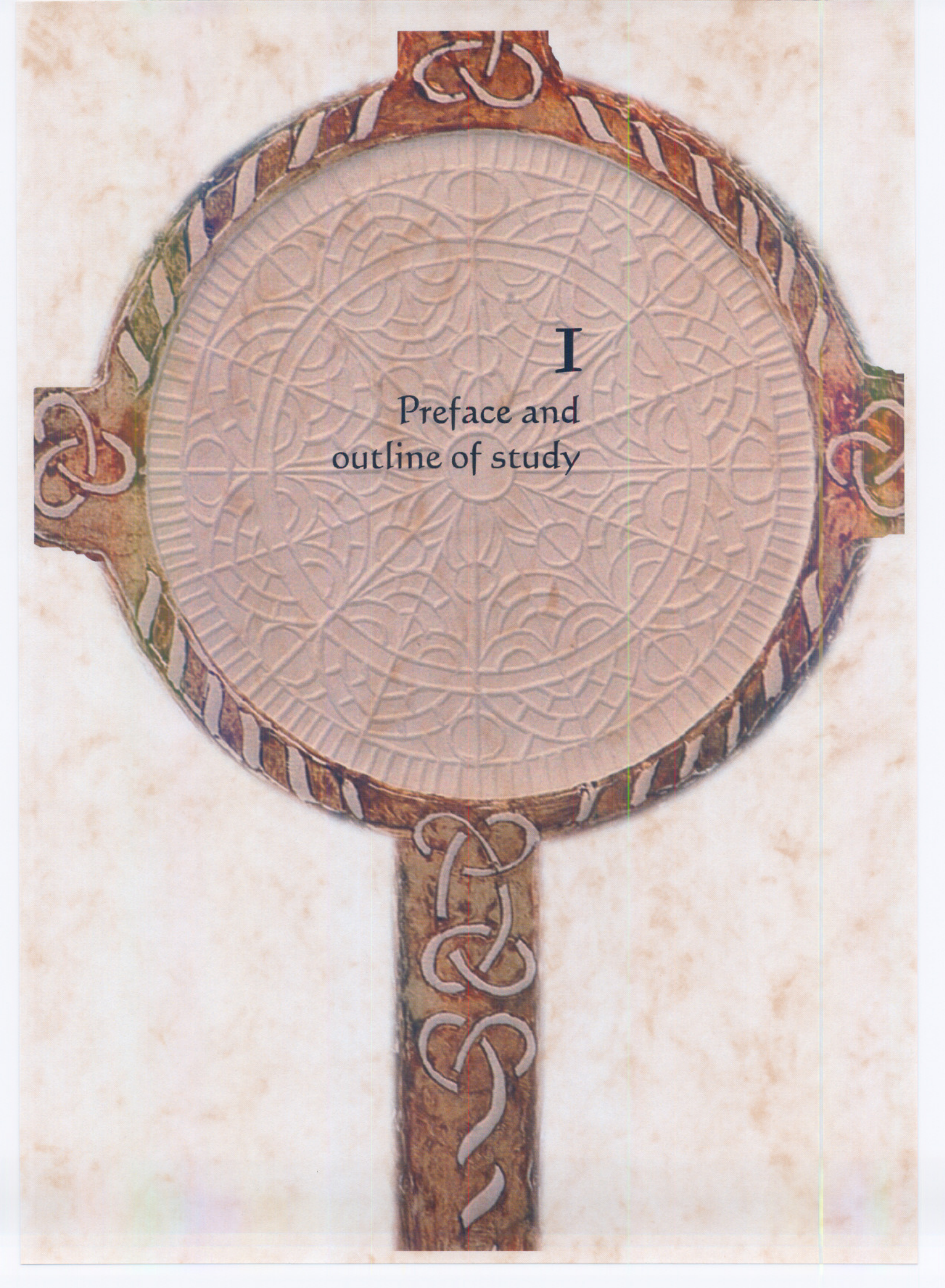
Results and conclusions of the individual manuscripts

- Results from the THUSA study showed that PC men and women reported more symptoms typical of an abnormal psychological and physiological profile than AC men and women. The PC men, compared to AC men, exhibited a larger vascular reactivity response as well as larger plasma renin activity. In contrast, the AC women showed a larger non-significant vascular reactivity response than PC women. All subjects though reacted with increased vascular reactivity on the stressor. Men with a PC strategy showed enhanced vascular reactivity, a perception of poorer health and larger stressor plasma renin activity. PC women reported more depressive symptoms and younger PC women indicated a higher prevalence of hypertension than younger AC women.
 - As a follow-up on the first manuscript, the aim was focused mainly on including the environmental effect, namely urbanisation, as possible explanatory factor for the atypical physiological AC womens' coping style. The rural AC subjects indicated more typical active coping central cardiac responses than rural PC subjects whereas urbanised AC and PC subjects indicated greater peripheral responses and hypertension prevalence rates. In addition, the urbanised AC men and women and PC women as opposed to their rural counterparts indicated symptoms more of a distress situation with increased values of prolactin and decreased values of testosterone. This was also accompanied by a perception of poorer health in women. Results of the AC style suggests that the typical physiological AC stimulation pattern of urbanised subjects and especially the women is dissociated from the "normal" physiological AC reaction and is now exhibited as a typical PC physiological stimulation pattern. The greater vascular reactivity, hypertension prevalence, perception of poorer health and endocrine distressed profile are associated with a PC and dissociated physiological AC style in an urban context in African men and women. No differences with regard to resting blood pressure or endocrine values were obtained when the AC and PC urbanised groups were compared. Africans develop cardiovascular dysfunction/hypertension during chronic stress or urbanisation. This implies a dissociation/habituation of physiological systems of African men and women despite having an active coping strategy. Active coping is, therefore, not necessarily "successful".
 - Results of the first two manuscripts direct further investigation concerning the effects of ageing and urbanisation on the development of cardiovascular dysfunction and metabolic syndrome indicators in gender groups. The second manuscript showed that all rural AC subjects exhibit a more typical active coping central cardiac response and that rural PC and all urbanised subjects (AC and PC) exhibit enhanced peripheral vascular responses on the handgrip test. Where peripheral vascular responses were more expected from older
-

individuals in Manuscript Three, the occurrence of this pattern is strengthened in the younger subjects. The greater fibrinogen values in all younger urbanised women (AC and PC) compared to rural women further strengthen the risk for the development of cardiovascular disease. Increased vascular reactivity, abdominal obesity and increased levels of triglycerides as well as perception of poorer health were apparent in the urbanised AC women, PC men and women in comparison to their rural counterparts. The typical physiological AC stimulation pattern of urbanised women is dissociated from the "normal" physiological AC responses and is now exhibited as a typical PC physiological stimulation pattern. A typical PC style in older urbanised subjects is implicated in the greater hypertension prevalence.

To conclude, it seems as if young urbanised Africans, and especially women, exhibit an AC style behaviourally with a dissociated physiological AC reaction pattern. Physiologically these women resemble a typical PC physiological cardiovascular and endocrine profile. This typical PC cardiovascular stimulation pattern is strengthened by a distressed endocrine profile, significant metabolic syndrome indicators and a perception of poorer health. Older PC style subjects also presented a greater hypertension prevalence. In this study it seems that cardiovascular changes that appear at a younger age might be influenced by other factors including urbanisation as a lifestyle factor as well as specific coping styles. Finally, a careful suggestion is made that specific coping mechanisms could be seen as a possible risk marker in the development of the metabolic syndrome.

Key words: *Africans, coping, vascular reactivity, urbanisation, endocrine, ageing, metabolic syndrome.*



I
Preface and
outline of study

1.1 PREFACE

This thesis consists of three manuscripts submitted for publication. Chapters 3, 4 and 5 were submitted for publication in peer reviewed journals*. Although the appropriate and relevant literature backgrounds are discussed in each separate manuscript, Chapter 2 gives a broad literature survey of relevant cardiovascular parameters and involved factors in cardiovascular and psychological research of Africans. The interaction of the nervous, metabolic and endocrine systems with coping mechanisms is also discussed. The relevant references are provided at the end of each manuscript according to the authors' instructions of the specific journal in which the manuscripts were submitted for publication. The relevant references used in the unpublished Chapters 2 and 6 are provided according to the mandatory style stipulated by the North-West University, Potchefstroom Campus, Potchefstroom, South Africa. The technical style used in Chapters 2 and 6 is, therefore, uniform but differs in the other chapters according to the authors' instructions of the specific journals.

*

- Manuscript 1 (Chapter 3): Submitted to the *International Journal of Psychophysiology* (2004);
- Manuscript 2 (Chapter 4): Submitted to *Biological Psychology Journal* (2005);
- Manuscript 3 (Chapter 5): Submitted to the *Journal of Hypertension* (2005).

1.2 OUTLINE OF STUDY

In Table 1.1 the outline of the study/thesis is given as well as a brief description of the content of the different chapters.

Table 1.1: Outline of study.

| SPECIFIC CHAPTER | CONTENT OF CHAPTERS |
|---------------------|--|
| 1. Chapter 1 | Preface and outline of study. |
| 2. Chapter 2 | Introduction, literature overview, questions arising from the literature and planned structure of thesis, motivation, aims and hypotheses. |
| 3. Chapter 3 | Manuscript 1: Coping mechanisms, perception of health and cardiovascular function in Africans. |
| 4. Chapter 4 | Manuscript 2: Specific coping strategies of Africans during urbanization: comparing cardiovascular, endocrine and perception of health data. |
| 5. Chapter 5 | Manuscript 3: Specific coping mechanisms, perception of health, vascular reactivity and metabolic syndrome indicators in Africans during urbanisation: The THUSA study. |
| 6. Chapter 6 | General summary, discussion, conclusions and recommendations. |

1.3 AUTHORS' CONTRIBUTIONS


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

Table 1.2: Authors' contribution list.

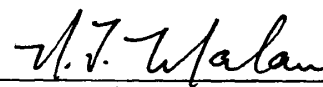
| <u>Name</u> | <u>Role in the study</u> |
|--|--|
| Mrs. L. Malan (M.Sc.) (Physiologist) | Responsible for literature searches, statistical analyses, collection of data, design and planning of manuscripts, interpretation of results and writing of all manuscripts. |
| Dr. A.E. Schutte (Ph.D.) (Physiologist) | Promoter. Supervised the writing of the manuscripts, initial planning and design of manuscripts. |
| Prof. N.T. Malan (D.Sc.) (Physiologist) | Co-promoter. Supervised the writing of the manuscripts, collection of data, initial planning and design of manuscripts. |
| Prof. M.P. Wissing (D.Phil.) (Psychologist) | Co-promoter. Supervised the writing of the manuscripts, collection of data, initial planning and design of manuscripts. |
| Prof. H.H. Vorster (D.Sc.) (Dietician and Physiologist) | Co-promoter. Supervised the writing of the manuscripts and collection of data. |
| Prof. H.S. Steyn (Ph.D.) (Statistician) | Responsible for statistical advice and design of Manuscripts One and Two. |
| Prof. J.M. van Rooyen (D.Sc.) (Physiologist) | Supervised the writing of the manuscripts and collection of data. |
| Dr. H.W. Huisman (Ph.D.) (Physiologist) | Supervised the writing of the manuscripts and collection of data. |

The following is a statement from the co-authors confirming their individual role in each study and giving their permission that the three manuscripts may form part of this thesis.

I declare that I have approved the above-mentioned manuscripts, that my role in the study, as indicated above, is representative of my actual contribution and that I hereby give my consent that they may be published as part of the Ph.D. thesis of Leoné Malan.



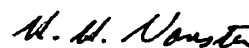
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2

Introduction and Literature Overview

INTRODUCTION

An alarming and rapid development of cardiovascular disease is now occurring in developing countries such as South Africa (WHO, 2003). The World Health Organisation (WHO) found little direct evidence of risk factors of common cardiovascular diseases in populations south of the Sahara (WHO, 2003). The psychosocial variable that is usually associated with an elevated risk for essential hypertension in African Americans is the lifestyle in high socio-ecological stress areas (Somova *et al.*, 1995; Din-Dzietham *et al.*, 2004). Africans living in South Africa (Van Rooyen *et al.*, 2002) and Zimbabwe (Somova *et al.*, 1995) in urbanised areas that are characterized by extremely high levels of crime, few job opportunities, low income, high social instability and low social support present abnormal blood pressure changes. Increases in systolic (22.8%) and diastolic (20.7%) blood pressure values above 140/90 mmHg were found under these circumstances (Van Rooyen *et al.*, 2002). Social support, which is an important factor in a traditional collectivistic environment such as the lifestyle of Africans, is implicated in this process as a moderator of stress reactivity (Dressler *et al.*, 1993).

The environment, previous experiences and perceptions influence the behavioural reactions as well as the person's perception of the stressor as a challenge or threat (Herd, 1991). Hypertension and degenerative effects in reaction to psychosocial stress seems to be a function of sympathetic stimulation and the secretion of neurohormones in the circulation (Gerra *et al.*, 2001; Heim *et al.*, 2000; Henry *et al.*, 1986; Herd, 1991). The behavioural reactions to a psychological stressor include somatomotor, neuroendocrine and cardiovascular components. Somatomotor reactions involve the active or passive handling of a stressor that poses a threat or challenge while the neuroendocrine reactions involve a combination of hypothalamic-pituitary-adrenal (HPA) axis and hypothalamic sympathetic-adrenal-medullary (SAM) secretions (Gerra *et al.*, 2001; Herd, 1991).

In most common cardiovascular diseases in Caucasians, factors like alcohol, smoking, physical inactivity, dietary saturated fat and low density lipoprotein particle size are strong confounders (WHO, 2003). In African Americans and Africans other supporting confounding factors are prevalent namely, low plasma renin activity and sodium pressor sensitivity responses (Fray, 1993; Opie, 2004). In addition, these individuals normally and when exposed to stressful situations, exhibit exaggerated cardiovascular reactivity and especially peripheral resistance responses compared to Caucasians. They are, therefore, at greater risk for the development of hypertension (Anderson & Mc Neilly, 1993; Hinderliter *et al.*, 2004; Obrist, 1981; Suarez *et al.*, 2004; Van Rooyen *et al.*, 2000).

Research by Anderson & Mc Neilly (1993) indicates that African Americans with hypertension also show another pattern of bio-psychological dynamics when compared to Caucasians,

namely “John Henryism”. Up to date, though, lifestyle and/or psychological aspects as confounding factors for hypertension, namely coping mechanisms in African Americans and Africans, have not been included in the WHO guidelines for hypertension (WHO, 2003). Although psychological factors are not recognized as a possible risk factor for hypertension, there is strong empirical support for the role of coping mechanisms in the development of essential hypertension (Olatunbosun *et al.*, 2000; Suzuki *et al.*, 2003). The negative influence of stress on physical health depends largely on the individual’s ability to cope or handle stress (Rosmond, 2005). Sustained stress or tension, anxiety and a passive mood of psychodefense could induce hypertension (Zhao, 1991). Obesity, especially abdominal obesity as a result of increased cortisol secretions and poor coping mechanisms, could also contribute to the prevalence of hypertension (Björntorp, 2001).

There is a lack of research regarding the role of psychological factors or coping behaviour and the status of cardiovascular dysfunction, especially in African Americans and Africans. The cardiovascular reactivity differences between gender groups as well as the effect of age could alter the manifestation of cardiovascular dysfunction in Africans. The role of coping mechanisms and the cardiovascular and endocrine profiles, subjective perception of health or well-being and metabolic syndrome indicators will form part of this research (Björntorp, 2001; Heim *et al.*, 2002; Hellhammer and Wade, 1993; Rosmond, 2005; WHO, 2003).

2. CARDIOVASCULAR DYSFUNCTION AND SPECIFIC COPING MECHANISMS IN AFRICANS

The general aim of this study was to determine whether African men and women with specific coping mechanisms differ in their responses with regard to cardiovascular dysfunction. In this an overview of the literature will be presented to obtain a broader overview about the coping behaviour of Africans and how it is linked to cardiovascular functioning.

The main clusters of coping strategies that will be distinguished are active coping (AC) and passive coping (PC). The manuscripts in this thesis will focus mainly on the following cardiovascular parameters: *systolic blood pressure (SBP)*; *diastolic blood pressure (DBP)*; *stroke volume (SV)*; *cardiac output (CO)*; *total peripheral resistance (TPR)* and *arterial compliance/Windkessel effect (Cw)*. Specific aspects pertaining to the assessment of blood pressure reactivity values in African Americans and/or Africans and the interaction of coping, perception of health as well as stress on the cardiovascular system, will be discussed. The influence of psychosocial stress or urbanisation on coping and the detrimental effects thereof on Africans’ health will also be included in the literature overview.

2.1 Coping and coping strategies

❖ Coping

Coping is defined as the most inclusive process wherein the impact of a stressor is handled (Zeidner & Zaklofske, 1996). Coping is not reflexive or automatic, but the third step in the stress response after primary and secondary appraisals of the stressor. During primary appraisal the person takes notice of the stressor and estimates the extent of threat according to previous experiences. Secondary appraisal refers to the evaluation of own capacity to handle the stress. Then a plan or action is set in action to handle or cope with the appraised threat effectively. The whole coping process (from primary appraisal to implementing a coping strategy) is influenced by the person's confidence that the goals will be reached (Zeidner & Zaklofske, 1996).

Zeidner and Zaklofske (1996) see coping as an active and conscious process which is interacting with factors like personality and previous experiences of stress management. Factors that influence a person's coping ability are personality (Denollet, 1998), reality perspective, skills, locus of control and cognitive styles (Lazarus, 1993). If the individual experiences that the demands are more than the resources he/she possesses, the demands will be threatening to the psychological, physical and sociological equilibrium of the individual. According to Lazarus (1993), coping has two functions:

- ❑ to manage problems that cause discomfort (problem-focused); and
- ❑ to control the emotions that develop (emotion-focused).

Coping can, therefore, be defined as a complex dynamic and active process that consists of cognitive, behavioural, intrapsychological and biological processes. Its aim is to eliminate, reduce or control the internal and external demands of the individual-environment interaction (Aldwin, 1994; Lazarus, 1993).

❖ Coping strategies

Lazarus (1993) defined coping strategies as specific behavioural responses that follow when an individual is exposed to a stressor and tries to cope with the impact of the stressor. It is, like coping, independent of the effectiveness of the outcome.

Lazarus (1991) and Carver *et al.* (1989) conceptualize that experiencing stress is a transactional or interactional process between the individual and the situation. The individual's appraisal or perception of the situation has a greater influence on the choice of coping strategy than the objective nature of the stressor.

Cross-cultural differences in coping are related to perspectives on the self in a western context. The self forms the basis of what the individual thinks, feels and does (Chang, 1996). This implies the relative importance of the individual-self versus social-self (Carver *et al.*, (1989). The self-construct, as social construct, is a cultural construct that shows cross-cultural variance. In collectivistic groups, the self is defined as part of the inner group. Independency in collectivistic groups (in Africans) means that the individual does not want to be a burden to his/her inner group (Van der Wateren, 1997). Independency in individualistic cultures (in Caucasians) indicates a need in the individual to do his/her own thing (Triandis *et al.*, 1990).

Carver and co-workers (1989) developed the COPE questionnaire and based their model of coping strategies on the functions of coping (Lazarus 1993). According to Carver and co-workers (1989), from a psychological point of view, distinction can be made between three coping strategies:

- (a) *problem-focused;*
- (b) *emotion-focused; and*
- (c) *less useful-coping strategy.*

- (a) *A problem-focused coping strategy is a cognitive, conscious process where action is planned or aimed to solve the problem.*
- (b) *An emotion-focused coping strategy is a process that aims to lessen or remove the effect of emotional discomfort that develops during experiencing the problem.*
- (c) *A less useful-coping strategy is typical where no attempt is made to solve the problem.*

The COPE Questionnaire was adapted culture sensitively, translated into Setswana and validated for Setswana speaking groups (S-COPE) by Stapelberg (1999). The S-COPE manifested good reliability and validity for Setswana speaking subjects (Africans) in the North West Province (Stapelberg, 1999). Stapelberg (1999) extracted an emic factor pattern from the original COPE through exploratory factor analysis (principal factors - maximum likelihood method of factor extraction with varimax rotation), indicating three clear and reliable factors with loadings >0.30 and eigenvalues > than 1. The extracted factors formed the subscales of the S-COPE and included: (1) Active outreach-to-others, (2) Surrender and resignation, and (3) Overt expression of distress. A brief description of the subscales includes:

Subscale 1: Active outreach to others (consisting of 26 items)

Active planning of actions and a focusing of energy and resources to solve problems characterize this factor. By reaching out to people or religion (including ancestors) for help or support, individuals trust the social system and/or religion and can use this as a supporting coping strategy.

A resistance to stress can be increased by an integration of active coping (AC) and a positive use of social resources. In Africans, turning towards religion was noted as an important factor in stress coping. Furthermore, males tend to use planning, whilst females use social support for emotional reasons (Stapelberg, 1999). Collectivism is a well-known values system in ethnic groups. Affiliation and interdependency are accentuated in African groups for they are fundamentally bound and socialised to seek help from the elders, leaders and ancestors (Bodibe, 1992).

Subscale 2: Surrendering and submissiveness (consisting of 11 items)

Behavioural and mental submissiveness go hand in hand with denial and acceptance. The most prominent behaviour in this subscale includes denial, submissiveness, withdrawal, surrendering and acceptance.

Although this subscale is related to universal coping strategies, the specific structure of this subscale in the African group can also reflect an endemic life perspective, where problems can be seen as part of life and must be accepted as a sign of God's/ancestors' will (Aldwin, 1994).

Subscale 3: Overt expression of distress (consisting of 6 items)

This subscale reflects an openly overt expression of feelings of distress, anxiety and uneasiness together with an acceptance that nothing can be done to solve the problem.

In the African context the public expression of grief or sorrow in a stereotyped manner is allowable, but is also sometimes expected of the individual (Aldwin, 1994).

Although Carver and co-workers (1989) indicated three coping strategies, the *digitome classification* of coping is mostly preferred by researchers and, therefore, from a physiological point of view a choice of the following two coping strategies were made, namely *active and passive coping strategies* (García-León *et al.*, 2003; Henry *et al.*, 1986; Hodapp *et al.*, 1992; Lorenzi, 2003; Penley & Tomaka, 2002; Saab *et al.*, 1997; Tomaka *et al.*, 1999).

The first subscale (active outreach to others) was taken to indicate active coping (approach strategy with strong emphasis on engagement in active coping, actively seeking social support, commitment to tasks and controllability) (*Cronbach alpha-reliability* = 0.85). The active coping subscale included items such as "I talk to someone who could do something helpful about the problem", "I take direct action to deal with the problem" and "I try to find comfort in my religion".

For the purpose of this study, the second and third factors (surrendering, submissiveness and overt expression of distress) were combined to form a measure of passive coping (avoidance

strategy with strong emphasis on appraisals of threat or uncontrollability, engagement in avoidant coping and distress (*Cronbach alfa-reliability* = 0.75). The passive coping subscale included items such as “I reduce the amount of effort I am putting into solving the problem”, “I just give up trying to reach my goal”, and “I become upset and am very aware of my feelings”.

The active and passive coping styles are discussed in depth respectively in Par. 2.2.5.1 and 2.2.6.1.

2.2 Cardiovascular risk factors

The risk stratification table from the World Health Organisation (WHO)/International Society of Hypertension (ISH) Guidelines (Brookes, 2003) indicate three major risk categories with progressively increasing likelihood of developing a major cardiovascular event (fatal and nonfatal stroke and myocardial infarction) within the next ten years (WHO, 2003). According to the USA and European Guidelines from 2003, prehypertension levels (SBP = 120-139 mmHg; DBP = 80-89 mmHg) are introduced. This signals the need for increased education of health care professionals and the public to reduce blood pressure and the development of hypertension in the general population (Brookes, 2003). In Table 2.1 the stratification risk figures are given and it enables a rapid preliminary assessment of cardiovascular risk.

The risk factors included are:

- ❖ *levels of systolic and diastolic blood pressure (grades 1-3);*
- ❖ *age (males > 55 years, females > 65 years);*
- ❖ *smoking;*
- ❖ *low density lipoprotein and high density lipoprotein cholesterol;*
- ❖ *total cholesterol;*
- ❖ *history of cardiovascular disease in first degree relatives before the age of 50; and*
- ❖ *obesity / physical inactivity (WHO, 2003).*

Other factors, which are more of a psycho-socio-physiological nature but still play an important role in the development of cardiovascular dysfunction or/and hypertension, are the psychological and socio-ecological factors (Fray, 1993). These include **personality** (Denollet, 1998), **mood state** (Gendolla & Krüsken, 2001; Krantz *et al.*, 1999; Light *et al.*, 1998); **social support** (Penninx *et al.*, 1998); **lifestyle** (Malan *et al.*, 1996; Opie, 2004; WHO, 2003) and especially **coping behaviour** (Gerin *et al.*, 2000; Gramer, 2003; Penley & Tomaka, 2002; Obrist, 1981).

Table 2.1: Stratification of risk to quantify prognosis of cardiovascular risk (WHO, 2003).

| Other risk factors and disease history | | Blood pressure (mmHg) | | |
|--|--|---|--|--|
| | | Grade I (SBP, 140-159 or DBP, 90-99) | Grade II (SBP, 160-179 or DBP, 100-109) | Grade III (SBP, ≥ 180 or DBP, ≥ 110) |
| I | No other risk factors | Low risk | Medium risk | High risk |
| II | 1-2 risk factors | Medium risk | Medium risk | High risk |
| III | 3 or more risk factors, or TOD, or ACC | High risk | High risk | High risk |

SBP, systolic blood pressure; DBP, diastolic blood pressure; TOD, target-organ damage; ACC, associated clinical conditions; Low risk, < 15%; Medium risk, 15-20%; High risk, > 20%.

2.2.1 Race and gender as risk factors in the development of cardiovascular dysfunction

The ethnic group in this study consisted of Setswana speaking black people of the North West Province in South Africa. Hereafter, they will be referred to as Africans. Much is known about African Americans regarding cardiovascular reactivity and psychological characteristics. However, literature on Africans about the status of coping mechanisms with regard to cardiovascular function and metabolic syndrome is lacking.

□ Race

African Americans as well as Africans exhibit greater cardiovascular reactivity when exposed to stress than Caucasians with some degree of frequency (Fray, 1993; Opie, 2004). Ethnicity is, therefore, powerfully related to the risk of most common cardiovascular diseases, especially stroke in African Americans (Whelton *et al.*, 2003; WHO, 2003). Cultural, social, psychological and genetic characteristics must be taken into account to obtain a better background for understanding the genesis of cardiovascular dysfunction in Africans when they are exposed to stress.

❖ Cultural characteristics

A strong spiritual orientation, deep sense of kinship and identification with the "tribe" and large group (collectivistic values), rather than a strictly individualistic orientation is characteristic of Africans (Bodibe, 1992; Van der Wateren, 1997). Conflict between the individual and the group/parents is managed through communication. Their most important coping strategy is to consult each other. Africans also tend to have a flexible concept of time and unashamed use of emotional expressiveness (Anderson, 1989; Ikuendbe, 1998). These factors cannot, therefore,

be ignored when validating or using any questionnaires in research on Africans (Stapelberg, 1999).

❖ **Social characteristics**

Social support is necessary to gain emotional support (Anderson & McNeilly, 1993; Dressler, 1993; Lepore, 1995; Penninx *et al.*, 1998). The individual who feels that he/she does not experience social support is in a continuous state of hypervigilant coping (Penninx *et al.*, 1998) and a state of enhanced sympathetic and cardiovascular reactivity can be exhibited (Light *et al.*, 1998). People who have collectivistic values and do not conform to the group's decision, very often experience inner aggression, solitude and helplessness (Uchino & Garvey, 1997).

❖ **Psychological characteristics**

African Americans and Africans who cope with life demands with increasing effort and determination ("John Henryism") also run additional cardiovascular risks (Collins & Winkleby, 2002; Fray, 1993; Manuck *et al.*, 1993). In this coping process they compensate for limited resources. John Henry was an African American characterizing a strong personality predisposition to cope fully and actively with psychosocial stressors in their environment. This appears to be happening with few resources for successful coping e.g., low socio-economic status and/or urbanisation. Individuals with this typical "John Henryism" coping profile are at greater risk for hypertension than their counterparts without this predisposition or those similarly disposed with requisite resources (James *et al.*, 1992).

❖ **Genetic characteristics**

Genetic factors/characteristics contributing to vascular dysfunction/hypertrophy in African Americans and Africans are:

- (a) An increased level of salt sensitivity (Mufunda *et al.*, 1994; Wright *et al.*, 2003). Up-regulated renal epithelium sodium channel activity with increased renal sodium reabsorption may explain the increased prevalence of hypertension in African Americans and Africans (Harsfield *et al.*, 2004; Opie *et al.*, 2004).
- (b) Low levels of plasma renin activity (PRA) and renin hyporeactivity (Opie, 2004). The PRA preserves end-organ perfusion by regulating extracellular fluid volume, sodium and water balance and cardiovascular activity (Brewster & Perazella, 2004). Renin is an enzyme whose synthesis is influenced by the hydrostatic pressure sensed at the glomerular afferent arterioles, angiotensin II levels and the quantity of sodium delivered to the macula densa. Renin acts to cleave angiotensinogen synthesized by the liver, forming angiotensin I (ANGI). Angiotensin-converting enzyme then converts ANGI to angiotensin II (ANGII). ANGI is a potent vasoconstrictor molecule that stimulates the

secretion of aldosterone, vasopressin as well as salt and water retention (Guyton & Hall, 2000).

The activation of ANGI receptors could contribute to hypertension through enhanced sodium retention. Blockade of the receptors should increase the compliance of large arteries (Middlemost, 1999) and reduce endothelial dysfunction, oxidative stress and inflammatory markers in the progression of vascular disease (Schiffrin, 2002). ANGII enhances blood pressure responses to sympathetic stimulation and has an indirect permissive adrenergic effect by stimulating the sympathetic nervous system at several levels, such as the brain stem, autonomic ganglia, presynaptic ANGII receptors and the endothelium. In the early phase of hypertension, which is often characterized by features suggestive of enhanced adrenergic activity, tachycardia and an increased cardiac output are present. In time there is a transition from a high cardiac output to an increased total peripheral resistance (TPR). The result could be a heightened α -adrenergic-induced peripheral arteriolar vasoconstriction, whereas β_2 vasodilatation is unchanged or downregulated (Opie, 2004).

In relation to Caucasians, Africans (Opie 2004) and African Americans normally and in a hypertensive state tend to have lower plasma prorenin and renin levels (Anderson, 1988; Opie 2004). Renin hyporeactivity and subsequently low renin hypertension is particularly apparent in older subjects and women of African American descent (Anderson, 1989; Dysart *et al.*, 1994; Holland *et al.*, 1993). The mechanism for this type of hypertension in ethnic groups is that renin hypo-activity could also be connected to suboptimal dietary intake of Ca^{2+} that suppresses Ca^{2+} -ATPase mediated Ca^{2+} efflux from the juxtaglomerular cells. This will result in increases in intracellular calcium (Ca^{2+}_i) and thus vascular resistance (Cooper & Borke, 1993; Seedat, 1999; Wright *et al.*, 2003).

Salt-loading experiments lead to increased tubular reabsorption of sodium, with inhibition of renin release, less formation of ANGII and less constriction of the efferent renal arterioles. In low renin groups, this compensatory mechanism is impaired (Guyton & Hall, 2000; Opie, 2004). The action of ANGII on intrarenal hemodynamics is critical to the blood pressure raising effect and could explain the hypoactivity hypertensive status in African Americans (Brewster & Perazella, 2004; Schiffrin, 2003; WHO, 2003).

Renin status is also associated with sympathetic nervous system activity (Esler *et al.*, 2001). During exposure to stress a psychosocial stress response may be triggered that stimulates the release of vasoconstrictor molecules that increases Ca^{2+}_i (calcium intracellular). This will result in higher active tension in vascular smooth muscle and total

peripheral resistance (Fray, 1993). Subjects with low levels of PRA tend to have enhanced adrenocortical responsiveness to ANGI and this may also explain both their low PRA and high blood pressure (Fray, 1993). Esler and co-workers (2001), however, postulated that low renin hypertensives have lower norepinephrine levels and inhibited norepinephrine responsivity indicating sympathetic underactivity. Sympathetic nervous system activity normally increases ANGI and, therefore, increases the vascular reaction. Vascular resistance, however, has an inverted relationship to renin secretion and this is strengthened by Cooper and Borke's (1992) findings that African Americans have an extremely high renal resistance and low renin plasma levels.

- (c) Another genetic factor distinctive of African Americans is a greater left ventricular wall thickness than Caucasians. In a recent review Hinderliter and co-workers (2004) indicated through their results of impedance cardiography that both sexes of African Americans have greater left ventricular wall thickness than Caucasians. Their greater peripheral vascular resistance may perhaps be due to structural changes in the peripheral vasculature (Hinderliter *et al.*, 2004) or greater physical activity (Opie, 2004). After exposure to mental stress, catecholamines can also cause vasoconstriction and increased diastolic blood pressure as well as vascular resistance with resultant left ventricular wall motion abnormalities. This lends support to a role for a mechanism involving reduced supply to the myocardium (Harshfield & Kapuku, 2004; Krantz *et al.*, 1999).

In support of the above findings, Din-Dzietham and co-workers (2004) emphasized an impairment of arterial dilatation in African Americans that precedes arterial wall thickening in the atherosclerotic process. It was also found that African Americans have larger intima-media thickness and stiffer carotid arteries than their Caucasian counterparts. The researchers associated socio-economic status and comorbidities of ethnic groups with arterial stiffness (Din-Dzietham *et al.*, 2004). Impaired brachial flow-mediated vasodilatory or enhanced forearm vascular resistance responses in African American women may be a result of endothelial dysfunction (Loehr *et al.*, 2004).

Despite all the above studies, environmental and social factors rather than genetic or constitutional factors seem to play the bigger role in ethnic reactivity differences (Cooper & Borke, 1992; Gupta *et al.*, 1995). However, all the above-mentioned factors (Collins & Winkleby, 2002; Fray, 1993; Hinderliter *et al.*, 2004) could potentiate in the genesis of hypertension in Africans. The identifying of effective coping strategies and the interaction thereof with blood pressure in animal research is a popular topic, but it is relatively unknown in human beings. This

emphasizes the necessity of research on humans with the aim to clarify the possible link of coping strategies and environmental factors with cardiovascular dysfunction.

□ **Gender**

The incidence of hypertension is slightly higher in African American men when compared to women (Whelton *et al.*, 2003). Young African American men at risk for hypertension exhibited greater systemic vascular resistance than Caucasians at rest and during exposure to mental stressors, but with no elevation in cardiac output (Light *et al.*, 1998; Marrero *et al.*, 1997). In contrast, African American women when exposed to stressors responded with a higher cardiac reactivity pattern (higher SBP, CO and SV) than men (Saab *et al.*, 1997). Suarez and co-workers (2004) emphasized this fact by indicating that norepinephrine secretions in African American women decreased with age resulting in a stronger central cardiac effect. Although the differences regarding hypertension prevalence between African men and women are not clear, African men indicated increased vascular resistance after exposure to the handgrip test (Van Rooyen *et al.*, 2002).

At most ages though the risk of cardiovascular diseases is greater in men than women, although this difference declines with increasing age (Collins & Winkleby, 2002; Whelton *et al.*, 2003, Safar & Smulyan, 2004; WHO, 2003).

The following factors could contribute to gender differences in blood pressure responses:

❖ **Physical characteristics factor**

Hypertensive men and women differ not only endocrinologically, but also in terms of their stature and the way in which the arterial tree ages (Din-Dzietham *et al.*, 2004; Safar & Smulyan, 2004). The shorter stature of women imposes a reduced length of the arterial tree. There is ample evidence that a relation between central pressure augmentation and height exists. The augmentation index is greater in women than it is in men (Dart & Kingwell, 2001). In young women, the brachial SBP is much lower than it is in men and the DBP less so. The resulting pulse pressure is also lower in women than in men. Arterial stiffening modifies these factors with ageing and differs in ways from men (Din-Dzietham *et al.*, 2004; Opie, 2004; Safar & Smulyan, 2004).

❖ **Psychological factor**

Saab and co-workers (1997) indicated that during exposure to behavioural stressors, African American men showed greater inhibitory-passive coping, hostility, pessimism and less social support seeking behaviour than their female counterparts (Fischer *et al.*, 2004). Psychosocial

and other physical factors influencing blood pressure in women are proposed to be different in men (Light *et al.*, 1998; Safar & Smulyan, 2004).

From a psychological point of view, it has been found that African (Stapelberg, 1999) and especially African American women make use of more adaptive coping strategies than men, but also manifest more feelings of helplessness than men. These ethnic women appear to be emotionally stronger and resilient towards a stressful situation (Fischer *et al.*, 2004; Smith & McCarthy, 1995).

❖ ***Endocrinological characteristics factor***

Possible hormonal effects when assessing stress reactivity in women include a reduced cardiovascular response during the follicular phase of the female sexual cycle when compared to those in the luteal phase (Hastrup & Light, 1984). It is, however, difficult to determine the different phases in people who are not well educated regarding this aspect. The use of hormone replacement therapy has been shown to be associated with 30-50% lower risks of coronary heart disease among postmenopausal women (WHO, 2003).

Estrogen might play an important role in the prevention of heart disease by lowering low-density lipoprotein cholesterol, increasing plasma levels of high-density lipoprotein cholesterol and plasma renin activity (De Bold, 1999). It promotes coronary vasodilatation (Safar & Smulyan, 2004), improves glucose metabolism with decreased serum insulin levels (De Bold, 1999) and inhibits left ventricular hypertrophy (Opie, 2004).

Estrogen also diminishes vascular tone by increasing the production of vasodilators such as endothelium-derived nitric oxide and prostacyclin (De Bold, 1999). Additional effects, apart from the lipoprotein profile, whereby estrogen exerts its cardioprotective effects must, therefore, be involved. A reduction of 50% in cardiovascular disease emerged as reflected by a multiple regression analysis with estrogen as independent variable (Hastrup & Light, 1984). With the loss of estrogen at menopause, there is no abrupt increase in blood pressure but there is elastin fragmentation and collagen accumulation in the arterial tree. This results in a substantial increase in the intrinsic rigidity of the arterial wall (Safar & Smulyan, 2004).

❖ ***Enzymatic characteristics factor***

Several lines of evidence suggest that gender-specific differences in the development of hypertension and heart failure might be related to the plasma renin activity system. Ganten and co-workers (1989) suggested that reproductive hormones might affect blood pressure by increasing renin mRNA and gene expression levels in extra-renal tissues such as the heart, adrenal gland, blood vessel wall and brain. Therefore, estrogen has its effect by reducing

angiotensin-converting enzyme activity, leading to a decrease in the conversion of ANGI to ANGI. It will decrease ANGI receptor gene expression and density (De Bold, 1999). Estrogen stimulates plasma renin activity and the vasoconstrictive/anti-natriuretic actions of PRA are counterbalanced by the vasodilatory/natriuretic effects of natriuretic peptide. It is feasible that estrogen, through the PRA system, might exert short and/or long term effects on the endocrine heart (De Bold, 1999).

2.2.2 Lifestyle: Urbanisation as risk factor in the development of cardiovascular dysfunction

In the ongoing transitional processes in South Africa, many Africans have been subjected to a process of rapid urbanisation, which may lead to social and cultural disruption causing increased levels of stress (Rahman *et al.*, 1997; Van Rooyen *et al.*, 2002). A lack of social support and excessive hostility appear to increase an individual's risk for heart disease and coronary-related deaths (Kop, 1999). Africans living in informal settlements, with lower socio-economic status (conventionally assessed by job status, education and/or income) could experience higher socio-ecological stress (Seedat, 1999). They will show indications of higher resting blood pressure values. Therefore, they are at substantially greater risk of developing hypertension than both Caucasians and other ethnic groups from less oppressive backgrounds (Calhoun, 1993; Light *et al.*, 1995; Seedat, 1999; WHO, 2003).

During psychosocial stress an individual monitors his/her own internal emotional state in maintaining anger and frustration. This suppressive state can trigger the release of physiological stress reaction molecules (for example, calcium) or neuromuscular neurotransmitters that may cause an increase in the total peripheral resistance and a higher blood pressure (Dressler, 1993; Garcia-Leon *et al.*, 2003; Gendolla & Krüsken, 2001). With Africans' disposition of a vascular hyperreactivity on stress exposure this could further potentiate increased blood pressure values.

Additionally, Kruger and co-workers indicated an association of obesity in African urbanised women with metabolic syndrome (MS) indicators (2001). During urbanisation changed dietary patterns (high fat diets) could lead to abnormalities in fibrinolysis (Vorster, 1999) as well as dyslipidemia resulting in increases in the plasma free fatty acid concentration and increases in the synthesis of plasma fibrinogen (Patterson *et al.*, 1996). Increased fatty acids as a result of sympathetic nervous system activation enhance vascular tone in obese individuals (Hall *et al.*, 2001). A lack of research exists regarding psychosocial factors and the involved coping behaviour in managing the heightened stress response, obesity and hypertension levels in Africans (Williams, 1986).

2.2.3 Ageing as risk factor in the development of cardiovascular dysfunction

Ageing is one of the risk factors for essential hypertension (Table 2.1) with an increasing risk in post-menopausal women (WHO, 2003).

Increasing age changes the mechanical characteristics of the heart resulting in a decrease in the buffer function of the blood vessels. These changes will have an impact on the hemodynamic variables such as blood pressure and pulse wave velocity (Guyton & Hall, 2000; Opie, 2004). The influence of increasing age on cardiovascular reactivity results from decreases in the compliance of the vascular system, including a combination of autonomic responses, decreases in arterial distensibility and changed pulse wave reflexes. Although the older heart appears to be less responsive to β -adrenergic stimulation (Goedhard, 1996; Pepe and Lakatta, 2005), with increasing age the systolic blood pressure increases so that values greater than 140 mmHg become common (Opie, 2004).

Additionally, the percentage of body fat mass increases with age up to 60 – 65 years in both sexes and is higher in women than in men. The tendency for elevation of visceral fat masses with age in both genders may be due primarily to the relatively low secretion of growth and sex steroid hormones, which follow ageing (Björntorp, 2001). The risk of developing heart disease increases for women aged 45 – 54 years from 26% in the non-obese, to 37% in the obese (Nelson, 2002). African American women have a longer survival time than obese Caucasians (Kruger *et al.*, 2001). In Africans the association between obesity and hypertension, hypercholesterolemia and hyperglycemia has become more pronounced both in rural and urban areas (James *et al.*, 2000).

A typical stressor, which evokes an alpha adrenergic stimulation pattern will increase the peripheral resistance, the mean blood pressure and cardiovascular reactivity in older individuals (Opie, 2004). Kuchel and Kuchel (1993) supported these findings by reporting an age related increase in basal and stimulated levels of norepinephrine in groups subjected to a lifestyle stressor namely, urbanisation. In urbanised Africans a positive correlation was found between blood pressure and ageing (Kruger *et al.*, 2001).

Lifestyle has an important, although indirect, role in the ageing process. The higher the level of stress the more important the age factor becomes (Nelson, 2002). It has been assumed that lifestyle factors are mediators in explaining the increasing variability in an individual's functional abilities, health and general well-being (Schroots, 1993). The type of coping style used, age and gender, as well as the perception of health can affect health outcomes, particularly in the context of life transitions (Ryff & Singer, 2002). In older individuals the use of more complex

psychological processes and more coping strategies, especially passive coping strategies, have been observed (Solomon, 1996).

2.2.4 The perception of own health or psychological well-being in the development of cardiovascular dysfunction

The coherency construct (Antonovsky, 1993) explains man's movement towards psychological well-being and consists of 3 core components:

- ❖ Understanding/comprehension;
- ❖ controllability; and
- ❖ meaning of life stressors (Frankl, 1967).

Wissing & Van Eeden (2002) support Antonovsky's definition of psychological well-being as one of the psychofortogenic strengths by stating that a psychological healthy person experiences life:

- ✓ as comprehensible, controllable and meaningful;
- ✓ where positive affect predominates over negative affect;
- ✓ with flexibility of thoughts; solving daily problems – characterized by less stress and active coping strategies;
- ✓ being stable and not over sensitive to failures and rejection.

Recent research has shown that positive correlations between psychological well-being and problem-focused or cognitive active coping exist (Ayers *et al.*, 1996; Van der Wateren, 1997). Avoidance or passive coping showed positive correlations with psychological distress and lower levels of well-being in adolescents (Ayers *et al.*, 1996; Holahan & Moos, 1987).

Psychological well-being or subjective perception of health can be measured by the General Health Questionnaire (GHQ):

The General questionnaire (GHQ)

The GHQ (Goldberg & Hiller, 1979) is a self-report questionnaire that measures perception of own health/well-being. A literal translation of questionnaires is inadequate in the case of cross-cultural research expressions and it must be replaced with more culturally known expressions (Van der Vijver & Leung, 1997). It has been done in the GHQ and meets the criteria as set by Smit (1991). It also shows good psychometric characteristics regarding Africans. If translated it does not lose validity or reliability and sex, age or educational level does not have a negative effect on GHQ results (Goldberg & Hiller, 1979).

The GHQ is a questionnaire consisting of four subscales containing seven items each. The four subscales include:

- ❖ Somatic symptoms (SS)
- ❖ Anxiety or sleeplessness (AS)
- ❖ Social dysfunction (SD)
- ❖ Depressive symptoms (DS).

A literature overview regarding the above symptoms of a subjective perception of health/well-being, implies the following:

❖ ***Somatic symptoms (SS)***

Self-rated heightened negative affect is more pronounced in subjects with a negative mood and somatic health complaints (Denollet, 1998) and may originate from a repressing/passive coping style. Emotional distress or poor perceived health is predicted by a decreased left ventricular ejection fraction that is also associated with cardiovascular dysfunction (Denollet, 1998).

❖ ***Anxiety and sleeplessness (AS)***

Antonovsky (1993) stated that an individual with high coherency levels will be less inclined to appraise situations as ego threatening and will, therefore, experience less somatic and psychological symptoms of anxiety (Antonovsky, 1993). The individual will cope more easily with stressors because he/she will experience the nature and extent of the stressor as comprehensible and controllable. Problems evolving from the stressor will be valued as controllable and through coping they will be meaningful (Antonovsky, 1993).

Anxiety is often accompanied by somatic manifestations that suggest changes in autonomic nervous system activity such as rapid heart rate, shortness of breath and sweating (Friedman & Thayer, 1998). Sympathetic nervous system and vagal activity are known to affect differentially the dimensions of heart rate, contractility and conduction velocity of pulse waves (Friedman & Thayer, 1998).

Although Hodapp and co-workers (1992) found that during active coping (AC), anxiety and anger were aroused, there appears to be little consistent evidence for a direct relationship between measures of anxiety and cardiovascular reactivity (Houston, 1986). People high in anxiety tend to be more responsive to cues that indicate a threat in the environment (Carels *et al.*, 2000). Anxiety and depression independent of conventional risk factors can be predictive of recurrent acute cardiovascular dysfunction (Tennant & McClean, 2000).

❖ Social dysfunction (SD)

In Africans (Stapelberg, 1999) and African Americans, men tend to use planning and women usually use social support for emotional reasons (Myers & McClure, 1993). Subjects with unsupportive social relationships are more likely to experience an increase in psychological and somatic problems. Subjects with low psychosocial resources are also vulnerable to illness and mood disturbances when their stress levels increase, even if they generally have little stress in their lives (DeLongis *et al.*, 1988). Social dysfunction has been observed in passive coping (PC) subjects and African American men who appear hostile and pessimistic (Myers & McClure, 1993; Saab *et al.*, 1997).

Individuals with heightened negative emotions (Type **D** personality/distressed personality) also experience less satisfaction with social support. They do report on a perception of high levels of daily stress, trait anxiety and depressive symptoms (Carels *et al.*, 2000). Psychosocial stressors (namely urbanisation) can also contribute to emotional responsiveness throughout the day (Myers & McClure, 1993).

A propensity to perceive these daily events as stressful might result in an increase in perceived stress and psychological distress. This can lead to heightened cardiovascular activation (Carels *et al.*, 2000). After exposure to psychosocial stressors a neurotic coping style, which is characterized by hypervigilant coping and social dysfunction, can be seen in hypertensives (Dressler, 1993). This may result in a volume overload and an enhanced secretion of vasoconstrictor molecules such as Ca^{2+} as well as an increased peripheral resistance and blood pressure (Myers & McClure, 1993).

Social support in a collectivistic group such as the Africans is very important. Researchers in studies of this specific group concluded that their social interaction facilitates the overt expression of distress. In addition, social support also makes submissive acceptance of problems more acceptable (Stapelberg, 1999).

❖ Depressive symptoms (DS)

Psychosocial factors contribute to greater psychological and physical effects in emotionally responsive individuals. This includes greater blood pressure increases associated with negative emotions, namely higher levels of perceived daily stress and social dysfunction symptoms as well as psychological distress, such as anxiety or depression (Carels *et al.*, 2000).

According to Carver and co-workers (1989), acceptance is a functional coping strategy because acceptance of the stressor as reality is a prerequisite for problem-focused coping. Contrary to this, it was found that in African Americans acceptance and negative perceived emotions

(somatic, anxiety, social dysfunction and depressive symptoms) were correlated to hostility, aggression and helplessness. Nothing can be done to change the situation or stressor and helplessness or depression sets in (APA/American Psychiatric Association, 1995).

In support of the above findings the coping strategies that are popular with Africans include surrendering and resigning, independent of socio-economic status and educational level (Stapelberg, 1999). The chronic use of submissiveness and overt expression of stress are associated with poor psychological health and pathology. This kind of strategy is also positively associated with life satisfaction, positive-negative affect balance, anxiety and insomnia (Wissing & Van Eeden, 2002). Therefore, negative emotions and pathology in chronic stress situations if the problems are not solved could be detrimental to their health (Stapelberg, 1999).

2.2.5 The contribution of a central adrenergic effect in the development of cardiovascular dysfunction

The cardiac cycle consists of a period of relaxation or diastole during which the heart fills with blood. This is followed by left ventricular contraction where blood in the left ventricle is prevented from re-entering the atrium (Opie, 2004). During diastole, filling of the ventricles normally increases the volume of each ventricle to about 110 to 120 ml. When the ventricles empty during systole, the volume decreases to about 70 ml, which is called the stroke volume output (Guyton & Hall, 2000).

The amount of blood pumped by the heart each minute, namely the cardiac output, can often be increased more than 100% by sympathetic nervous system stimulation. In contrast, it can be decreased to as low as zero or almost zero by vagal (parasympathetic) stimulation (Guyton & Hall, 2000). Increases in cardiac output (CO) or stroke volume (SV) increases the systolic blood pressure (SBP) rather than the diastolic blood pressure (DBP), as well as increasing the contractility and left ventricular ejection fraction (Middlemost, 1999, Opie, 2004). Researchers indicated that subjects with high casual systolic pressure showed greater SV, CO, heart rate and myocardial contractility increases than subjects with normal casual pressure (Middlemost, 1999; Sherwood *et al.*, 1993). Whelton and co-workers (2003) concluded that SBP and pulse pressure are more important determinants of cardiovascular and renal disease risk than DBP.

The central adrenergic pattern of stimulation are mediated by β_1 -adrenergic pathways. The blood pressure increases via central mechanisms, e.g., increased catecholamines, heart rate, SBP, SV, CO, with smaller increases in DBP and vascular resistance. Skeletal muscle vasodilatation increases while flow through the kidneys is redistributed and reduced (García-León *et al.*, 2003; Henry *et al.*, 1986; Obrist, 1981; Waldstein *et al.*, 1997). Salt and water absorption by the gut increases and its excretion by the kidneys decreases. Vasoconstriction

centralizes blood volume and salt appetite increases to further protect fluid-salt resources (García-León *et al.*, 2003).

Sympathetic stimulation of the kidneys increases renin release and, by stimulating β_2 -receptors, increases in epinephrine lead to norepinephrine release. Small changes in corticosteroid secretion and greater increases in testosterone, with a central cardiac reaction pattern, have been observed (Esler *et al.*, 2001; Opie, 2004). This type of central adrenergic activity is normally evoked when an individual sees the stressor as a challenge and he/she actively copes with the stressor (Gerin *et al.*, 2000; Suzuki *et al.*, 2003; Williams, 1986).

2.2.5.1 Active coping strategy

Some psychological stress could demand defensive active coping, effortful control, attention and vigilance (García-León *et al.*, 2003; Henry *et al.*, 1986). Active coping (AC) sometimes requires little in the way of physical activity but some degree of control, in accordance with his/her abilities and efforts, is necessary. Even the perception of active behavioural control over an anticipated event (i.e. without actual control) can be accompanied by an increased SBP. Controllability facilitates adjustment to stressors and enhances defensive, effortful coping (Henry & Stephens, 1986; Tomaka *et al.*, 1993; Williams, 1986), although the effort involved in exerting control may be associated with increases in arousal (Krantz *et al.*, 1986; Smith *et al.*, 2000).

Gramer and co-workers (2003) suggested that dominant subjects are more pronounced active copers as they have greater task engagements (Hodapp *et al.*, 1992, Smith *et al.*, 2000). However, when they could not express their anger through direct action, their DBP increased (Light *et al.*, 1998; Tomaka *et al.*, 1993).

Personal coping resources (high control and self-esteem) as well as emotional support (a buffer effect) are directly associated with less depressive symptoms in cardiac disease (Penninx *et al.*, 1998). Using AC as coping strategy, social support is sought in helping to solve the problem. All other competitive activities are suppressed until all problems are solved successfully with perfect timing and control in the execution of planned actions. This is the most adaptive and constructive effort/strategy where a person tries to change a situation/behaviour of others or evaluate his/her own attitude and needs and accordingly develops skills and strategies (Light *et al.*, 1998).

Gendolla and Krüsken (2001) found that task valence (increases in effort or active coping) do not automatically result in increased achievement. Performance on pleasant tasks resulted in an elated mood whilst performance on an unpleasant task resulted in a depressed mood.

Persuasive evidence of heightened vascular reactivity in Africans (Van Rooyen *et al.*, 2002) and African American subjects, regardless of gender, exists (Fray, 1993). These subjects exhibit smaller heart rate increases to laboratory stressors. The suggestion is made that beta-adrenergic influences may not underlie the higher rates of hypertension in these ethnic groups when compared to Caucasians (Anderson, 1989, Fray, 1993). This emphasizes why it is important to evaluate the vascular or peripheral adrenergic pattern of responses in African subjects.

2.2.6 The contribution of a vascular/peripheral adrenergic effect in the development of cardiovascular dysfunction

The resistance against blood flow of the entire systemic circulation, called the total peripheral resistance (TPR) is an important regulator of blood pressure. Vasoconstriction or vasodilatation can be induced by increasing the TPR or reducing the blood pressure, because $BLOOD\ PRESSURE = CO \times TPR$ (Opie, 2004). The TPR is regulated through at least three mechanisms:

- (a) Autonomic control with α_1 -adrenergic mediated vasoconstriction in contrast to vagally or β_2 -adrenergic-mediated vasodilatation.
- (b) Action of vasoconstrictive neurohormones such as angiotensin II.
- (c) Endothelial control (vasoconstrictive endothelin versus vasodilatory nitric-oxide) (Opie, 2004).

The arterial system has two distinct but separate functions aiding in distensibility. This includes a *conduit function* (to deliver blood at high pressure to body tissues) and a *buffering function* (to smooth pulsations caused by intermittent cardiac ejection). The arteries are thus able to store part of the SV during each systole and drain this volume during diastole ("*Windkessel effect*") (Middlemost, 1999). The rate of blood flow (conductance) is directly proportional to the fourth power of the radius of the vessel. This demonstrates that the diameter of a blood vessel or reduction of the diameter of the arterial lumen is the most powerful determinant of resistance to flow (Opie, 2004). The *buffering function* is altered in the early phase of hypertension. This is a consequence of both the elevated blood pressure and also intrinsic alterations in the arterial wall (Middlemost, 1999). The diminished C_w contributes to an increase in the pulsatile component of blood pressure, which is an independent risk factor for cardiovascular complications (Middlemost, 1999).

Vascular compliance or capacitance is a measure of the volume of blood that can be stored in any given portion of the circulatory system. It is dependent on changes in volume and pressure in the arterial system ($\Delta v/\Delta p$) (Guyton & Hall, 2000). Compliance and distensibility are quite

different. A highly distensible vessel, which has a slight volume may have far less compliance than a much less distensible vessel, which has a large volume. This is because arterial compliance (Cw) is equal to distensibility times volume OR Cw is related to distensibility and arterial diameter (Guyton & Hall, 2000; Opie, 2004). Cw can be estimated from the decay in DBP as well as by the approach of: $Cw = \text{stroke volume/pulse pressure}$. Elevations of pulse pressure can be secondary to a rise or fall in Cw. An elevated resting pulse pressure is being recognized as a risk factor for coronary disease (Dart and Kingwell, 2001). Increased stiffness of the aorta and large arteries also leads to an increase in pulse pressure through a reduction in arterial compliance. Resulting effects are seen on wave reflection as well as end points such as left ventricular hypertrophy. This is due to a reduced buffering capacity available from the arterial wall (Dart & Kingwell, 2001). Vasoconstrictive factors including ANGII and catecholamines, which reduce arterial compliance, may increase the potential for vascular injury (Middlemost, 1999).

The vascular/peripheral adrenergic pattern of sympathetic stimulation is mediated by α -adrenergic pathways with stimulation of the locus coeruleus and secretion of norepinephrine. Blood pressure is elevated via vascular mechanisms with increases in skeletal muscle vasoconstriction, diastolic blood pressure and vascular resistance. Weaker effects on heart rate, SV and CO are observed (Henry *et al.*, 1986; Williams, 1986). This is accompanied by increases in adrenocorticotrophic hormone (ACTH) and cortisol with decreases in testosterone (Henry *et al.*, 1986).

An increase in vascular muscle tone is caused by sympathetic nervous system activation as well as increases in the pressure at each volume in the arteries or veins (Guyton & Hall, 2000). A decrease in compliance during sympathetic nervous system activity can be seen and can, therefore, with chronic suppression be indicative of cardiovascular dysfunction (Resnick *et al.*, 2000). Blood pressure surges could result in damage to the endothelium or loss of elasticity in the arterioles with age as well as decreased levels of nitric-oxide and increased levels of endothelin. This may cause an increased total peripheral resistance (TPR). When the total peripheral resistance is elevated, diastolic rather than systolic blood pressure rises (Guyton & Hall, 2000; Middlemost, 1999; Opie, 2004).

A close relationship exists between TPR and hypertension. The initial phase of hypertension is characterised by increased TPR associated with trophic factors in the blood vessel wall (Marrero *et al.*, 1997). Cardiac hypertrophy are influenced not only by the levels of blood pressure and TPR but also by the state of arterial distensibility (Opie, 2004). According to Middlemost (1999), cardiac hypertrophy is better correlated to systolic dysfunction than diastolic dysfunction. Contrary to this, Hinderliter and co-workers (2004) found that left ventricular

hypertrophy in African Americans is better correlated with vascular reactivity or increased DBP. Opie (2004) supports this diastolic dysfunction effect in Africans because a loss of distensibility with a stiffer ventricle and impaired relaxation with a decreased early diastolic filling occurs during left ventricular hypertrophy.

This type of vascular/peripheral α -adrenergic activity is normally evoked when an individual sees the stressor as a threat and he/she passively copes with the stressor (Gerin *et al.*, 2000; Henry *et al.*, 1986; Suzuki *et al.*, 2003; Williams, 1986).

2.2.6.1 Passive coping strategy

In contrast to AC, passive coping (PC) is elicited by situations in the degree to which it is perceived as controllable (García-León *et al.*, 2003; Houston, 1986; Obrist, 1981; Tomaka *et al.*, 1993; Waldstein *et al.*, 1997). Sustained stress or tension and anxiety and a passive mood of psycho-defense could induce hypertension (Zhao, 1991).

In many hypertensives an anger suppressing style is found, which may be part of a psychological profile that includes a lack of appropriate assertiveness. They also have a tendency toward greater interpersonal self-consciousness, anxiety and submissiveness (García-León *et al.*, 2003). The individual experiences a serious doubt that he/she will reach desired goals. This is a negative cycle and leads to hopelessness and helplessness (Carver *et al.*, 1989). Such emotional reactions could produce a decrease in β -adrenergic activity with an increase in HPA-axis activity and behavioural inhibition (García-León *et al.*, 2003).

This is a less adaptive strategy with short-term consequences or situations that cannot be solved and are out of the individual's control. Ethnic groups with few resources are at greater risk for hypertension (Myers & McClure, 1993). With an increased cardiovascular reactivity and more effortful coping to stress the chances of developing cardiovascular dysfunction are greater in these groups (Anderson & McNeilly, 1993). In older individuals the use of more complex psychological processes and more coping strategies, especially passive coping strategies, are observed (Solomon, 1996).

2.2.7 The role of sympathetic nervous system activity and stress in the development of cardiovascular dysfunction

2.2.7.1 Stress, cardiovascular dysfunction and the metabolic syndrome

When exposed to stress a brisk adrenergic reaction and high or modest blood pressure changes can be observed (Opie, 2004). The reasons are twofold:

-
- (a) Adrenergic activation induces α_1 -adrenergic vasoconstriction (Kop, 1999) and β_2 -mediated peripheral arteriolar vasodilatation. This increases the heart rate especially in genetically predisposed subjects with more vasodilatory β_2 -receptors in the arterioles.
 - (b) Stress also provokes a prolonged endothelin response, which impairs vasodilatation. Excess α_1 -adrenergic vasoconstriction is found in those likely to develop hypertension (prehypertensives) (Opie, 2004). In subjects prone to react with an enhanced vascular reactivity indications are that a higher density of α -adrenergic receptors exist (Rosmond, 2005).

The increases in cardiac demand induced by mental arousal with increases in blood pressure coincide with decreases in coronary blood supply. Both these factors promote the likelihood of ischemia (Kop, 1999). The enhanced α -adrenergic vasoconstriction during stress can also cause acceleration of hypertension and it may also be responsible for insulin resistance. A functional bypass in the microcirculation of the skeletal muscles is caused. This will result in decreases of nutritional blood flow to the muscle cells and the insulin-stimulated extraction of glucose (insulin resistance) (Smith *et al.*, 2004).

Subjects with sympathetic nervous system overactivity or neurogenic early stages of hypertension exhibit excessive coronary risk factors (Denollet, 1998; Rozanski *et al.*, 1999). This includes left ventricular and arteriolar hypertrophy, dyslipidemia, insulin resistance, higher hematocrit and platelet overactivity (Julius, 1999, Opie, 2004, Smith *et al.*, 2004). As hypertension escalates, the hemodynamic pattern changes from a high cardiac output (central) to a high resistance (peripheral) pattern with alterations in the structure and responsiveness of the heart and blood vessels (Smith *et al.*, 2004). Decreased compliance and diminished β -adrenergic responsiveness tend to decrease the cardiac output, whereas the development of vascular hypertrophy increases vascular resistance. In parallel, the sympathetic tone is downregulated, since, with emerging vascular hyperresponsiveness, less sympathetic drive is needed to maintain the elevated blood pressure (Julius & Nesbitt, 1996).

Selye's general adaptation syndrome postulates that prolonged, uncontrollable physical and/or psychological distress may also ultimately result in a state of exhaustion (Selye, 1956). The exhaustion preceding cardiac events is the consequence of prolonged psychological distress (Appels, 1990). Psychological distress is characterised by a lack of energy, increased irritability and demoralization (Kop, 1999). Subjects with a tendency to experience distress tend to reflect a chronic psychological condition and subjects who display the largest increase will then also be at increased risk for hypertension (Gerin *et al.*, 2000).

2.2.7.2 Cardiovascular reactivity values in the assessment of blood pressure

Reactivity is defined as the deviation of a physiologic response parameter from a resting value in response to a discrete environmental stimulus (Krantz & Manuck, 1984). A specific situation may also have a large effect on blood pressure reactivity only if the individual possesses certain trait characteristics (i.e. it is unrelated to the circumstances in which the reactivity occurs, for example race or gender). Stressful events produce an increase in cardiovascular parameters such as blood pressure and heart rate. Individuals who display very large increases are at increased risk for the development of hypertension (Al'Absi & Arnett, 2000).

More exposure to chronic social and environmental stressors, which interact with biological, behavioural and psychological risk factors may cause an elevated secretion of catecholamines. This may lead to an enhanced Na^+ retention, volume overload and the mobilization of free fatty acids (Fray, 1993). This could also result in morphological changes in the arterial vasculature through:

- ❖ enhanced platelet aggregation that leads to the thickening of vascular smooth muscle and blood vessel walls (Folkow, 1987; Gidron *et al.*, 2002); and
- ❖ the absorption of free fatty acids through the arterial walls where they are changed to triglycerides that form plaque on the walls of arteries. This may eventually lead to arterial rupture resulting in acute coronary heart disease (Gerin *et al.*, 2000; Gidron *et al.*, 2002; Opie, 2004).

Cardiovascular reactivity (CVR) has marker status meaning it can predict a disease outcome but does not necessarily cause the specific outcome (Gerin *et al.*, 2000). It also provides additional information about stressful and challenging laboratory tasks (García-León *et al.*, 2003). The value of CVR patterns lies in the ability of a specific stressor to elicit reactions typical of those provoked by the large number of stressful situations the person will encounter in the real world (García-León *et al.*, 2003; Gerin *et al.*, 2000). These and the following motivations justify the use of CVR values in this study instead of using only resting values.

Social support is implicated in this process as a moderator of stress reactivity (Dressler *et al.*, 1993). High levels of social support are presumed to diminish blood pressure and perceived stress responses in men and women, thereby reducing health risks (Lepore, 1995). The mere presence of friends can reduce stress responses in reaction to stressors (Gerin *et al.*, 2000). Obrist (1981) elaborated on the cost of possible coping mechanisms whereby enhanced cardiac reactions could contribute to the development of high blood pressure and eventually to hypertension. This theory presumes that repeated exposures to acute psychological stress in persons who are highly responsive to it, and the relatively sustained blood pressure elevations

this provokes, over time may lead to a resetting of that person's blood pressure at a higher level. From the literature it is clear that African Americans as well as Africans exhibit greater reactivity than Caucasians with some degree of frequency (Fray, 1993; Opie, 2004). This is especially true for peripheral resistance responses and puts them at a greater risk for the development of hypertension (Anderson, 1989; Fray, 1993; Hinderliter *et al.*, 2004; Saab *et al.*, 1997; Suarez *et al.*, 2004; Van Rooyen *et al.*, 2000).

2.2.7.3 Stressor: The hand dynamometer as laboratory stressor

The work description of the Africans in this study included physical work (domestic, farming, gardening, abattoir and other blue collar work). The hand dynamometer, which is not culturally specific, relatively easy to execute and correlates with their everyday task was, therefore, chosen as stressor. Saab and co-workers (1997) made it clear that gender as well as ethnicity also need to be considered in understanding which task reactivity predicts to blood pressure levels in a natural environment. Regarding the gender aspect it has been found that men normally respond with greater blood pressure reactivity during exposure to this stressor (Piha, 1993).

The isometric handgrip test or hand dynamometer is described as a stressor with a physical (Yeragani *et al.*, 1990) and psychological component (Anderson, 1989). Williams (1986) reported that this stressor normally elicits an α -adrenergic stimulated stress response typical of passive coping (PC) and indicates an elevated vascular resistance pattern along with parasympathetic nervous system withdrawal (Julius & Nesbitt, 1996). Additionally Africans (Van Rooyen *et al.*, 2002) and African Americans (Manuck *et al.*, 1990) indicated greater increases in DBP than Caucasians during a handgrip test. Researchers suggested that these increases in DBP during isometric exercise predict systemic hypertension better than blood pressure during dynamic exercise (MacArthur & MacArthur, 2003; Majahalme *et al.*, 1997). In contrast Julius and Nesbitt (1996) found that the usual response to isometric exercise is a rise in CO but in subjects with poor cardiac functioning, responses are eventually marked with an increase in vascular resistance.

2.2.7.4 Stress hormones

The following hormones, namely cortisol, testosterone, prolactin, growth hormone and the catecholamines are some of the hormones that are related to responses to stress situations (Heim *et al.*, 2000; Henry *et al.*, 1986; Selye, 1956; Suzuki *et al.*, 2003). An introductory paragraph of three of the stress hormones relevant to this thesis (cortisol, prolactin and testosterone) is given. As a follow-up, an integration of their role during stress situations in the development of cardiovascular dysfunction (Par. 2.2.8) and the role of cortisol in the metabolic syndrome (Par. 2.2.9) will be given.

❖ Cortisol

During stress the hypothalamus secretes corticotropin releasing hormone via the limbic system, which stimulates the pituitary gland to secrete adrenocorticotrophic hormone (ACTH). ACTH stimulates the adrenal cortex to secrete corticosteroids (including cortisol) in the vascular system to bind to cortisol receptors. This will result in increased gluconeogenesis, protein mobilization, fat mobilization and stabilization of lysosomes (Manuck *et al.*, 1993). Peak secretions are after 6 – 8 hours of sleep with a decrease in levels just before awakening. Cortisol receptors are widely distributed throughout the body and this emphasizes the extensive effect of cortisol. Circadian rhythm, stress reactions and feedback inhibition are the neuro-endocrine control mechanisms involved in cortisol secretion (Greenspan & Strewler, 1997).

Cortisol is secreted principally as an anticipatory stress hormone (Arthur, 1987) with an anti-inflammatory function to prepare the body for a stress reaction (Munck *et al.*, 1984). It is also involved with the control of different moods and plays an important part in the psychological changes during stress situations by affecting dopamine and serotonin levels (Lechin *et al.*, 1990). Increased levels of cortisol as well as diabetogenic hormones, such as the catecholamines and growth hormone, are evident during stress. The increased levels of these hormones can play an important role in the etiology of insulin resistance associated diseases such as Type 2 diabetes and hypertension (Rosmond, 2005). The effect of cortisol on the cardiovascular system is to sensitize the arterioles for the catecholamines. An enhanced alpha-adrenergic effect can contribute to an increased vascular reactivity as a result of cortisol and norepinephrine's effect on the arteriole (Guyton & Hall, 2000).

❖ Prolactin

Human prolactin is secreted by the anterior pituitary gland with peak secretions between 05:00 – 07:00. Its amino acid sequences show a 16% homology with somatotrophin or human growth hormone. Prolactin secretion is normally greater in women because estrogen induces prolactin synthesis and secretion (Greenspan & Strewler, 1997).

Prolactin also acts as a cortisol antagonist and this is one of the most important stress associated functions of prolactin (Gala, 1990), the reason being that it has a modulatory effect on the anti-inflammatory action of cortisol (Gala, 1990; Montgomery *et al.*, 1990). Prolactin secretion is increased during stress situations and, therefore, aids as a sensitive indicator of stress experiencing (Gala, 1990). A decrease in secretion has also been observed if levels were already high or during exposure to chronic stress situations (Greenspan & Strewler, 1997).

❖ Testosterone

The pituitary luteinizing hormone is the main important stimulus for the synthesis and secretion of testosterone. Testosterone is a steroid hormone with an anabolic function, which moves easily over the lipid membrane to reach the receptor of the target cell (Montgomery *et al.*, 1990). This hormone attaches to a specific receptor on the surface of Leydig cells resulting in the production of cyclic-adenosine monophosphate (cAMP), which triggers the process. Peak secretions occur early in the morning (Greenspan & Strewler, 1997).

Changes in the testosterone plasma levels have been linked to the type of stress reaction an individual is experiencing (Henry *et al.*, 1986). Chronic and/or emotional stress on the one hand and a feeling of no/low control on the other hand results in decreases in testosterone production and secretion (Orr & Mann, 1990). Individuals having a perception of control or acute stress will exhibit a fight-or-flight reaction with corresponding high testosterone levels (Henry *et al.*, 1986; Orr & Mann, 1990). High levels of testosterone are reported to attenuate vascular responsiveness resulting in vasodilatation (Zhao & Li, 1998).

2.2.8 *The interaction of coping, stress hormones and cardiovascular dysfunction*

The body's principal adaptive responses to stress stimuli are mediated by an intricate stress system. This system includes mainly the hypothalamic-pituitary-adrenocortical (HPA axis) and the sympatho-adrenal-medullary system (SAM) (Heim *et al.*, 2000). The HPA axis enhances the inflammatory response by secreting corticotropin releasing hormone and adrenocorticotrophic hormone (ACTH) respectively from the hypothalamus and pituitary gland. This results in the secretion of cortisol from the adrenal glands, which suppresses the inflammatory response (Greenspan & Strewler, 1997; Guyton & Hall, 2000).

There is no clearcut and generally accepted model for cortisol responses to stress. According to Heim *et al.*, (2000) and Helhammer and Wade (1993), hypercortisolism is associated with the initial phase of stress in men and hypocortisolism is associated with chronic stress in women. Experiencing stress leads to a sustained hyperactive sympathetic nervous system and the role of cortisol is to antagonize catecholamine elevations. If cortisol levels are attenuated on experiencing stress, they will lead to a disruption in the sympathetic nervous system - HPA axis interaction and depression (Brown *et al.*, 1999). A process of facilitation or habituation exemplifies changes in HPA responsiveness as a result of previous or chronic stress exposure (Jaferi *et al.*, 2003). A mixed pattern of habituation and sensitization with no evidence of a substantial heritability of the individual's cortisol response to stress exposure has been found (Wüst *et al.*, 2005).

With dysregulation of the HPA axis activity, a heightened sensitivity of the HPA negative feedback inhibition appears with a progressive sensitisation of the entire HPA axis and down-regulation of hypothalamic glucocorticoid receptors (Hellhammer & Wade, 1993; Resnick *et al.*, 1995). This results in decreased levels of circulating cortisol and enhanced negative feedback sensitivity of glucocorticoid receptors in the stress response system (Van Itallie, 2002). Dysregulation of this system, caused by the cumulative burden of chronic environmental stress challenges or allostatic load (McEwen, 2003) contributes to the development of a variety of illnesses. These illnesses include hypertension, atherosclerosis, metabolic syndrome as well as endothelial dysfunction and even necrosis (Gerin *et al.*, 2000; Rozanski *et al.*, 1999; Smith *et al.*, 2004; Van Itallie, 2002).

Prolactin secretion may inhibit testosterone secretion (Greenspan & Strewler, 1997). During distressing situations, namely those characterized by threat, lack of control and anticipation of aversive events, increases in cortisol and prolactin and low testosterone levels have been observed (Suzuki *et al.*, 2003). In urbanised African women a hypocortisolism, hyperprolactinemia and low levels of testosterone have been found (Huisman *et al.*, 2002). This endocrine profile also observed in urbanised individuals (Malan *et al.*, 1996), has been associated with adrenocortical habituation of repeated stress and passive coping (Greenspan & Strewler, 1997; Heim *et al.*, 2000; Henry, 1993; Kasckow *et al.*, 2001). Huisman and co-workers (2002) also found greater prolactin but no significant differences regarding cortisol and testosterone levels in urbanised African men compared to their rural counterparts. An endocrine profile of higher prolactin as well as lower testosterone levels may disturb the balance between vasoconstriction and vasodilatation in favour of vasoconstriction (Huisman *et al.*, 2002). This may increase vascular reactivity and enhance the development of cardiovascular dysfunction.

2.2.9 *The interaction of coping, cortisol, cardiovascular dysfunction and metabolic syndrome indicators*

The metabolic syndrome describes the clustering of risk factors for cardiovascular dysfunction (Lorenzo *et al.*, 2003). The rising prevalence of the metabolic syndrome (MS) could in part be a consequence of the global obesity problem (Grundy *et al.*, 2004), predisposing in the development of Type 2 diabetes and hypertension (Barton *et al.*, 2003). Kruger and co-workers (2001) indicated an association of obesity in African women with MS indicators. In this study the definition of the WHO for MS indicators (Grundy *et al.*, 2004) was scrutinized for the possible development of the metabolic syndrome and cardiovascular dysfunction (Table 2.1).

Obesity and especially central obesity is associated with the dyslipidemia seen in the MS (Katsilambros, 2000). Psychosocial stress stimulates catecholamine secretion and induces mobilisation of fatty acids. Fatty acids and a glycerol group in plasma are transported as

compounds by proteins. When absorbed through the arterial walls, it is changed to triglycerides (Guyton & Hall, 2000). Triglycerides (TG) in the arterial walls cause atherosclerotic plaque and may increase the peripheral resistance accompanied by a reduced compliance of the arteries (Vavrejnová *et al.*, 1993).

Table 2.2: Metabolic syndrome indicators according to the WHO (Grundy *et al.*, 2004).

| | Glucose /IFG | HDL-C | TG | WHR | HT |
|----|---------------------------|------------------------|---------------------------|--|---|
| MS | $\geq 6.1 \text{ mmol/l}$ | $< 0.9 \text{ mmol/l}$ | $\geq 1.7 \text{ mmol/l}$ | > 0.90 (men), > 0.85 (women) | SBP ≥ 140 mmHg &/or DBP $\geq 90 \text{ mmHg}$ |

WHO, World Health Organisation; MS, metabolic syndrome; IFG, impaired fasting glucose; HDL, high density lipoprotein; TG, triglycerides; WHR, waist-to-hip ratio; HT, hypertension prevalence; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Atherogenic lipid abnormalities of the MS include increased TG, total cholesterol, decreased low density lipoprotein, very low density lipoprotein, remnant lipoproteins, apolipoprotein B and decreased high density lipoproteins (HDL-C) (Reaven, 2003). High TG and low HDL-C levels accentuating the ratio of their plasma concentrations (TG-to-HDL-C) are risk factors for cardiovascular dysfunction (Reaven, 2003).

The uptake of fuels (oxygen, glucose and fatty acids) by the heart depends partly on their arterial concentrations and partly on the energy demand (Guyton & Hall, 2000). Glucose metabolism protects the threatened heart, whereas fatty acid metabolism is harmful to the ischemic heart (Opie, 2004). Urbanisation as psychosocial stressor increases a vulnerability in ethnic groups to hypertension, diabetes, obesity and stroke (Mufunda *et al.*, 1994). Falkner (1993) suggested a genetic inability of the insulin stimulated glucose absorption system in ethnic groups. According to this mechanism, a decrease in the peripheral absorption of glucose occurs with an increase in β -mediated sympathetic activity resulting in insulin resistance.

Fibrinogen is another major cardiovascular risk factor especially in African women and is positively correlated to systolic and diastolic blood pressure and negatively correlated to high density lipoprotein levels (HDL-C) (Vorster, 1999). Obesity is a state characterised by high levels of C-reactive protein, plasminogen activator inhibitor 1 (PAI-1) and fibrinogen levels (Grundy *et al.*, 2004). PAI-1 is the main inhibitor of the fibrinolytic system and increased levels of obesity, PAI-1 and C-reactive protein as well as hyperglycemia could metabolically link the inflammatory and prothrombotic states (Grundy *et al.*, 2004).

A waist-to-hip ratio (WHR) > 0.90 in men and > 0.85 in women is indicative of central abdominal obesity (WHO, 2003). Furthermore, a WHR of ≥ 92 cm is associated with a nearly three-fold increased risk of coronary heart disease (Sowers, 2003). The increased levels of the metabolic syndrome in the United States of America (25%) appear to be related to the typical Western diet and decreased physical activity (Sowers, 2003). Certain disparities do exist in ethnic groups. African Americans have the highest rate of obesity (31.1%), which also occurs at a younger age than in Caucasians or Hispanic groups (Sowers, 2003). The Wiseman Project shows that obesity is highly prevalent among low-income African American women (Nelson *et al.*, 2002). In the THUSA study conducted in the North West Province of South Africa amongst rural dwellers, high rates of overweight (25.2%) and obesity (28.6%) prevailed (Kruger *et al.*, 2001). This is consistent with the prevalence of obesity amongst African women in Southern Africa with an incidence of 34.4% in the suburbs of Cape Town and 22.6% in Durban (Walker, 2003).

Environmental influences could also play a role in the prevalence of obesity. Higher levels of obesity and Type 2 diabetes occur in transitional/migrating urbanised Asian Indians in comparison to rural subjects (Misra & Vikram, 2004). Despite adequate public health campaigns and publicity, a higher fat and carbohydrate intake exists in women. They tend to have more insulin resistance and cardiovascular risk factors than men. Although obesity has been linked to cardiovascular diseases and Type 2 diabetes (Misra & Vikram, 2004), there are conflicting reports about the risks of obesity in different ethnic groups in South Africa. Rural African women do have a lower frequency of adverse metabolic sequelae associated with obesity (Kruger *et al.*, 2001). In addition, obesity was not a risk factor for cardiovascular diseases in an apparently healthy rural and urban population of African women in the North West Province (Van Rooyen *et al.*, 2002). Hypertension and severe obesity have increased to epidemic proportions amongst African women in Southern Africa. There is common concern that this combination may also increase their risk of Type 2 diabetes (Du Plessis *et al.*, 2002). According to the NHANES III study, the likelihood of diabetes also increases with increasing overweight duration in women (Janssen *et al.*, 2004).

Abdominal obesity and metabolic syndrome patients showed sensitisations of the HPA axis (Al'Absi & Arnett, 2000; Rosmond, 2005). Cortisol activates lipoprotein lipase, the gatekeeper of lipid accumulation in adipocytes (Rosmond, 2005). Furthermore, cortisol in the presence of insulin inhibits the lipid mobilizing system. These events are mediated by the glucocorticoid receptors and the density of these receptors is higher in intra-abdominal areas and visceral rather than other fat depots. The activity of cortisol leading to an accumulation of fat will then be accentuated in this adipose tissue (Björntorp, 2001).

An excess of body weight or increased abdominal fat has a consistent correlation with increased blood pressure. The risk for hypertension increases and is related to HPA axis dysregulation and insulin resistance (Björntorp, 2001; Sharabi *et al.*, 2004). The risk of developing heart disease increases in women aged 45 – 54 years from 26% in the non-obese to 37% in the obese (Nelson *et al.*, 2002). The association between blood pressure and body weight is at least as strong as that between blood pressure and age and is especially prominent in certain ethnic women (Sharabi *et al.*, 2004), including African women (Kruger *et al.*, 2001). Obesity is associated with increased intravascular volume and cardiac output, accompanied by inappropriately normal total peripheral resistance. Left ventricular hypertrophy is a consequence of a sustained pressure overload and is often associated with diastolic dysfunction (Opie, 2004) in African Americans (Hinderliter *et al.*, 2004).

From a psychological point of view the process of vital exhaustion could occur during exposure to chronic stress (Raikonen *et al.*, 1994). This is a mental state at which people arrive when their resources for adapting to stress are broken down. It is associated with the clustering of physiologic factors such as abdominal obesity, augmented glycemic responses to glucose ingestion, increased levels of insulin and C-peptide, dyslipidemia and deficient fibrinolysis (Raikonen *et al.*, 1994). Sympathetic stimulation plays a major role in causing obesity-induced hypertension (Julius & Nesbitt, 1996). The increasing prevalence of eating disorders and obesity in Westernised societies raised many questions about the role of emotions or psychogenic factors in the etiology of these problems (Guyton & Hall, 2000; Canetti *et al.*, 2002). Obese individuals are unable to distinguish between hunger and anxiety because they learnt to eat in response to anxiety or perceived anxiety as well as in response to hunger. Negative more than positive emotions increase food consumption. The influence of emotions on eating behaviour is also stronger in obese than in non-obese people (Canetti *et al.*, 2000). In African American women with higher levels of perceived stress, an elevated and sustained desire for intense sweet foods occurs (Schiffman *et al.*, 2000). If they use this to compensate for feelings of stress, this compensation may also attribute to weight gain (Schiffman *et al.*, 2000). Stress-related eating and drinking may to some extent be considered a normal but ineffective and unhealthy way of coping in the long run (Canetti *et al.*, 2000). It is, therefore, important to prevent this kind of coping behaviour from developing into addictive behaviour. In women less social support during exposure to stress accentuates this kind of behaviour (Laitinen *et al.*, 2002). As far as the author could determine, research on this particular dietary pattern in Africans has not been done.

Björntorp (2001) further developed theories regarding the essential role of psychosocial stress in the development of visceral fat accumulation and obesity. According to Björntorp's model (2001), the primary event in the chain of adverse metabolic events is the chronic arousal of the

HPA axis and stimulation of the sympathetic nervous system. This occurs as a result of a defeat or depression reaction to psychosocial stress or perceived stress (Steptoe *et al.*, 2003; Stunkard *et al.*, 2003). Elevated cortisol, particularly when combined with secondary inhibition of sex steroids and growth hormone secretions is associated with a defeat reaction according to Henry *et al.* (1986). This causes accumulation of fat in visceral adipose tissues as well as increases in metabolic abnormalities (Björntorp, 2001). It could result in increased insulin sensitivity causing insulin resistance with disturbed lipid and glucose metabolism and promoting atherogenesis. The effect is directly on vascular smooth muscle proliferation and the elevation of circulating levels of triglycerides and low density lipoproteins (Clarkson *et al.*, 2003). Concomitantly, accumulation of visceral fat is enhanced because of the high density of glucocorticoid receptors in visceral tissue. Visceral fat is, therefore, basically an indicator of the hormonal disturbance. Glucocorticoid exposure is also followed by increased food intake and “leptin” resistant obesity. The consequence might be “stress-eating” (Björntorp, 2001).

The WHR and saggital abdominal diameter are dependent on elevated cortisol and/or low sex steroid and growth hormones (insulin-like growth factor). These variables serve as reasonable approximations of the long-term endocrine abnormalities (HPA axis activation/physiological adaptation) associated with stress (Björntorp, 2001; Drapeau *et al.*, 2003). The effect of an increased sympathetic tone is related to overweight and a decreased beta adrenoceptor responsiveness or downregulation (Valentini *et al.*, 2001). The synergistic effect of norepinephrine on cortisol through an increase in sympathetic tone will result in increases of total peripheral resistance and blood pressure (Greenspan & Strewler, 1997; Valentini *et al.*, 2001).

Zeidner and Zaklofske (1996) showed a couple of coping strategies that are consistently associated with negative psychological and physiological health. Stress experiencing is lessened through overeating, alcohol abuse, smoking, self-blaming and the use of social support to evade responsibility (Björntorp, 2001). In overeating, there is an attempt to reduce the activity of the HPA axis (chronic stress-response network) with its attendant anxiety (Dallman *et al.*, 2003). Urbanisation has been associated with increases in stress and societal maladjustment (Misra & Vikram, 2004). The effect of coping styles and whether they contribute to the higher levels of hypertension and metabolic syndrome in rural and urbanised Africans requires research.

2.3 Questions arising from the literature

The questions arising from the literature are the following:

- Do African gender groups with either active or passive coping mechanisms differ regarding cardiovascular function, plasma renin activity and their subjective perception of health? (Addressed in Chapter 3, Manuscript 1);
- Will psychosocial stress or urbanisation play a role when active or passive coping strategies of African gender groups are compared regarding cardiovascular function, stress hormones and their subjective perception of health? (Addressed in Chapter 4, Manuscript 2);
- Will younger and older age African gender groups elicit different physiological responses when urbanised? When active and passive coping strategies in these rural-urbanised groups are compared, are there any differences regarding cardiovascular function, metabolic syndrome indicators and perception of own health? (Addressed in Chapter 5, Manuscript 3).

The above questions urge the need for further exploration of these behavioural reactions and coping mechanisms of Africans in order to assist in the management and prevention of cardiovascular diseases. The planned structure of the investigation included a literature overview as well as own research of the interaction of specific coping mechanisms and cardiovascular reactivity in African gender (Manuscripts 1, 2 and 3) and age groups (Manuscript 3). The train of thought is presented in Figure 2.1:

- The influence of the perception of own health (Manuscripts 1, 2, 3), plasma renin activity (Manuscript 1), endocrine hormones (Manuscripts 2, 3), fibrinogen (Manuscript 3) and metabolic syndrome indicators (Manuscript 3) on the cardiovascular profile of African gender groups with specific coping mechanisms, formed the central part of the study. The interaction of these physiological and psychological variables (Manuscripts 1, 2, 3), especially during urbanisation (Manuscripts 2, 3) in different age groups (Manuscript 3) in the development of hypertension (Manuscripts 1, 2, 3), will be scrutinised. A background overview will include characteristics of Africans regarding genetic, psychological predisposition, ethnic, physical and sympathetic nervous system stimulation patterns. The role of the hypothalamus-pituitary-adrenal cortex axis during stress is taken into account.

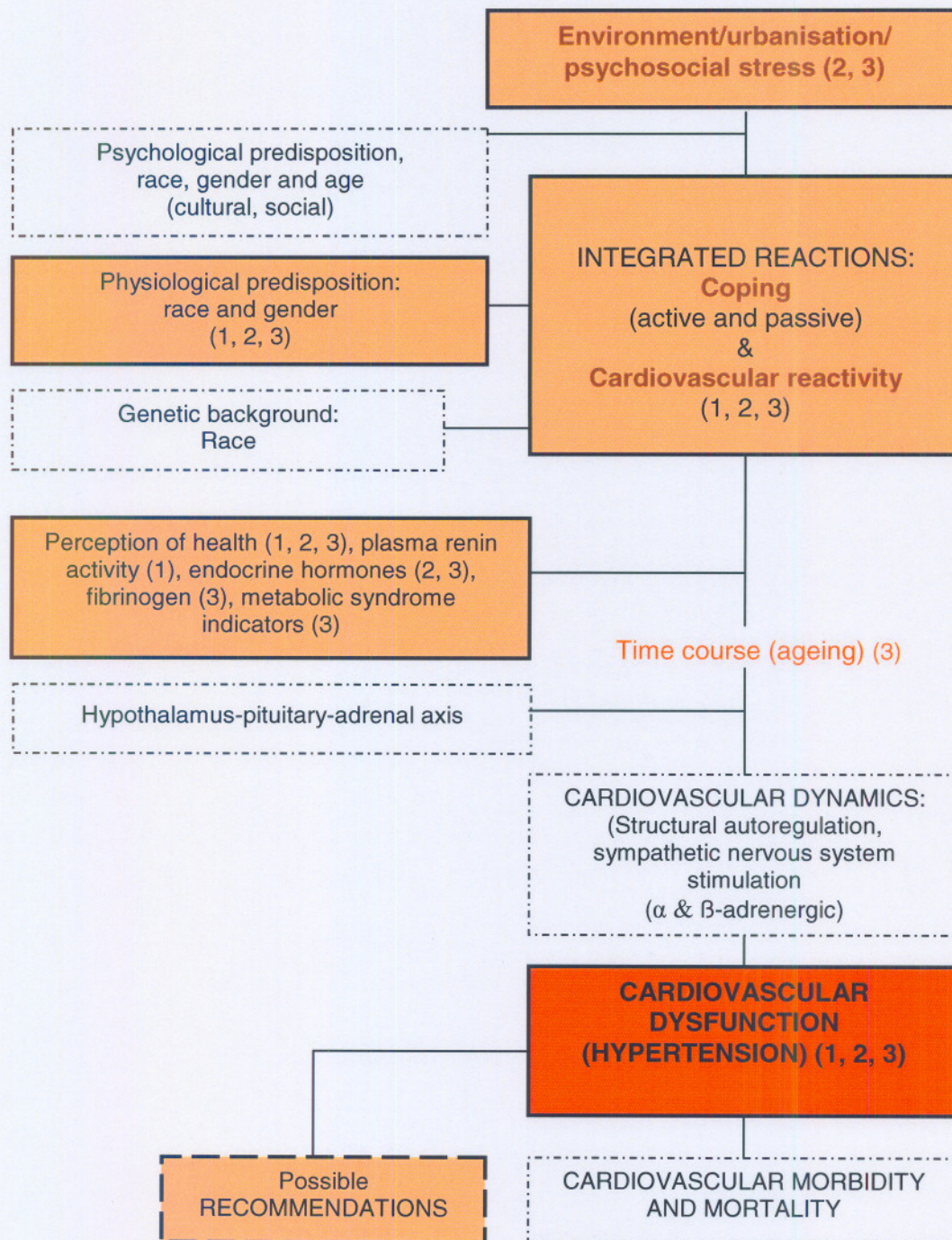


Figure 2.1: Schematic presentation of the planned structure of the thesis. Where: dotted lines, literature overview; solid lines, own research (background, coral, orange) 1, 2, 3 indicate Manuscript 1 (Chapter 3), Manuscript 2 (Chapter 4), Manuscript 3 (Chapter 5).

2.4 MAIN AIM, TITLES, MOTIVATION, SPECIFIC AIMS, OBJECTIVES AND HYPOTHESES FOR EACH MANUSCRIPT IN THIS STUDY

This thesis consists of three manuscripts submitted for publication. Since the relevant background is discussed in the manuscripts, only a brief motivation, aims and proposed hypotheses for each manuscript will be provided here.

| |
|---|
| MAIN AIM OF THESIS: TO DETERMINE THE ROLE OF SPECIFIC COPING MECHANISMS IN AFRICANS WITH REGARD TO THE STATUS OF CARDIOVASCULAR DYSFUNCTION. |
|---|

2.4.1 Manuscript 1 (Chapter 3)

Title: Coping mechanisms, perception of health and cardiovascular function in Africans.

Motivation:

Repeated exposure to acute psychological stress provokes relatively sustained blood pressure elevations. In persons who are highly responsive to stress exposure a resetting of that person's blood pressure at a higher level appears over time (Obrist, 1981). African Americans and Africans are prone to respond to stress situations with hyperreactivity. Therefore, the influence of stress coping mechanisms (namely active or passive coping) might contribute to the genesis of cardiovascular dysfunction in Africans. In Henry and co-workers' research (1986) on rats they found that passive coping especially results in higher blood pressure, loss of control and a feeling of distress. Other researchers confirmed these results in Caucasians (Gerin *et al.*, 2000; Suzuki *et al.*, 2003) but it was not confirmed in Africans. To explore these possibilities the African subject groups for this study need to be chosen according to clear responses on a Setswana COPE (S-COPE) questionnaire (Stapelberg, 1999). The influence of certain coping strategies as well as the perception of own health measured by the General Health Questionnaire and the interaction thereof with blood pressure in Africans, will be investigated.

Additionally, plasma renin activity (Esler *et al.*, 2001), which is known as a contributory factor in low renin hypertension in African Americans will be included. This activity has also been integrated in understanding the higher prevalence of cardiovascular dysfunction in Africans (Opie, 2004). In this manuscript there will be an attempt to gain some insight into cultural specific coping strategies of Africans and the physiological reactions of the Africans after exposure to a stressor, namely the handgrip test.

Specific aim:

To compare active and passive coping strategies of Africans with perception of own health and cardiovascular data in a convenience sample of African men and women who participated in the THUSA study. (All data will be adjusted for age and resting values.)

Objectives:

- a) To determine AC and PC African gender groups by using the COPE Questionnaire (Carver *et al.*, 1979), which was adapted and translated for Setswanas (S-COPE) (Stapelberg, 1999);
- b) To determine subjective perception of health measured by the translated General Health Questionnaire (Goldberg & Hiller, 1979);
- c) To determine the plasma renin activity values, measured by radio immuno assay, which will be compared with blood pressure variables;
- d) To determine the resting systolic and diastolic blood pressure values;
- e) To determine the typical AC and PC reactivity values e.g. respectively a central cardiac (cardiac output, stroke volume) and peripheral (arterial compliance, total peripheral resistance) stimulation pattern after application of the handgrip stressor;
- f) To identify the hypertension prevalence of AC and PC subjects according to the guidelines of the World Health Organisation (2003).

Hypotheses:

- Firstly, that a passive or avoidance-focused coping strategy in Africans is associated with cardiovascular dysfunction or prevalence of hypertension.
- Secondly, a passive or avoidance-focused coping strategy in Africans is associated with a perception of poorer health.

2.4.2 Manuscript 2 (Chapter 4)

Title: Specific coping strategies in Africans during urbanisation: comparing cardiovascular, endocrine and perception of health data.

Motivation:

The possibility of environmental influences or psychosocial stress on the typical coping styles of subjects as a contributory factor in the genesis of cardiovascular dysfunction will be investigated. In the ongoing transition processes in South Africa, many Africans have been subjected to a process of rapid urbanisation, which may lead to social and cultural disruption causing increased levels of stress (Van Rooyen *et al.*, 2002). Psychosocial factors and coping behaviour in managing the heightened stress response need attention. A lack of social support

and excessive hostility appear to increase an individual's risk for heart disease and coronary-related deaths (Kop, 1999; Saab *et al.*, 1997; Somova *et al.*, 1995).

Urbanisation as psychosocial stressor could influence the psychological and physiological profile. The subjective perception of health measured in Manuscript 1 (Chapter 3) motivated the additional research on the stress hormones or endocrine profile of rural-urban African men and women (Henry *et al.*, 1986). Certain coping behaviours used in stressful settings may cause dysregulation of mainly two systems, namely the hypothalamic-pituitary-adrenocortical axis (HPA-axis) and the sympatho-adrenal-medullary system (SAM). Changes in these two systems could contribute to cardiovascular diseases (Appels, 1990), enhanced cortisol (HPA-axis) and adrenergic (SAM) reactions respectively. Adrenocortical habituation of repeated stress and passive coping has been associated with this endocrine profile (Greenspan & Strewler, 1997; Heim *et al.*, 2000; Henry, 1993; Kasckow *et al.*, 2001). These factors motivated the research to determine the link between the endocrine, cardiovascular responses and perception of own health to coping strategies.

Specific aim:

Specific coping strategies of Africans during urbanisation will be compared and correlated with endocrine, cardiovascular and perception of health data. This research will be performed in a convenience sample of African gender groups who participated in the THUSA study. (All data will be adjusted for age and resting blood pressure values.)

Objectives:

- a) To determine AC and PC African gender groups by using the COPE Questionnaire (Carver *et al.*, 1979), which was adapted and translated for Setswanas (S-COPE) (Stapelberg, 1999);
- b) To determine subjective perception of health measured by the translated General Health Questionnaire (Goldberg & Hiller, 1979);
- c) To determine the resting systolic and diastolic blood pressure values;
- d) To determine the typical AC and PC reactivity values e.g. a central cardiac (cardiac output, stroke volume) and peripheral (arterial compliance, total peripheral resistance) stimulation pattern respectively in the rural and urban subjects after application of the handgrip stressor;
- e) To determine the resting endocrine values, namely cortisol, prolactin and testosterone measured by radio immuno assay, of the rural and urbanised AC and PC gender groups. These results will be correlated to cardiovascular data and integrated as supportive factor to the perception of health results;
- f) To determine the contribution of urbanisation as dependent variable towards physiological responses with a logistic regression analysis;

- g) To extend the investigation of the first manuscript by firstly comparing the cardiovascular, endocrine and perception of health results of the AC gender groups in rural and urban areas. Secondly, these results in PC African gender groups in rural and urban areas will be compared. Thirdly, these results in AC and PC urbanised groups will be compared.

Hypotheses:

- A typical passive coping mechanism in African gender groups during urbanisation firstly exhibits cardiovascular dysfunction and secondly, a distressed endocrine profile as well as a perception of poorer health.

2.4.3 Manuscript 3 (Chapter 5)

Title: Specific coping mechanisms, perception of health, vascular reactivity and metabolic syndrome indicators in Africans during urbanisation: The THUSA study.

Motivation:

The prevalence of hypertension is increasing rapidly in the developed world with overweight and obesity being known as risk factors (WHO, 2003). Björntorp (2001) further developed theories regarding the essential role of psychosocial stress in the development of visceral fat accumulation and obesity. According to this model the primary event in the chain of adverse metabolic events is the chronic arousal of the HPA-axis and stimulation of the sympathetic nervous system as a result of a defeat or depression reaction to psychosocial stress or perceived stress (Steptoe *et al.*, 2003; Stunkard *et al.*, 2003).

This motivated further scrutinizing of coping strategies in different age groups resulting in a possible clustering of co-morbidities identifying cardiovascular dysfunction and the association with metabolic syndrome risk factors (e.g. fibrinogen, glucose, triglycerides, high density lipoprotein, abdominal obesity, hypertension prevalence). The perception of own health and cortisol levels will support a profile of depression and distress adding to the development of cardiovascular dysfunction (Björntorp, 2001; Hall *et al.*, 2001; Rosmond, 2005; Whelton *et al.*, 2003).

Where the results of the previous manuscripts were adjusted for age, in this Manuscript the role of age in coping mechanisms during exposure to psychosocial stress (urbanisation) will be explored. Firstly, the rural-urban effects on variables in different age groups will be compared and secondly, the effect of age on variables between urbanised age groups (≤ 40 years and ≥ 45 years) (Bunker *et al.*, 1993; Nelson *et al.*, 2002) will be explored.

Specific aim:

To compare specific coping mechanisms of Africans during urbanisation in different age groups with perception of health, vascular reactivity and metabolic syndrome indicator values. This investigation will be conducted in a convenience sample of African gender and age groups (≤ 40 versus ≥ 45 years) who participated in the THUSA study (All data will be adjusted for cardiovascular resting values).

Objectives:

- a) To determine AC and PC African gender groups by using the COPE Questionnaire (Carver *et al.*, 1979), which was adapted and translated for Setswanas (S-COPE) (Stapelberg, 1999);
- b) To determine the subjective perception of health measured by the translated General Health Questionnaire (Goldberg & Hiller, 1979);
- c) To extend the investigation of the first two manuscripts by focusing on the following results of the urbanised men and women age groups (≤ 40 years and ≥ 45 years) (Bunker *et al.*, 1993; Nelson *et al.*, 2002) e.g. cardiovascular (diastolic blood pressure, total peripheral resistance, cardiac output, arterial compliance), anthropometric (waist-hip-ratio), fasting, resting glucose, fibrinogen, triglycerides and high density lipoprotein values;
- d) To determine the typical AC and PC reactivity values e.g. a central cardiac (cardiac output, stroke volume) and peripheral (arterial compliance, total peripheral resistance) stimulation pattern respectively in the rural and urban groups after application of the handgrip stressor;
- e) To determine the hypertension prevalence of the AC and PC rural and urbanised men and women age groups (≤ 40 years and ≥ 45 years) according to the WHO guidelines of 2003 ($\geq 140/90$ mmHg);
- f) To compare specific coping mechanisms with indicators of the metabolic syndrome of the rural and urbanised gender age groups (≤ 40 years and ≥ 45 years) according to the guidelines of the WHO (Grundy *et al.*, 2004);
- g) To determine the supporting evidence of a distress situation by measuring fasting, resting cortisol values and perception of health or well-being index. The resting cortisol values, measured by radio immuno assay, will also aid as a supportive measure for abdominal obesity in chronic stress situations.

Hypothesis:

- A typical passive coping mechanism in younger and older urbanised Africans exhibits enhanced vascular reactivity, metabolic syndrome indicator values and a perception of poorer health.

2.5 REFERENCES

- Al' ABSI, M. & ARNETT, D.K. 2000. Adrenocortical responses to psychological stress and risk for hypertension. *Biomedicine & pharmacotherapy*, 54:234-244.
- ALDWIN, C.M. 1994. Stress, coping, and development: an integrative perspective. New York : Guilford Press. 331 p.
- AMERICAN PSYCHIATRIC ASSOCIATION (APA). 1995. Diagnostic and statistical manual of mental disorders. 4th ed. Washington : American Psychiatric Association. 75 p.
- ANDERSON, N.B. 1989. Racial differences in stress-induced cardiovascular reactivity and hypertension: current status and substantive issues. *Psychological bulletin*, 105:89-105.
- ANDERSON, N.B., LANE, J.D., MONOU, H., WILLIAMS, R.B. & HOUSEWORTH, S.J. 1988. Racial differences in cardiovascular reactivity to mental arithmetic. *International journal of psychophysiology*, 6(2):161-164.
- ANDERSON, N.B. & MCNEILLY, M. 1993. Autonomic reactivity and hypertension in blacks: Toward a contextual model. (In Fray J.C.S. & Douglas, J.G. Pathophysiology of hypertension in blacks. New York : Oxford University Press, p. 104-125.)
- ANTONOVSKY, A. 1993. Complexity, conflict, chaos, coherence, coercion and civility. *Social science and medicine*, 37(8):969-974.
- APA **see** AMERICAN PSYCHIATRIC ASSOCIATION.
- APPELS, A. 1990. Mental precursors of myocardial infarction. *Britain journal of psychiatry*, 156:465-471.
- ARTHUR, A.Z. 1987. Stress as a state of anticipatory vigilance. *Perceptual and motor skills*, 64:75-85.
- AYERS, T.S., SANDLER, I.N., WEST, S.G. & ROOSA, M.W. 1996. A dispositional assessment of children's' coping: testing alternative models of coping. *Journal of personality*, 64(4):923-958.
- BARTON, M., CARMONA, R., ORTMANN, J., KRIEGER, J.E. & TRAUPE, T. 2003. Obesity-associated activation of angiotensin and endothelin in the cardiovascular system. *International journal of biochemistry & cell biology*, 35(6):826-837.
- BJÖRNTORP, P. 2001. Do stress reactions cause abdominal obesity and comorbidities? *Obesity reviews*, 2:73-86.
- BLASCOVICH, J. & KATKIN, E.S. 1993. Cardiovascular reactivity to psychological stress and disease. Washington, D.C. : American Psychological Association. 473 p.

- BODIBE, R.C. 1992. Traditional healing: an indigenous approach to mental health problems. (In UYS, J. Psychological counseling in the South African context. Johannesburg : Maskew Miller Longman. 165 p.)
- BONGARD, S., PFEIFFER, J.S., AL'ABSI, M., HODAPP, V. & LINNENKEMPER, G. 1997. Cardiovascular responses during effortful active coping and acute experience of anger in women. *Psychophysiology*, 34:459-466.
- BREWSTER, U.C. & PERAZELLA, M.A. 2004. The renin-Angiotensin-Aldosterone system and the kidney: effects on kidney disease. *American journal of medicine*, 116:263-272.
- BROOKES, L. 2003. The Seventh report of the Joint National Committee on prevention, detection, evaluation, and the treatment of high blood pressure – the NHLBI JNC7Press Conference. *Medscape Cardiology*, 7(1).
- BROWN, E.S., RUSH, A. & McEWEN, B.S. 1999. Hippocampal remodeling and damage by corticosteroids - implications for mood disorders. *Neuropsychopharmacology*, 21(4):474-484.
- BUNKER, C.H., UKOLI, F.A., NWANKWO, M.U., OMENE, J.A., CURRIER, G.W., HOLIFIELD-KENNEDY, L., FREEMAN, D.T., VERGIS, E.N., YEH, I.I. & KULLER, L.H. 1993. Factors associated with hypertension in Nigerian civil servants. *Preventive medicine*, 21:710-722.
- CALHOUN, D.A. 1993. Hypertension in blacks: socio-economic stress and sympathetic nervous system activity. *American journal of medical science*, 304:306-311.
- CANETTI, L., BACHAR, E. & BERRY, E.M. 2002. Food and emotion. *Behavioural processes*, 60:157-164.
- CARELS, R.S., BLUMENTHAL, J.A. & SHERWOOD, A. 2000. Emotional responsivity during daily life: relationship to psychosocial functioning and ambulatory blood pressure. *International journal of psychophysiology*, 36(1):25-33.
- CARROLL, D. 1992. Health psychology: stress, behaviour and disease. London : Palmer Press. 129 p.
- CARVER, C.S., SCHEIER, M.F. & WEINTRAUB, J.K. 1989. Assessing coping strategies: a theoretically base approach. *Journal of personality and social psychology*, 57(2):267-283.
- CHANG, E.C. 1996. Cultural differences in optimism, pessimism, and coping: predictors of subsequent adjustment in Asian American and Caucasian American college students. *Journal of counseling psychology*, 43(1):113-123.
- CLARKSON, T.B., MANUCK, S.B. & KAPLAN, J.R. 2003. Potential role of cardiovascular reactivity in atherogenesis. (In Whelton, P.K., He, J. & Louis, G.T. Lifestyle modification for the prevention and treatment of hypertension. New York : Dekker. p. 191.)

- COLLINS, R. & WINKLEBY, M.A. 2002. African American women and men at high and low risk for hypertension: a signal detection analysis of NHANES III, 1988-1994. *Preventive medicine*, 35(4):303-312.
- COOPER, R.S. & BORKE, J.L. 1992. Intracellular ions and hypertension in blacks. (In Fray, J.C.S. & Douglas, J.G. Pathophysiology of hypertension in blacks. New York : Oxford University Press. p. 12-13.)
- DALLMAN, M.F., PECORARO, N., AKANA, S.F., LE FLEUR, S.E., GOMEZ, F., HOUSHYAR, H., BELL, M.E., BHATNAGAR, S., LAUGERO, K.D. & MANAL, O.S. 2003. Chronic stress and obesity: a new view of "comfort food". *Neuroscience*, 100(20):11696-11701.
- DART, A.M. & KINGWELL, B.A. 2001. Pulse pressure: a review of mechanisms and clinical relevance. *Journal of the American College of Cardiology*, 37(4):975-984.
- DE BOLD, M.L.K. 1999. Estrogen, natriuretic peptides and the renin-angiotensin system. *Cardiovascular research*, 41:524-531.
- DELONGIS, A., FOLKMAN, S. & LAZARUS, R.S. 1988. The impact of daily stress on health and mood: psychological and social resources as mediators. *Journal of personality and social psychology*, 54(3):486-495.
- DENOLLET, J. 1998. Personality and coronary heart disease: the type-D scale-16 (DS16). *Annals of behavioural medicine*, 20(3):209-215.
- DIN-DZIETHAM, R., COUPER, D., EVANS, G., ARNETT, D.K. & JONES, D.W. 2004. Arterial stiffness is greater in African Americans than in whites. *American journal of hypertension*, 17:304-313.
- DRAPEAU, V., THERRIEN, F., RICHARD, D. & TREMBLAY, A. 2003. Is visceral obesity a physiological adaptation to stress? *Panminerva medicine*, 45(3):189-195.
- DRESSLER, W.W. 1993. Social and cultural influences in cardiovascular disease: a review. (In Fray, J.C.S. & Douglas, J.G. Pathophysiology of hypertension in blacks. New York : Oxford University Press. p. 69.)
- DU PLESSIS, L.A.S., LOOTS, J.M. & BRITS, J.S. 2002. Abdominal fat distribution and cardiovascular risk factors in hypertensive females. *South African journal for research in sport, physical education and recreation*, 15:157-158.
- DYSART, J.M., TREIBER, F.A., PFLIEGER, K., DAVIS, H. & STRONG, W.B. 1994. Ethnic differences in the myocardial and vascular reactivity to stress in normotensive girls. *American journal of hypertension*, 7:15-22.

- ESLER, M., RUMANTIR, M., KAYE, D. & LAMBERT, G. 2001. The sympathetic neurobiology of essential hypertension: disparate influences of obesity, stress and noradrenalin dysfunction. *American journal of hypertension*, 14:138S-146S.
- FALKNER, B. 1993. Characteristics of prehypertension in black children. (In Fray J.C.S. & Douglas, J.G. Pathophysiology of hypertension in blacks. Oxford : Oxford University Press. p. 50-60.)
- FISHER, A.H., MOSQUERA, P.M.R., VAN VIANEN, A.E.M. & MANSTEAD, A.S.R. 2004. Gender and culture differences in emotion. *Emotion*, 4(1):87-94.
- FOLKOW, B. 1987. Psychosocial and central nervous system influences in primary hypertension. *Circulation*, 76:110-119.
- FRANKL, V.E. 1967. Man's search for meaning: an introduction to logotherapy. 10th ed. New York : Washington Square Press. 215 p.
- FRAY, J.C.S. 1993. Subcellular dysregulation of renin and prorenin expression in black essential and diabetic hypertensives. (In Fray, J.C.S. & Douglas, J.G. eds. Pathophysiology of hypertension in blacks. New York : Oxford University Press. p. 217-232.)
- FRIEDMAN, B.H. & THAYER, J.F. 1998. Anxiety and automatic flexibility: a cardiovascular approach. *Biological psychology*, 47:243-263.
- GALA, R. 1990. The physiology and mechanisms of the stress-induced changes in prolactin secretion in the rat. *Stress medicine*, 8:213-218.
- GANTEN, U., SCHRÖDER, G. & WITT, M. 1989. Sexual dimorphism of blood pressure in spontaneously hypertensive rats: effects of anti-androgen treatment. *Journal of hypertension*, 7:721-726.
- GARCÍA-LEÓN, A., REYES DEL PASO, G., ROBLES, H. & VILA, J. 2003. Relative effects of harassment, frustration, and task characteristics on cardiovascular reactivity. *International journal of psychophysiology*, 47:159-173.
- GENDOLLA, G.H.E. & KRÜSKEN, J. 2001. Mood state and cardiovascular response in active coping with an affect-regulative challenge. *International journal of psychophysiology*, 4(2): 169-180.
- GERIN, W., PICKERING, T.G., GLYNN, L., CHRISTENFIELD, N., SCHWARTZ, A., CARROLL, D. & DAVIDSON, K. 2000. An historical context for behavioural models of hypertension. *Journal of psychosomatic research*, 48:369-377.
- GERRA, G., ZAIMOVIC, A., MASCETTI, G.G., GARDINI, S., ZAMBELLI, U., TIMPANO, M., RAGGI, M.A. & BRAMBILLA, F. 2001. Neuroendocrine responses to experimentally-induced psychological stress in healthy humans. *Psychoneuroendocrinology*, 26(1):91-107.

- GIBBS, J.T. & FUERY, D. 1994. Mental health and well being of black women: toward strategies of empowerment. *American journal of community psychology*, 22(4):559-583.
- GIDRON, Y., GILUTZ, H., BERGER, R. & HULEIHEL, M. 2002. Molecular and cellular interface between behaviour and acute coronary syndromes. *Cardiovascular research*, 56(1): 15-21.
- GIRDLER, S.S., TURNER, J.R., SHERWOOD, A. & LIGHT, K.C. 1993. Gender differences in blood pressure control during a variety of behavioural stressors. (In Blascovich, J. & Katkin, E.S. Cardiovascular reactivity to psychological stress & disease. Washington, D.C. : American Psychological Association. p. 184-185.)
- GOEDHARD, W.J.A. 1996. Life-expectancy vs. age of retirement: a paradox? (In Goedhard, W.J.A., ed. Age and work, 3. Den Haag : Pasmans Offsetdrukkerij. p. 141-158.)
- GOLDBERG, D.P. & HILLER, V.F. 1979. A scaled version of the General Health Questionnaire. *Psychological medicine*, 9:139-145.
- GOLDSTEIN, D.S. & MCDONALD, C.C. 1993. Biochemical indices of cardiovascular reactivity. (In Blascovich, J. & Katkin, S. Cardiovascular reactivity to psychological stress and disease. Washington, D.C. : American Psychological Association. p. 195-196.)
- GRAMER, M. 2003. Cognitive appraisal, emotional and cardiovascular responses of high and low dominant subjects in active performance situations. *Personality and individual differences*, 34(7):1303-1318.
- GREENSPAN, F.S. & STREWLER, G.J. 1997. Basic and clinical endocrinology. London : Appleton & Lange. 823 p.
- GRUNDY, M.S., BREWER, H.B., CLEEMAN, J.I., SMITH, S.C. & LENFANT, C. 2004. Definition of Metabolic Syndrome. Report of the National Heart, Lung, and Blood Institute. American Heart Association Conference on scientific issues related to definition. *Circulation*, 109:433-438.
- GUPTA, R., GUPTA, H.P., KESWANI, P., SHARMA, S., GUPTA, V.P. & GUPTA, K.D. 1995. Coronary heart disease and coronary risk factors prevalence in rural Rajasthan. *Association Physicians India*, 42:24-26.
- GUYTON, A.C. & HALL, J.E. 2000. Textbook of medical physiology. 10th ed. Philadelphia, Pa. : Saunders. 1064 p.
- HALL, J.E., HILDEBRANDT, D.A. & KUO, J. 2001. Obesity hypertension: role of leptin and sympathetic nervous system. *American journal of hypertension*, 14:103S-115S.
- HARBURG, E., BLAKELOCK, E.H. & ROPER, P.J. 1986. Resentful and reflective coping with arbitrary authority and blood pressure. (In Blascovitch, J. & Katkin, E.S. Cardiovascular

reactivity to psychological stress and disease. Washington, D.C. : American Psychological Association. p. 95-120.)

HARSHFIELD, G.A. & KAPUKU, G.K. 2004. Race differences in stress-induced pressure natriuresis and left ventricular geometry. *American journal of hypertension*, 17(5):2.

HASTRUP, J.L. & LIGHT, K.C. 1984. Sex differences in cardiovascular stress responses: modulation as a function of menstrual cycle phases. *Journal of psychosomatic research*, 28(6):475-483.

HEIM, C., EHLERT, U. & HELLHAMMER, D.H. 2000. The potential role of hypocortisolism in the pathophysiology of stress-related bodily disorders. *Psychoneuroendocrinology*, 25:1-35.

HELLHAMMER, D.H. & WADE, S. 1993. Endocrine correlates of stress vulnerability. *Psychotherapy and psychosomatics*, 60:8-17.

HENRY, J.P., STEPHENS, P.M. & ELY, D.L. 1986. Editorial review: Psychosocial hypertension and the defense and defeat reactions. *Journal of hypertension*, 4:687-697.

HERD, J.A. 1991. Cardiovascular response to stress. *Physiological reviews*, 71:305-327.

HINDERLITER, A.L., BLUMENTHAL, J.A., WAUGH, R., CHILUKURI, M. & SHERWOOD, A. 2004. Ethnic differences in left ventricular structure: relations to hemodynamics and diurnal blood pressure variation. *American journal of hypertension*, 17:43-49.

HODAPP, V., BONGARD, S. & HEILIGTAG, U. 1992. Active coping, expression of anger, and cardiovascular reactivity. *Personality and individual differences*, 13(10):1069-1076.

HOLAHAN, C.J. & MOOS, R.H. 1987. Personal and contextual determinants of coping strategies. *Journal of personality and social psychology*, 52(5):946-955.

HOLLAND, O.B., GOMEZ-SANCHEZ, C., FAIRCHILD, C. & KAPLAN, N.M. 1993. Role of renin classification for diuretic treatment of black hypertensive patients. (In Fray, J.C.S. & Douglas, J.G. Pathophysiology of hypertension in blacks. New York : Oxford University Press. p. 271-232.)

HOUSTON, B.K. 1986. Psychological variables and cardiovascular and neuroendocrine activity. (In Blascovitch, J. & Katkin, E.S. Cardiovascular reactivity to psychological stress and disease. Washington, D.C. : American Psychological Association. p. 218-218.)

HUISMAN, H.W., VAN ROOYEN, J.M., MALAN, N.T., ELOFF, F.C., MALAN, L., LAUBSCHER, P.J. & SCHUTTE, A.E. 2002. Prolactin, testosterone and cortisol as possible markers of changes in cardiovascular function associated with urbanisation. *Journal of human hypertension*, 16:829-835.

IKUENDBE, P. 1998. Moral education and moral reasoning in traditional African cultures. *Journal of value enquiry*, 32:25-42.

- JAFERI, A., NOWAK, N. & BHATNAGAR, S. 2003. Negative feedback functions in chronically stressed rats: role of the posterior paraventricular thalamus. *Physiology & behaviour*, 78:365-373.
- JAMES, S.A., KENNAN, N.L., STROGATZ, D.S., BROWNING, S.R. & GARRET, J.M. 1992. Socioeconomic status, John Henryism, and blood pressure in black adults. *American journal of epidemiology*, 135:59-67.
- JANSSEN, I., KATZMARZYK, P.T. & ROSS, R. 2004. Duration of overweight and metabolic health risk in American men and women. *Annals of epidemiology*, 14:585-591.
- JULIUS, S. 1999. The role of sympathetic over activity in the pathophysiology of cardiovascular diseases. *American journal of hypertension*, 12(4):2.
- JULIUS, S. & NESBITT, S. 1996. Sympathetic over activity in hypertension. *American journal of hypertension*, 9:113S-1120S.
- KASCKOW, J.W., BAKER, D. & GERACIOTI, T.D. 2001. Corticotropin-releasing hormone in depression and post-traumatic stress disorder. *Peptides*, 22(5):845-851.
- KATSILAMBROS, N. 2000. New developments in obesity. *European journal of internal medicine*, 11(2):65-74.
- KAUFMAN, J.S., TRACY, J.A., DURAZO-ARVIZU, R.A. & COOPER, R.S. 1997. Lifestyle, education, and prevalence of hypertension in populations of African origin. *Annals of epidemiology*, 7(1):22-27.
- KEARNEY, P.M., WHELTON, M., REYNOLDS, K., WHELTON, P.K. & HE, J. 2003. Worldwide prevalence of hypertension: a systematic review. *Journal of hypertension*, 22(1): 11-19.
- KOP, W.J. 1999. Chronic and acute psychological risk factors for clinical manifestations of coronary artery disease. *Psychosomatic medicine*, 61:476-487.
- KRANTZ, D.S. & MANUCK, S.B. 1984. Acute psychophysiological reactivity and risk of cardiovascular disease: a review and methodologic critique. *Psychological bulletin*, 96:435-464.
- KRANTZ, D.S., SANTIAGO, H.T., KOP, W.J., MERZ, C.N., ROZANSKI, A. & GOTTDIENER, J.S. 1999. Prognostic value of mental stress testing in coronary artery disease. *American journal of cardiology*, 84:1292-1297.
- KRUGER, H.S., VENTER, C.S. & VORSTER, H.H. 2001. Obesity in African women in the North West Province, South Africa is associated with an increased risk of non-communicable diseases: the THUSA study. *British journal of nutrition*, 86(6):733-740.

- KUCHEL, O.C. & KUCHEL, G.A. 1991. Peripheral dopamine in the pathophysiology of hypertension: interaction with aging and lifestyle. *Hypertension*, 18:709.
- LAITTINEN, J., EK, E. & SOVIO, U. 2002. Stress-related eating and drinking behaviour and body mass index and predictors of this behaviour. *Preventive medicine*, 34:29-39.
- LAZARUS, R.S. 1993. Coping theory and research: past, present, and future. *Psychosomatic medicine*, 55:234-247.
- LECHIN, F., VAN DER DIJS, B., RADA, I., JARA, H., LECHIN, A.E., CABRERA, A., LECHIN, M.E., JIMENEZ, V., GOMES, F., VILLA, S., ACOSTA, E. & AROCHA, L. 1990. Plasma neurotransmitters and cortisol in duodenal ulcer patients: role of stress: a study of coping men. New York : Academic Press. 218 p.
- LEPORE, S.J. 1995. Cynicism, social support, and cardiovascular reactivity. *Health psychology*, 14(3):210-216.
- LIGHT, K.C., KOTHANDAPANI, R.V. & ALLEN, M.T. 1998. Enhanced cardiovascular and catecholamine responses in women with depressive symptoms. *International journal of psychophysiology*, 28:157-166.
- LOEHR, R., ESPELAND, M.A., SUTTON-TYRELL, K., BURKE, G.L., CROUSE, J.R. III. & HERRINGTON, D.M. 2004. Racial differences in endothelial function in postmenopausal women. *American heart journal*, 148(4):606-611.
- LORENZI, R. 2003. European and US Guidelines differ on "Prehypertension". [Web:] <http://www.medscape.com/viewarticle/457239> [Date of access: 27 June 2003].
- LORENZO, C., OKOLOISE, M., WILLIAMS, K., STERN, M.P. & HAFFNER, S.M. 2003. The metabolic syndrome as predictor of type 2 diabetes: the San Antonio heart study. *Diabetes care*, 26(11):3153-3159.
- MACARTHUR, J.D. & MACARTHUR, CT. 2003. Research network on socioeconomic status and health. [Web:] <http://www.macses.ucsf.edu/research/psychosocial/notebook/reactivitytable.html> [Date of access: 21 October 2003].
- MAJHALME, S., TURJANMAA, V., TUOMISTO, M., LU, H. & UUSITALO, A. 1997. Blood pressure responses to exercise as predictors of blood pressure level after 5 years. *American journal of hypertension*, 10:106-116.
- MALAN, N.T., BRITS, J.S., ELOFF, F.C., HUISMAN, H.W., KRUGER, A., LAUBSCHER, P.J. & PRETORIUS, P.J. 1996. The influence of acculturation on endocrine reactivity during acute stress in urban black males. *Stress medicine*, 12:55-63.
- MANUCK, S.B., KAMARCK, T.W., KASPROWICZ, A.S. & WILDSTEIN, S.R. 1993. Stability and patterning of behaviourally evoked cardiovascular reactivity. (In Blascovich, J. & Katkin,

-
- E.S. Cardiovascular reactivity to psychological stress and disease. Washington, D.C. : American Psychological Association. p. 111-131.)
- MARRERO, A.F., AI'ABSI, M., PINCOMB, G.A. & LOVALLO, W.R. 1997. Men at risk for hypertension show elevated vascular resistance at rest and during mental stress. *International journal of psychophysiology*, 25:185-192.
- McADOO, W.G., WEINBERGER, M.H., MILLER, J.Z., FINEBERG, N.S. & GRIM, C.E. 1990. Race and gender influence hemodynamic responses to psychological and physical stimuli. *Journal of hypertension*, 8:961-967.
- McEWEN, B. 2003. Mood disorders and medical illness: mood disorders and allostatic load. *Biological psychiatry*, 54:200-207.
- MIDDLEMOST, S.J. 1999. Beyond systolic and diastolic blood pressure. *Cardiology*, 21:28-35.
- MISRA, A. & VIKRAM, N.K. 2004. Insulin resistance syndrome (Metabolic syndrome) and obesity in Asian Indians: evidence and implications. *Nutrition*, 20:482-491.
- MONTGOMERY, R., CONWAY, T.W. & SPECTOR, A.A. 1990. Biochemistry - a case oriented approach. 5th ed. Toronto : Mosby. 680 p.
- MUFUNDA, J., SOMOVA, L. & CHIFAMBA, J. 1994. Pathophysiological mechanisms of urbanisation - related hypertension and the sodium pressor response in black Zimbabweans. *South African medical journal*, 83:507-510.
- MUNCK, A., GUYRE, P.M. & HOLBROOK, N.J. 1984. Physiological functions of glucocorticoids in stress and their relation to pharmacological actions. *Endocrine reviews*, 5:25-44.
- MYERS, H.F. & McCLURE, F.H. 1993. Psychosocial stressors in hypertension in blacks. The case for an interactional perspective. (In Fray, J.C.S. & Douglas, J.G. Pathophysiology of hypertension in blacks. New York : Oxford University Press. p. 90-96.)
- NELSON, T.L. 2002. Obesity and associated coronary heart disease risk factors in a population of low income African American and white women: the North Carolina WISEWOMAN project. *Preventive medicine*, 35:1-6.
- OBRIST, P.A. 1981. Cardiovascular psychophysiology: a perspective. London : Plenum. 201 p.
- OLATOBOSUN, S.T., KAUFMAN, J.S., COOPER, R.S. & BELLA, A.F. 2000. Hypertension in a black population: prevalence and biosocial determinants of high blood pressure in a group of urban Nigerians. *Journal of human hypertension*, 14:249-257.

- OPIE, L.H. 2004. Heart physiology: from cell to circulation. 4th ed. Philadelphia, Pa. : Lippincott Williams & Wilkins. 648 p.
- ORR, T.E. & MANN, D.R. 1990. Effects of restraint stress on plasma LH and Testosterone concentrations, Leydig cell LH/HCG receptors and in vitro testicular steroidogenesis in adult rats. *Hormones and behaviour*, 24:324-341.
- PATTERSON, S.M., KRANTZ, D.S., GOTTDIENER, J.S., HECHT, G., VARGOT, S. & GOLDSTEIN, D.S. 1996. Prothrombic effects of environmental stress: changes in platelet function, hematocrit and total plasma protein. *Psychosomatic medicine*, 57:527-529.
- PENLEY, J.A. & TOMAKA, J. 2002. Associations among the Big Five, emotional responses, and coping with acute stress. *Personality and individual differences*, 32:1215-1228.
- PENNINX, B.W.J.H., VAN TILBURG, T., BOEKE, A.J.P., DEEG, D.J.H., KRIEGSMAN, D.M.W. & VAN EIJK, J.T.M. 1998. Effects of social support and personal coping resources on depressive symptoms: different for various chronic diseases? *Health psychology*, 6:551-558.
- PEPE, S. & LAKATTA, E.G. 2005. Aging hearts and vessels: Masters of adaptation and survival. *Cardiovascular Research*, 66:190-193.
- PIHA, S.J. 1993. Cardiovascular responses to various autonomic tests in males and females. *Clinical autonomic research*, 3:15-200.
- RAHMAN, M., DOUGLAS, J.G. & WRIGHT, J.T. 1997. Pathophysiology and treatment implications of hypertension in the African-American population. *Epidemiology and clinical decision making*, 26:125-136.
- RAIKKONEN, K., KELTIKANGAS-JARVINEN, L. & HAUTANEN, A. 1994. The role of psychosocial stress and the insulin resistance syndrome. *Metabolism*, 45:1533-1538.
- REAVEN, G.M. 2003. Importance of identifying the overweight patient who will benefit the most by losing weight. *Annals of internal medicine*, 138:420-423.
- RECKELHOFF, J.F. 2001. Gender differences in the regulation of blood pressure. *Hypertension*, 37:1199-1208.
- RESNICK, L.M., MILITIANU, D., CUNNINGS, A.J., PIPE, J.G., EVELHOCH, A., SOULEN, R.L. & LESTER, M.A. 2000. Pulse waveform an analysis of arterial compliance: relation to other techniques, age, and metabolic variables. *American journal of hypertension*, 13:1243-1249.
- ROHR, U.D. 2002. The impact of testosterone imbalance on depression and women's health. *Maturitas*, 41(1):25-46.
- ROSMOND, R. 2005. Role of stress in the pathogenesis of the metabolic syndrome. *Psychoneuroendocrinology*, 30:1-10.

- ROSMOND, R., DALLMAN, M.F. & BJORNTORP, P. 1998. Stress-related cortisol secretion in men. Relationship between abdominal obesity and endocrine, metabolic and hemodynamic abnormalities. *Journal of clinical endocrinology and metabolism*, 83:1853-1859.
- ROZANSKI, A., BLUMENTHAL, J.A. & KAPLAN, J. 1999. Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. *Circulation*, 99: 2192-2217.
- RYFF, C.D. & SINGER, B. 2002. From social structure to biology. (In Snyder, C.R. & Lopez, S.J. Handbook of positive psychology. New York : Oxford University Press. p. 541-555.)
- SAAB, P.G., LLABRE, M.M., SCHNEIDERMAN, N., HURWITZ, B.E., MCDONALD, P.G., EVANS, J., WOHLGEMUTH, P., HAYASHI, P. & KLEIN, B. 1997. Influence of ethnicity and gender on cardiovascular responses to active coping and inhibitory-passive coping challenges. *Psychosomatic medicine*, 59(4):434-446.
- SAFAR, M.E. & SMULYAN, H. 2004. Hypertension in women. *American journal of hypertension*, 17:82-87.
- SCHARABI, Y., GROTTI, I., HUERTA, M. & GROSSMAN, E. 2004. Susceptibility of the influence of weight on blood pressure in men versus women. *American journal of hypertension*, 17:404-408.
- SCHIFFMAN, S.S., GRAHAM, B.G., SATTELY-MILLER, E.A. & PETERSON-DANCY, M. 2000. Elevated and sustained desire for sweet taste in African Americans: a potential factor in the development of obesity. *Nutrition*, 16(10):886-893.
- SCHIFFRIN, E.L. 2002. Beyond blood pressure: the endothelium and atherosclerosis progression. (Multidisciplinary research group on hypertension.) *American journal of hypertension*, 15(10)1:S115-S122.
- SCHOMMER, N.C., KUHR, M., HELHAMMER, D.H., LUEDKE, R., ROTHE, U. & KIRSCHBAUM, C. 2000. Differences in habituation to psychosocial stress between the HPA-axis, the cardiovascular system and peripheral catecholamines. *Psychoneuroendocrinology*, 25(1):S53.
- SCHROOTS, J.J.F. 1993. Health and aging from a behavioural perspective. (In Schroots, J.J., ed. Aging, health and competence. Amsterdam : Elsevier. p. 112.)
- SEEDAT, Y.K. 1999. Hypertension in black South Africans. *Journal of human hypertension*, 13:97-103.
- SELYE, H. 1956. The stress of life. London : Longmans Green. 230 p.

-
- SHERWOOD, A., ROYAL, S.A. & LIGHT, K.C. 1993. Laboratory reactivity assessment: effects of casual blood pressure status and choice of task difficulty. *International journal of psychophysiology*, 14(1):81-95.
- SMIT, G.J. 1991. *Psigometrika*. Bloemfontein : HAUM. 180 p.
- SMITH, G.T. & McCARTHY, D.M. 1995. Methodological considerations in the refinement of clinical assessment instruments. *Psychological assessment*, 7(3):300-308.
- SMITH, P.A., GRAHAM, L.N., MACKINTOSH, A.F., STOKER, J.B. & MARY, S.G. 2004. Relationship between central sympathetic activity and stages of human hypertension. *American journal of hypertension*, 17(3):217-222.
- SMITH, T.W., RUIZ, J.M. & UCHINO, B.N. 2000. Vigilance, active coping, and cardiovascular reactivity during social interaction in young men. *Health psychology*, 19(4):382-392.
- SOLOMON, R. 1996. Coping with stress: a physician's guide to mental health in aging. *Geriatrics*, 51:46-51.
- SOMOVA, L.I., CONNOLLY, C. & DIARA, K. 1995. Psychosocial predictors of hypertension in black and white Africans. *Journal of hypertension*, 13(2):193-199.
- SOWERS, J.R. 2003. Obesity as a cardiovascular risk factor. *American journal of medicine*, 115(8A):37S-41S.
- STAPELBERG, R. 1999. Psychometric characteristics of the Cope and SACS in a Setswana speaking South African group. Potchefstroom : Potchefstroom University for Christian Higher Education. (MA.) 280 p.
- STEPTOE, A., OWEN, N., KUNZ-EBRECHT, S.R. & BRYDON, L. 2003. Loneliness and neuroendocrine, cardiovascular, and inflammatory stress responses in middle aged men and women. *Psychoneuroendocrinology*, 29:593-611.
- STUNKARD, A.J., FAITH, M.S. & ALLISON, K.C. 2003. Depression and obesity. *Society of biological psychiatry*, 54:330-337.
- SUAREZ, E.C., SAAB, P.G., LLABRE, M.M., KUHN, C.M. & ZIMMERMAN, E. 2004. Ethnicity, gender, and age effects on adrenoceptors and physiological responses to emotional stress. *Psychophysiology*, 41:450-460.
- SUZUKI, S., KUMANO, H. & SAKANO, Y. 2003. Effects of effort and distress coping processes on psychophysiological stress responses. *International journal of psychophysiology*, 47:117-128.
-


-
- TENNANT, C.C. & MCLEAN, L. 2000. Mood disturbances and coronary heart disease: progress in the past decade. (5 p.). [Web:] <http://www.mja.com.au>. [Date of access: 20 October 2002].
- TOMAKA, J., BLASCOVICH, J., KELSEY, R.M. & LEITTEN, C.L. 1993. Subjective, physiological, and behavioural effects of threat and challenge appraisal. *Journal of personality and social psychology*, 65(2):248-260.
- TOMAKA, J., PALACIOS, R., SCHNEIDER, K.T., COLOTLA, M., CONCHA, J.B. & HERRALD, M.M. 1999. Assertiveness predicts threat and challenge reactions to potential stress among women. *Journal of personality and social psychology*, 76(6):1008-1021.
- TRIANDIS, H.C., McCUSKER, C. & HUI, C.H. 1990. Multimethod probes of individualism and collectivism. *Journal of personality and social psychology*, 59:1006-1020.
- UCHINO, B.N. & GARVEY, T.S. 1997. The availability of social support reduces cardiovascular reactivity to acute psychological stress. *Journal of behavioural medicine*, 20(1):15-27.
- VALENTINI, M., JULIUS, S., BROOK, R.D., BISOGNANO, J.D., BARD, R.L. & KACIROTI, N. 2001. Relationship of sympathetic tone and beta adrenoreceptor responsiveness to blood pressure and overweight. *American journal of hypertension*, 14(4):224A.
- VAN DER VIJVER, T. & LEUNG, K. 1997. Methods and data analysis for cross-cultural research. London : Sage. 80 p.
- VAN DER WATEREN, E. 1997. Die dinamiek van waardes, coping style en psigologiese gesondheid by 'n groep jeugdige. Potchefstroom : Potchefstroom Universiteit vir Christelike Hoër Onderwys. (MA.) 189 p.
- VAN ITALLIE, T.B. 2002. Stress: a risk factor for serious illness. *Metabolism*, 51(6)2:40-45.
- VAN ROOYEN, J.M., HUISMAN, H.W., ELOFF, F.C., LAUBSCHER, P.J., MALAN, L., STEYN, H.S. & MALAN, N.T. 2002. Cardiovascular reactivity in black South-African males of different age groups: the influence of urbanisation. *Ethnicity and disease*, 12(1): 69-75.
- VAVREJNOVÁ, V., NEDVÍDKOVÁ, J., HORVATH, M., FRANTÍK, E. & STERZL, I. 1993. Cardiovascular responses to handgrip isometric exercise in male subjects with high versus low cardiovascular reactivity to psychological stress. *Homeostasis*, 34:324-327.
- VENTER, C.S. & VORSTER, H.H. 2000. An epidemiological study of hypertension and its determinants in a population in transition: the THUSA study. *Journal of human hypertension*, 14:779-787.
- VORSTER, H.H. 1999. Fibrinogen and women's health. *Thrombosis research*, 95:137-154.

- WALDSTEIN, S.R., BACHEN, E.A. & MANUCK, B. 1997. Active coping and cardiovascular reactivity: a multiplicity of influences. *Psychosomatic medicine*, 59:620-625.
- WALKER, A.R.P. 2003. World pandemic of obesity - any hope of its being controlled? *South African medical journal*, 93(8):598-600.
- WHELTON, P.K., HE, J. & LOUIS, G.T. 2003. Lifestyle modification for the prevention and treatment of hypertension. New York : Dekker. 191 p.
- WHO see WORLD HEALTH ORGANIZATION
- WILLIAMS, R.B. 1986. Patterns of reactivity and stress. (In Matthews, K.A., Weiss, S.M., Detré, T., Dembroski, T.M., Falkner, B., Manuck, S.B. & Williams, R.B., eds. Handbook of stress, reactivity and cardiovascular disease. New York : Wiley. p. 109-125.)
- WISSING, M.P. & VAN EEDEN, C. 2002. Empirical clarification of the nature of psychological well being. *South African journal of psychology*, 32(1):32-44.
- WORLD HEALTH ORGANIZATION. 2003. World Health Organization / International Society of Hypertension (ISH) statement on management of hypertension. *Journal of hypertension*, 21:1983-1992.
- WORLD MEDICAL ASSOCIATION DECLARATION OF HELSINKI. 2000. Ethical principles for medical research involving human subjects. (10.p) [Web:] <http://www.wma.net/c/policy/b3.htm>. [Date of access: 19 April 2004].
- WRIGHT, J.T., RAHMAN, M., SCARPA, A., FATHOLAH, M., GRIFFIN, V., JEAN-BAPTISTE, R., ISLAM, M., EISSA, M., WHITE, S. & DOUGLAS, J.G. 2003. Determinants of salt sensitivity in black and white normotensive and hypertensive women. *Hypertension*, 42:1087.
- WÜST, S., FEDERENKO, I.S., VAN ROSSUM, E.F.C., KOPER, J.W. & HELLHAMMER, D.H. 2005. Habituation of cortisol responses to repeated psychosocial stress - further characterization and impact of genetic factors. *Psychoneuroendocrinology*, 30(2):199-211.
- YERAGANI, V.K., MEIRI, P.C., POHL, R., BALON, R., DESAI, N. & GOLEC, S. 1990. Heart rate and blood pressure changes during postural change and isometric handgrip exercise in patients with panic disorder and normal controls. *Acta psychiatrica Scandinavica*, 81:9-13.
- ZEIDNER, M. 1993. Personal and contextual determinants of coping and anxiety in an evaluative situation: A prospective study. *Personality and Individual Differences*, 16(6):899-918.
- ZEIDNER, M., ZAKLOFSKE, D. 1996. Adaptive and maladaptive coping. (In Zeidner, M., Endler, N.S., eds. Handbook of coping. Canada: Wiley. p. 60-80.)
- ZHAO, S-P. & LI, X-P. 1998. The association of low plasma testosterone level with coronary artery disease in Chinese men. *International journal of cardiology*, 63(2):161-164.

Title: Coping mechanisms, perception of health and cardiovascular function in Africans.

Main aim: To compare active and passive coping strategies of African gender groups with perception of own health, plasma renin activity and cardiovascular data, where all data were adjusted for age and resting data.

Hypotheses: Firstly, a passive or avoidance-focused coping strategy in Africans is associated with cardiovascular dysfunction or prevalence of hypertension. Secondly, a passive or avoidance-focused coping strategy in Africans is associated with a perception of poorer health.

The image shows a circular manuscript cover, likely made of wood or leather, with a complex, symmetrical design. The central part is a large circle filled with a dense, interlocking knotwork pattern, possibly a variation of the Celtic 'Garden of Eatin'' or a similar design. This central circle is surrounded by a wide border of smaller, repeating knotwork motifs. The entire cover is set against a light, textured background. The text '3 Manuscript I' is printed in the center of the cover.

3
Manuscript I

INTERNATIONAL JOURNAL OF PSYCHO- PHYSIOLOGY - AUTHOR GUIDELINES

Submission policy: Manuscripts should be addressed to the Editor. Submission implies that it has not previously been published and that it is not being considered for publication elsewhere.

1. Organization of the article: Full Length Reports should be divided into sections headed by a caption (Introduction, Materials and Methods, Results, Discussion, Acknowledgements, References, etc.). The preferred medium of final submission to the Editor is on disk with the accompanying reviewed and revised manuscript.

2. Title page: The title page should contain: (i) complete title (ii) full names of all authors; (iii) complete affiliations; (iv) the number of text pages (including figures and tables) and the number of figures and tables; (v) the name and complete address of the corresponding author, telephone number, facsimile number and E-mail address.

3. Abstract. Description of the purpose of the report and should not exceed 250 words. Include a maximum of 8 keywords, which reflects the entries the author(s) would like to see in an index.

4. Authors' full names, academic or professional affiliations, and complete addresses (*telephone and fax numbers as well as e-mail address*) should be included on a separate title page.

5. Literature references. Citation of literature references in the text should be given at the appropriate place by the author's name followed by year in parentheses. Should there be more than two authors, the first author's name should be followed by et al. When there are two or more papers by the same author(s) appearing in the same year these should be distinguished by a, b, c, etc. after the year. All references cited in the text should be listed at the end of the paper on a separate page (also double spaced) according to the Harvard system. Every reference cited in the text should appear in the list of references and vice versa. Literature references must be complete, including initials of author(s) cited, year, title of paper referred to, and title of journal (abbreviated according to the List of Serial Title Word Abbreviations, CIEPS/ISDS, Paris, 1985 [ISBN 2-904938-02-8]), followed by volume and first and last pages of article (see example a below). The form of literature references to books should be author, initials, year, title of book, volume or edition, publisher, city and page number(s) referred to

(see example b below). References to authors contributing to multi-author books or to proceedings printed in book form should be similar to those for books (see example c below).

(a) Jutai, J.W., Hare, R.D., Connolly, J.F., 1987. Psychopathy and event-related brain potentials (ERPs) associated with attention to speech stimuli. *Pers. Individ. Differ* 8, 175-184.

(b) Bures, J., Buresová, O., Huston, J.P., 1983. *Techniques and Basic Experiments for the Study of Brain and Behavior*, 2nd edn., Elsevier, Amsterdam, 326 pp.

(c) Swaab, D.F., 1982. Neuropeptides. Their distribution and function in the brain. In: Buijs, R.M., Pévet, P., Swaab, D.F. (Eds.), *Chemical Transmission in the Brain. The Role of Amines, Amino Acids and Peptides*, Progress in Brain Research, Vol. 55, Elsevier, Amsterdam, pp. 97-122.

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- Each illustration must have a legend, double spaced on a separate page and begin with the number of the illustration they refer to.
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Coping mechanisms, perception of health and cardiovascular function in Africans.

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ABSTRACT

The purpose of this study was to compare active and passive coping strategies of Africans with perception of own health and cardiovascular data. The subjects included 236 apparently healthy Africans (men = 109; women = 127). The COPE questionnaire was adapted, translated and validated for Africans. Scores on reliable subscales were used to classify men and women into more active coping (AC) and more passive coping (PC) subgroups. The General Health Questionnaire measured subjective perception of health. Blood pressure was recorded before and during application of the handgrip test, using the Finapres, a continuous non-invasive blood pressure monitor. Plasma renin activity (PRA) values, measured with radio immuno assay, were compared to blood pressure variables. Analyses of co-variance, adjusted for resting values and age, indicated that PC men responded with a larger increase in total peripheral resistance (TPR) ($p = 0.006$), larger decrease in stroke volume ($p = 0.07$), smaller increase in cardiac output ($p = 0.09$) and larger increases in PRA resting ($p = 0.04$) and reactivity ($p \leq 0.05$) values than AC men. All PC women reported more depressive symptoms ($p \leq 0.05$) and young PC women presented greater hypertension prevalence rates ($p \leq 0.01$) than AC women. In conclusion, all AC and PC subjects reacted with increased vascular reactivity to the handgrip test. PC men presented enhanced vascular reactivity and PRA values. Younger PC women indicated a higher hypertension prevalence rate than younger AC women. PC subjects reported a more negative perception of health than AC subjects.

Keywords: Africans, coping, perception of health, vascular reactivity, hypertension, renin.

Word count: 245.

†Corresponding author

Introduction

From literature reviews it is evident that Africans (Van Rooyen et al., 2000) and African Americans exhibit exaggerated cardiovascular reactivity and peripheral resistance responses at rest and when exposed to stressful situations compared to Caucasians. They are, therefore, more prone to develop cardiovascular dysfunction and/or hypertension (Obrist, 1981; Anderson & McNeilly, 1993; Hinderliter et al., 2004).

Subjects with sympathetic nervous system overactivity or early stages of neurogenic hypertension exhibit excessive coronary risk factors like left ventricular and arteriolar hypertrophy (Smith et al., 2004), dyslipidemia, insulin resistance, increased hematocrit and platelet overactivity (Julius, 1999). As hypertension escalates, the hemodynamic pattern changes from a high cardiac output to a high vascular resistance pattern, with alterations in the structure and responsiveness of the heart and blood vessels. Decreased arterial compliance and diminished β -adrenergic responsiveness tend to decrease the cardiac output, whereas the development of vascular hypertrophy increases vascular resistance. Simultaneously, the sympathetic tone is down-regulated, since, with emerging vascular hyperresponsiveness, less sympathetic drive is needed to maintain the elevated blood pressure (Julius, 1999).

Genetic factors contributing to a vascular reactivity pattern both in African Americans and Africans are:

- (1) An increased level of salt sensitivity (Mufunda et al., 1994; Wright et al., 2003);
- (2) Low levels of plasma renin activity (PRA), especially in black women (Holland et al., 1993; Seedat, 1999; Opie, 2004).

Psychological factors that could contribute to enhanced cardiovascular responses in Africans are factors that are associated with urbanization and the confrontation with individualistic value systems. These are different from their traditional collectivistic value system in which interdependence, duty to in-group and maintaining harmony are important values (Wissing & Van Eeden, 2002).

A lifestyle factor that could contribute to the development of essential hypertension in Africans is coping mechanisms i.e. active versus passive coping (James et al., 1992; Suzuki et al., 2003). The precise relationship between coping processes and stress responses are unknown (Suzuki et al., 2003). It is also not well described how a particular coping style may be associated with factors that maintain and aggravate psychosomatic diseases in Africans. The specific coping strategies chosen may be related to individual differences in sensitivities of approach-related and avoidance-related motivational systems as conceptualized by Gray (1990) and empirically supported by Elliot and Thrash (2002). Obrist (1981) elaborated from a

physiological perspective on possible coping mechanisms (active and passive coping) whereby enhanced cardiac reactions could contribute to the development of high blood pressure and eventually to hypertension:

Active coping (AC) involves a beta 1 (β_1)-adrenergic mediated pattern of stimulation and the blood pressure increases via central mechanisms, e.g. increased catecholamines, heart rate, systolic blood pressure (SBP), stroke volume (SV) and cardiac output (CO), with smaller increases in diastolic blood pressure (DBP) and total peripheral resistance (TPR) (García-León et al., 2003; Henry et al., 1986; Obrist, 1981; Suzuki et al., 2003). This type of central adrenergic activity is normally evoked when an individual sees the stressor as a challenge and actively copes with the stressor. Even the perception of active behavioral control over an anticipated event (i.e. without actual control) can be accompanied by an increased SBP (Gerin et al., 2000; Williams, 1986).

Using AC as coping strategy, social support is sought to help solve the problem and all other competitive activities are suppressed until all problems are solved successfully (Stapelberg, 1999). Controllability facilitates adjustment to stressors and enhances defensive, effortful coping, although the effort involved in exerting control may be associated with increases in arousal (Krantz et al., 1999; Tomaka et al., 1993).

In contrast to AC, *passive coping* (PC) is mediated by alpha (α)-adrenergic pathways (stimulation of the locus coeruleus and thus norepinephrine). The blood pressure is elevated via vascular mechanisms with increases in skeletal muscle vasoconstriction, DBP and TPR, and decreases in the Windkessel compliance. Weaker effects on central cardiac variables e.g., heart rate, SV and CO, are apparent (Williams, 1986). A close relationship exists between an enhanced vascular reactivity with a heightened TPR response and hypertension (Opie, 2004).

A particular event may be experienced as more or less stressful depending on the degree to which it is perceived as a threat or as controllable (Henry et al., 1986; Obrist, 1981; Suzuki et al., 2003). A PC strategy is elicited by situations over which the person experiences little or no control and is indicative of surrendering and resigning behavior. Nothing can be done to change the situation or stressor and helplessness or depression sets in. The use of avoidance and overt uncontrolled expression of stress are associated with poor psychological health and pathology (Updegraff et al., 2004).

In African Americans, "John Henryism" is known which represents a strong personality disposition of effortful active coping, with few resources for successful coping (James et al., 1992), whereas no cultural specific coping strategies for Africans are known.

Exploration and understanding the coping mechanisms in Africans and whether they contribute to their higher prevalence of hypertension (Van Rooyen et al., 2000) enhances the need for this type of research.

The *hypotheses* are then firstly, that a passive or avoidance-focused coping strategy in Africans is associated with cardiovascular dysfunction or prevalence of hypertension. Secondly, a passive or avoidance-focused coping strategy in Africans is associated with a perception of poorer health.

Methods

Study design

The THUSA study (Transition and Health during Urbanization in South Africa) is a cross-sectional comparative epidemiological project, which extended over a period of two years (1996-1998). With the assistance of a bio-statistician, 37 magistrate districts or study sites in the North West Province were randomly selected. In the weeks preceding the collection of data, the sites were visited to obtain consent from tribal chiefs and government officials to work in the area and notify the local community of the visit of the research team. A convenience sample of all volunteers was recruited within each study site. Fieldworkers were recruited and trained with regard to the recruitment of subjects and supplying information to the subjects.

Subjects

Only 236 subjects of the original 821 subjects, with a complete renin data set and clear responders to active and passive coping scales were included. Subjects complying with the inclusion criteria of apparently healthy Setswana-speaking men (109) and women (127), aged 16 – 70 years were included. Hereafter, the Setswana-speaking men and women will be referred to as Africans.

Exclusion criteria for the entire study were: users of medication for hypertension; epilepsy; a history of/ or current psychotherapy and explicit diseases like metabolic, cardiovascular and cerebrovascular, such as diabetes, atherosclerosis and cerebrovascular bleedings (stroke). Subjects who had resting systolic ≥ 140 mmHg and/or diastolic ≥ 90 mmHg values were classified as hypertensive according to the WHO cut-off points (WHO, 2003).

Subjects were divided into two groups: (a) active coping (men = 54; women = 62) and (b) passive coping (men = 55; women = 65) (see Table 1) according to their responses to an †adapted and validated Setswana COPE Questionnaire (S-COPE) (Stapelberg, 1999).

†A copy of the S-COPE Questionnaire can be obtained from the corresponding author.

The S-COPE Questionnaire is based on the original Carver COPE questionnaire (Carver et al., 1989).

The Ethics Committee of the North-West University, Potchefstroom Campus approved the study. The study protocol conforms to the ethical guidelines of the Declaration of Helsinki (The World Medical Association Declaration of Helsinki, 2000). Informed consent was obtained from the subjects and the parents of underaged adolescents

Table 1: Descriptive characteristics of subjects.

| Subjects: (N=236) | Men | | Women | |
|----------------------|-------------|-------------|-------------|-------------|
| | AC (N=54) | PC (N=55) | AC (N=62) | PC (N=65) |
| Age (years) | 31.2 ± 10.1 | 37 ± 15.2 | 37.5 ± 14.9 | 32.7 ± 14.2 |
| Mass (kg) | 66 ± 16.2 | 62.1 ± 15.8 | 58.5 ± 16.9 | 58.9 ± 16.9 |
| Height (m) | 1.59 ± 6.5 | 1.58 ± 5.7 | 1.69 ± 7.2 | 1.69 ± 7.4 |
| SBP (mmHg) | 112 ± 16.2 | 116 ± 18.3 | 114 ± 16.85 | 113 ± 17.9 |
| DBP (mmHg) | 72.3 ± 10.9 | 72.3 ± 13.1 | 76.6 ± 14.2 | 75.4 ± 13.6 |

AC, active coping; PC, passive coping; N, number of subjects; SBP, systolic blood pressure; DBP, diastolic blood pressure; age, mass, height and blood pressure values are mean ± standard deviation.

Measuring instruments and apparatus

Blood pressure

Resting and stressor blood pressure was recorded by the method of Peñáz (Silke & McAuley, 1998). The **FIN**ger-**Ar**terial-**PRE**ssure device is non-invasive and monitors finger arterial blood pressure continuously (Silke & McAuley, 1998). Reactivity values (%) were calculated as changes from resting/baseline ($\% = ((X_{\text{stressor}} - Y_{\text{resting}}) / Y_{\text{resting}}) \times 100$) which were substantiated by means of the Riva-Rocci/Korotkoff method. The Finapres device is not ideal for obtaining absolute values but validated for relative changes (Imholz et al., 1998). The focus of this paper will, therefore, be on the relative changes. Data were stored on magnetic tape by means of a Kyowa RTP-50A four-channel data recorder and digitized for further analysis by means of the Fast Modelflo software program. The Fast Modelflo three element model integrates the subject's gender, body mass and stature and determines an age dependent aortic flow curve from the surface area beneath the pressure/volume curve and can, therefore, additionally calculate cardiac output (CO), stroke volume (SV); total peripheral resistance (TPR) and arterial "Windkessel" compliance of the arterial system (Wesseling et al., 1993). When

comparing invasive intra-arterial thermo-dilution-determined SV with the Modelflo software-determined SV, the Modelflo software determined aortic flow from non-invasively determined finger pressure during orthostasis correctly. This technique is, therefore, an alternative to the invasive intra-arterial measurements, without the risks and ethical questions inherent to invasive measurements (Harms et al., 1999; Wesseling et al., 1993).

Psychological questionnaires

For evaluating the psychological perception of own health and coping strategies, registered psychologists used the 28-item General Health Questionnaire (GHQ) (Goldberg et al., 1997) and the translated COPE Questionnaire of Carver et al., (1989). The latter was adapted and validated for Setswana-speaking groups by Stapelberg (1999). Both questionnaires manifested good reliability and validity for Setswana-speaking subjects in the North West Province (Stapelberg, 1999; Wissing & Van Eeden, 2002).

- ❖ *GHQ* - Cronbach alpha-reliability value: 0.82 – 0.86 (Goldberg et al., 1997) and 0.77 to 0.84 for subscales in this sample for Africans. The GHQ consists of 4 subscales with 7 items each. Subscales include somatic symptoms, anxiety and insomnia, social dysfunction and depressive symptoms. Subjects had to report on their own perceived health pattern endured for the past few weeks. Each item was evaluated on a 0-0-1-1 scale (Goldberg et al., 1997) where “end-users” (1 and 4) and “middle-users” (2 and 3) are reduced. The value of response possibilities one (1) and two (2) are equal to nil (0) and three (3) and four (4) equal to one (1). The range of the scores on the scale varies from 0 (for no symptoms) to 28 where severe pathology is present.
- ❖ *COPE Questionnaire* - Cronbach alpha-reliability value was 0.45-0.86 for sub-scales (Carver et al., 1989); S-COPE Questionnaire Cronbach alpha-reliability value was 0.85 and 0.70 for sub-scales used in an African population (Stapelberg, 1999).

The COPE questionnaire (Carver et al., 1989) is a multidimensional self-reporting questionnaire with 53 items. Each item was evaluated by using a 4-point Likert Scale that varied from 1 (I usually don't) to 4 (I usually do). Higher scores contributed towards an active or passive coping mechanism. The COPE was adapted for culture sensitivity and translated into Setswana. Exploratory factor analysis (principal factors - maximum likelihood method of factor extraction with varimax rotation), extracted three clear and reliable factors with loadings > 0.30 and eigenvalues > 1 from the original adapted Setswana translated COPE, to form the S-COPE (Stapelberg, 1999). The resulting factors which formed the subscales of the S-COPE are (1) active outreach to others, (2) surrender and resignation and (3) overt expression of distress. Participants in this study were grouped according to their scores on

these subscales by using median splits. Subjects responding to both were excluded and, therefore, independent clear responders for active or passive coping were ascertained.

- (1) Factor 1 (the *active outreach* score), forming the active coping group of this study, was calculated from items on commitment to tasks, controllability and engagement in active coping (Cronbach alpha-reliability value = 0.85).
- (2) A combination of factor 2 and 3 (*surrender, resignation and overt expression of distress scores*) formed the passive coping group. These scores were calculated from the items from factor 2 and 3 on appraisals of threat or uncontrollability and engagement in avoidant coping (Cronbach alpha-reliability value = 0.75).

Blood samples and biochemical analyses

Fasting resting and stressor blood samples (using a winged infusion set – 21G, with a heparin block - 0.5ml in 9ml normal saline) were obtained from the medial cubital vein or vena cephalica in the non-dominant arm by a registered nurse. Plasma renin activity (PRA) was determined by using a ¹²⁵I Radio Immuno Assay method of Incstar, Minnesota, USA (CA-1533, CA-1553).

Stressor/Task

The isometric handgrip test was performed with the dominant hand (Lafayette Instrument, IN.47903). Maximum strength was determined before the onset of any recordings. Due to the magnitude of the study, only one stressor was applied. This instrument is not culture specific and simulates physical work and endurance typical for this subject group. It normally evokes a stronger α - but weaker β -adrenergic autonomic stimulation pattern. This stimulation pattern relates to specific coping mechanisms i.e. passive coping to an α -adrenergic response or active coping to a β -adrenergic response (Julius, 1999; MacArthur & MacArthur, 2003).

Experimental procedure

Data collection was performed between 07:00 and 13:00 and each individual was occupied for approximately 2 hours. On arrival, the fasting subjects were all introduced to the experimental setup to minimise their anticipation stress (Obrist, 1981). Subjects completed the demographic and psychological questionnaires individually in their home language with the aid of trained Setswana-speaking fieldworkers under supervision of psychologists. After the winged infusion set was inserted, resting blood samples were obtained and the heparin block started. Plasma and serum samples were prepared according to standard methods. Subsequently, the subject was connected to the Finapres apparatus and blood pressure continuously recorded whilst in a sitting position. After a resting period of at least 10 minutes, resting blood pressure values of one minute were obtained. Blood pressure was regarded as resting when the systolic

pressure did not change by more than 10mmHg during the last minute of this period; otherwise the resting period was extended with a maximum of 2 minutes. The subject was exposed to the handgrip test at 50% of his maximum for 1 minute to challenge the cardiovascular system (Waldstein et al., 1997). A second blood sample was then taken for PRA stressor analysis.

Statistical analyses

All processed data were transferred to Microsoft Excel 2000 and further analysed by means of the software computer package STATISTICA (Statsoft, 2000). A 2 X 2 analysis of covariance (ANCOVA), adjusted for age and resting values, was conducted for each of the following variables namely cardiovascular reactivity, perception of health, plasma renin activity (PRA) and hypertension prevalence. Significant interaction on the main effects (coping X gender) led to one-way ANCOVA's per gender group. Logistic regression analyses were fitted for hypertension prevalence on gender, age and coping as independent variables. Fisher exact tests p values were determined for significance of the relationship between hypertension prevalence and coping for each gender and age group.

Results

A 2 X 2 ANCOVA on cardiovascular reactivity, health perception, PRA and hypertension prevalence scores with main effects coping style and gender was performed. No significant interaction for perception of health, PRA or hypertension prevalence values were obtained. A significant 2-way interaction showed for TPR reactivity ($F(1,231) = 4.43, p = 0.04$). This motivated the research regarding vascular reactivity per gender group. Subsequent one-way ANCOVA's, adjusted for age and resting values were, therefore, performed to do the following comparisons.

The resting blood pressure values (Table 1) were within normal blood pressure ranges (WHO, 2003). Changes in the cardiovascular parameters during exposure to the handgrip test are shown in Figure 1. All subjects indicated a vascular reaction pattern, e.g. higher DBP and TPR values than SV and CO values.

The PC men (Figure 1) showed a more pronounced vascular reactivity response. Their cardiovascular reactivity values indicated significantly greater TPR ($F(1,104) = 7.66, p \leq 0.01$) responses with smaller increases in CO ($F(1,104) = 2.82, p = 0.09$) and greater decreases in SV ($F(1,104) = 3.36, p = 0.07$). In contrast, the AC women (Figure 1) suggested an overall greater peripheral or vascular reactivity response than the PC women, although no significant differences occurred.

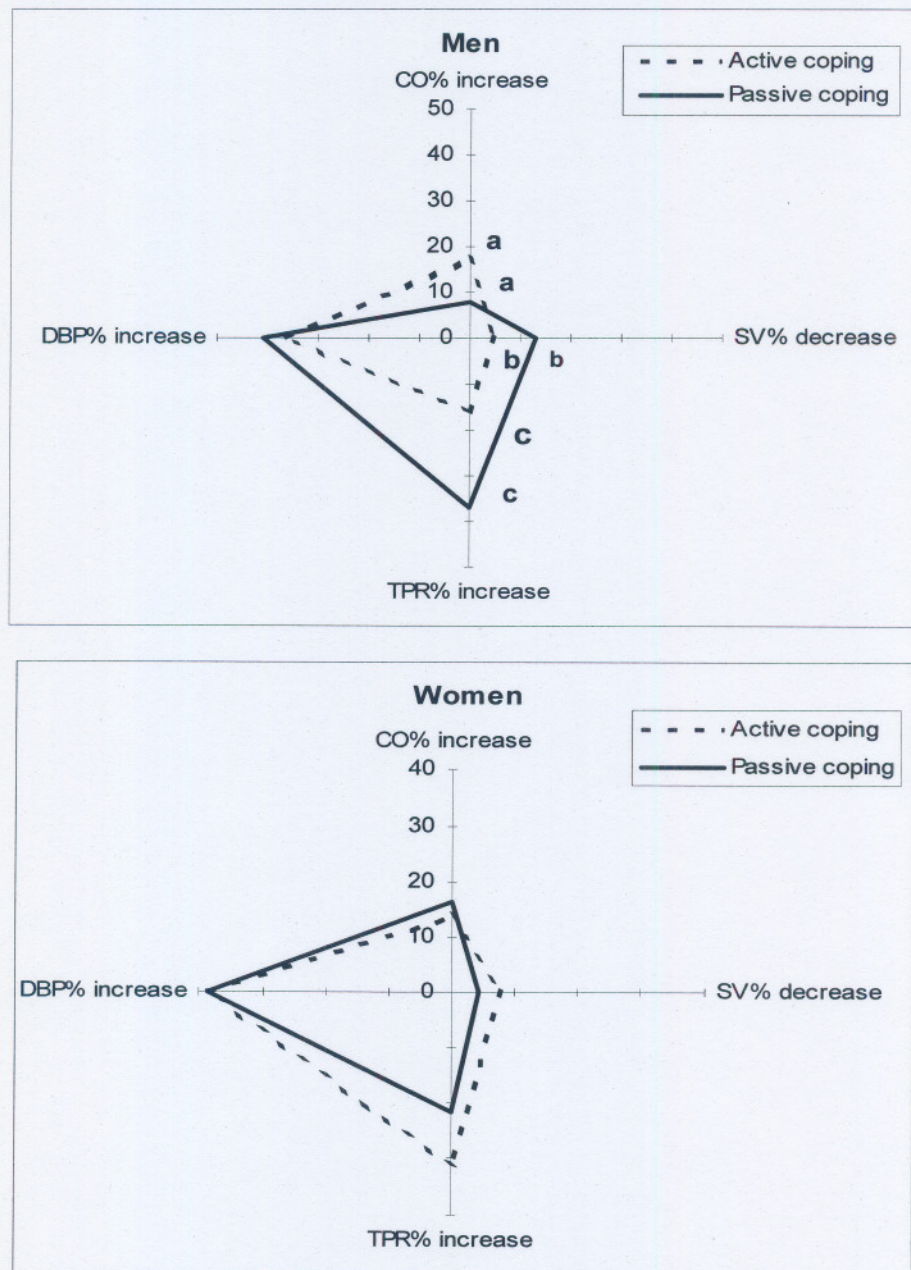


Figure 1: Star representation of the mean vascular reactivity pattern of active (men: $N = 54$; women: $N = 62$) and passive (men: $N = 55$; women: $N = 65$) coping Africans. CVR is expressed as % change from resting values after application of handgrip test for one minute; CO increase, cardiac output increase; SV decrease, stroke volume decrease; TPR increase, total peripheral resistance increase; DBP increase, diastolic blood pressure increase. Values with the same superscript letters differ significantly, a, $p = 0.09$; b, $p = 0.07$; c, $p \leq 0.01$.

Coping main effects combining men and women showed significance for PRA reactivity values ($F(1, 141) = 3.16, p \leq 0.01$). PRA and enhanced TPR values have been associated with low renin hypertension in Africans (Opie, 2004). The significant interaction of TPR motivated ANCOVA analyses for PRA per gender group. All subjects, i.e. AC and PC men and women, presented (Figure 2) below normal PRA resting values (normal values, 3.3ng/ml/h) (Greenspan

and Strewler, 1997). The PC men differed significantly from the AC men with their higher PRA resting ($F(1,63) = 4.38, p = 0.04$) and reactivity ($F(1, 60) = 3.95, p \leq 0.05$) values.

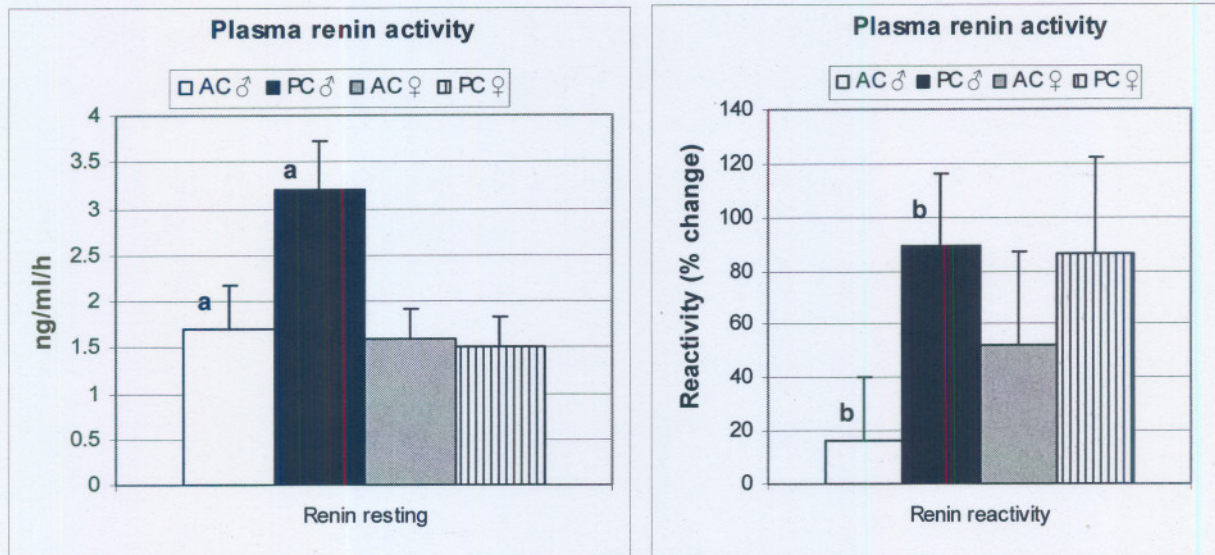


Figure 2: Plasma renin activity values in active (men: N = 54; women: N = 62) and passive (men: N = 55; women: N = 65) coping Africans. Values are mean (\pm) standard error of mean; AC, active coping; PC, passive coping; ♂, men; ♀, women. Values with the same superscript letters differ significantly, a, $p = 0.04$; b, $p \leq 0.05$.

Coping main effects combining men and women showed significance for GHQ subscales (Figure 3) namely anxiety symptoms ($F(1,232) = 8.63; p \leq 0.01$), social dysfunction ($F(1,232) = 7.11; p \leq 0.01$) and depressive symptoms ($F(1,232) = 4.08; p = 0.04$). A PC strategy, eliciting an enhanced TPR response, has been associated with a perception of poorer health (Updegraff et al., 2004). The significant interaction of TPR and greater reactivity values especially in PC men motivated ANCOVA analyses for perception of health per gender group. In Figure 3, the PC men when compared to AC men, experienced significant increased anxiety and insomnia ($F(1,106) = 8.99, p = 0.003$) and social dysfunction symptoms ($F(1,106) = 4.32, p = 0.04$). The PC women indicated more depressive symptoms ($F(1,125) = 3.77, p \leq 0.05$) when compared to AC women. The GHQ total scores indicated that PC men ($F(1,106) = 6.58; p \leq 0.01$) reported on a perception of poorer health.

Results of logistic regression analyses, when combining men and women, as well as in men alone, a good fit for the model did not exist. In women the results included, Chi square = 7.00, $p = 0.03$; odds ratio (age, 1.44; coping, 3.35). Age and especially coping in women have more pronounced effects and motivated subsequent Fisher exact tests (Figure 4) to evaluate hypertension prevalence rates in smaller age (≤ 40 years and ≥ 45 years) and gender groups. Subsequently the highest prevalence of hypertension occurred in the younger (≤ 40 years) PC women ($F(1,85) = 7.8, p \leq 0.01$) when compared to their AC counterparts.

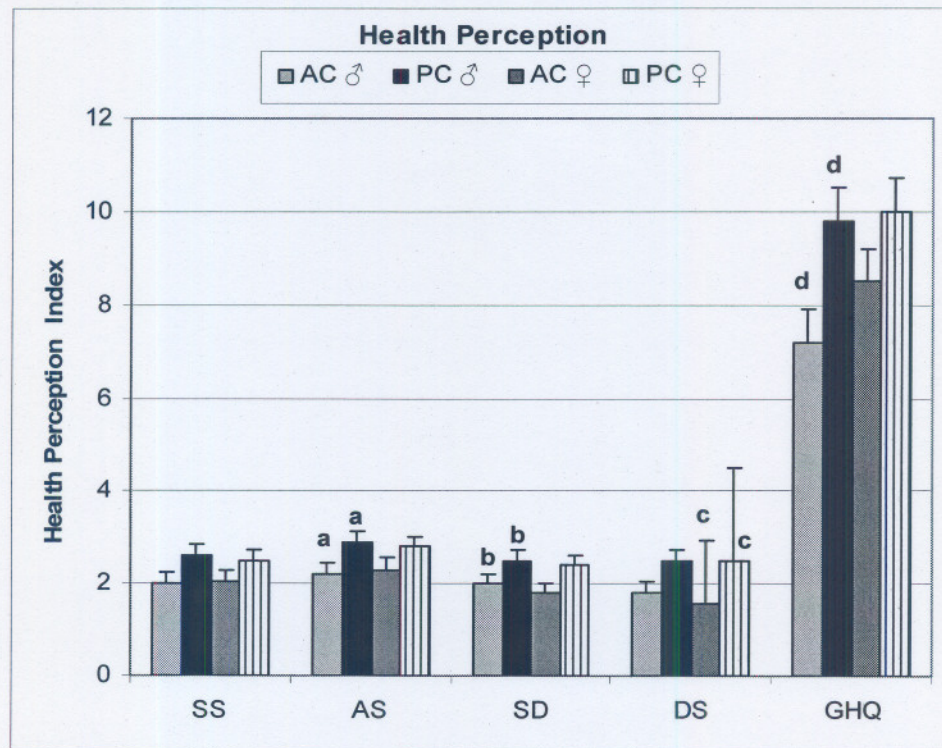


Figure 3: Health perception index of active (men: N = 54; women: N = 62) and passive (men: N = 55; women: N = 65) coping Africans. Values are mean (\pm) standard error of mean; AC, active coping; PC, passive coping; ♂, men; ♀, women; SS, somatic symptoms; AS, anxiety symptoms; SD, social dysfunction; DS, depression symptoms. Values with the same superscript letters differ significantly, a, $p = 0.003$; b, $p = 0.04$; c, $p \leq 0.05$; d, $p \leq 0.01$.

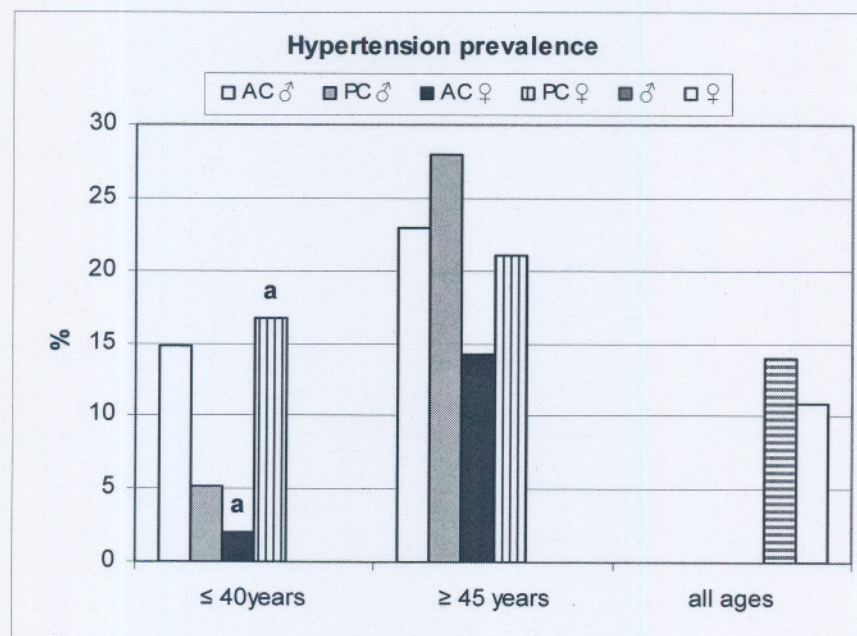


Figure 4: Fisher exact chi-square significance of the prevalence of hypertension of active (men: N = 54; women: N = 62) and passive (men: N = 55; women: N = 65) coping Africans. Values are mean (\pm) standard error of mean; AC, active coping; PC, passive coping; ♂, men; ♀, women. Hypertension prevalence: systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg. Values with the same superscript letters differ significantly, a, $p \leq 0.01$.

Discussion

The aim of this study was to compare active and passive coping strategies of Africans with perception of own health and cardiovascular data. A more or less even distribution regarding the total of subjects choosing AC or PC strategies was present (Table 1). The subjects' resting SBP and DBP values were also within normal blood pressure ranges (WHO, 2003). When the African subjects were exposed to the stressor, all the AC and PC subjects reacted with larger vascular reactivities (Van Rooyen et al., 2000). The use of a typical coping strategy (AC or PC) can interact with the task demand to potentiate or increase the size of the stress responses. Cardiovascular reactivities as markers of stress responses were, therefore, obtained (Garcia-León et al., 2003; Gerin et al., 2000; Suzuki et al., 2003).

Men

After exposure to the handgrip test, PC men showed larger increases in TPR, larger decreases in SV and smaller increases in CO compared to the AC men. These values indicate a trend where the significantly greater TPR or vascular reactivity could account for a lower pulse pressure reactivity. Although the PRA values of the PC men in Figure 2 still indicated a hypoactivity, their significantly higher PRA values could explain the enhanced vasoconstrictive effects superimposed by a higher vascular reaction. Low PRA levels are associated with a suboptimal intake of Ca^{2+} that suppresses Ca^{2+} - ATPases mediated Ca^{2+} efflux with resulting increases in intracellular Ca^{2+} (Ca_i), vascular resistance and hypertension (Cooper & Borke, 1993).

The interaction of a decrease in SV and reduced compliance will increase the pulse pressure due to a reduced buffering capacity available from the arterial wall (Dart & Kingwell, 2001; Middlemost, 1999). This will lead to increased stiffness at higher distending pressures and could be indicative of altered left ventricular function at high pressures. The higher vascular and PRA responses in the PC men indicate increased sympathetic nervous system activity with heightened alpha-receptor stimulation. The result is vasoconstriction and increases in DBP, volume expansion and peripheral vascular hyperreactivity. At later stages with increasing age, left ventricular hypertrophy could result in hypertension (Harshfield et al., 2004; Opie, 2004; Wright et al., 2003).

A recent review by Hinderliter and co-workers (2004) found that African Americans of both sexes indeed have greater left ventricular wall thickness than Caucasians and that their greater peripheral vascular resistance may perhaps be due to structural changes in the peripheral vasculature. Another study also found that African Americans have larger intima-media thickness and stiffer carotid arteries than their Caucasian counterparts (Din-Dzietham et al., 2004). Although African American data are not necessarily applicable to Africans, exposure

to mental stress may also lead to vasoconstriction and increased DBP and TPR caused by catecholamines binding to α -receptors. The result could be left ventricular wall motion abnormalities thus lending support to a role for a mechanism involving reduced supply (Gottdiener et al., 1994).

The manifestations of enhanced PRA and vascular reactivity values are in accordance with the profile of the PC men's overall perception of own poorer health. Tennant and McClean (2000) suggested that anxiety and depression, independent of conventional risk factors, could be predictive of recurrent acute cardiovascular dysfunction. In this study, the PC men also reported significantly higher levels of anxiety symptoms and social dysfunction, which could imply unsupportive social relationships where they are more likely to experience an increase in psychological and somatic problems.

Passive coping in African men, where they also have a negative perception of health, especially anxiety symptoms and social dysfunction, could intensify their insecurity and low control over the situation. Supported by larger changes in their PRA and TPR levels, it could contribute to higher vascular reactivity and possible cardiovascular dysfunction, increasing with age.

Women

In contrast, the PC women reacted quite differently from the PC men (Figure 1). The PC women when compared to the AC women suggested non-significantly smaller vascular reaction patterns, with the lowest resting PRA values (1.5ng/ml/h) of all men and women (Figure 2). Both the AC and especially the PC women's plasma renin hypoactivity could potentiate future cardiovascular dysfunction as low renin hypertension is known especially in black women (Holland et al., 1993; Opie, 2004). The PC younger women (≤ 40 years) indeed indicated a higher hypertension prevalence rate than AC younger women. Regression analyses indicated that in women the chances of age and a PC style showing higher hypertension prevalence rates were 3.34 greater than for AC women.

A PC style may originate from a repressing or avoidant coping style that characterizes individuals with emotional distress. The PC women reported a perception of poorer health but only on the depressive scale. Carels and Co-workers (2000) associated these symptoms with greater blood pressure increases. The higher hypertension prevalence rates in the younger PC women, where estrogen's protective function (De Bold, 1999) is still present, may be affected by both a PC style and lower resting PRA values. Together with a negative perception of health with regard to depressive symptoms, these findings may predict possible future cardiovascular dysfunction.

Researchers have found that African women make use of more adaptive coping strategies than men and that they appear to be emotionally stronger and resilient towards a stressful situation (Stapelberg, 1999). No obvious evidence for this statement was found in this study on African women.

In conclusion, the cardiovascular reactions during exposure to the handgrip test indicated an elevated vascular resistance pattern. Despite their behavioral disposition, i.e. an active or a passive coping strategy, an enhanced α -adrenergic vascular reactivity was apparent in all subjects. This implies that their greater vascular reactivity may be due to a cardiovascular dysfunction pattern including intrinsic wall structure properties augmented by a plasma renin hypoactivity, especially in women. A passive coping style enhances this cardiovascular dysfunction pattern. As only the younger PC women presented higher hypertension prevalence rates the first hypothesis is, therefore, only partially accepted. The second hypothesis, namely that a perception of poorer health is associated with a passive coping style, is accepted.

Weaknesses of this study include groups that were too small for more significant differences to prevail especially testing hypertension prevalence. Only one stressor was used and when comparing active and passive coping mechanisms an additional task that typically produces a myocardial pattern is necessary. The golden standard, pulse wave velocity, was not used to measure arterial compliance and also the psychosocial environment, which could influence coping mechanisms, ought to be considered for future studies.

It is recommended that in early childhood, children should have the opportunity to learn how to cope with everyday stressors under guided supervision. By learning how to manage stress while adapting constructive coping strategies can also help in the behavioral prevention of future cardiovascular dysfunction.

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References

- Anderson, N.B., McNeilly, M., 1993. Autonomic reactivity and hypertension in blacks: toward a contextual model. In: Fray, J.C.S., Douglas, J.G., Pathophysiology of hypertension in blacks. Oxford University Press, New York, pp. 104-125.
- Bunker, C.H., Ukoli, F.A., Nwankwo, M.U., Omene, J.A., Currier, G.W., Holifield-Kennedy, L., Freeman, D.T., Vergis, E.N., Yeh, L.L., Kuller, L.H., 1993. Factors associated with hypertension in Nigerian civil servants. *Prev. Med.* 21, 710-722.
- Carels, R.S., Blumenthal, J.A., Sherwood, A., 2000. Emotional responsivity during daily life: relationship to psychosocial functioning and ambulatory blood pressure. *Int. J. Psychophysiol.* 36(1), 25-33.
- Carver, C.S., Scheier, M.F., Weintraub, J.K., 1989. Assessing coping strategies: a theoretically base approach. *J. Pers. Soc. Psychol.* 57(2), 267-283.
- Cooper, R.S., Borke, J.L., 1993. Intracellular ions and hypertension in blacks. In: Fray, J.C.S., Douglas, J.G., Pathophysiology of hypertension in blacks, Oxford University Press, New York, pp. 12-13.
- Dart, A.M., Kingwell, B.A., 2001. Pulse pressure - a review of mechanisms and clinical relevance. *J. Am. Coll. Cardiol.* 37(4), 975-984.
- De Bold, M.L.K., 1999. Estrogen, natriuretic peptides and the renin-angiotensin system. *Cardiovasc. Res.* 41, 524-531.
- Din-Dzietham, R., Couper, D., Evans, G., Arnett, D.K., Jones, D.W., 2004. Arterial stiffness is greater in African Americans than in whites. *Am. J. Hypertens.* 17, 304-313.
- Elliot, A.J., Trash, T.M., 2002. Approach avoidance motivation in personality: approach and avoidance temperaments and goals. *J. Pers. Soc. Psychol.* 82, 804-818.
- García-León, A., Reyes Del Paso, G., Robles, H., Vila, J., 2003. Relative effects of harassment, frustration, and task characteristics on cardiovascular reactivity. *Int. J. Psychophysiol.* 47, 159-173.
- Gerin, W., Pickering, T.G., Glynn, L., Christenfield, N., Schwartz, A., Carroll, D., Davidson, K., 2000. An historical context for behavioral models of hypertension. *J. Psychosom. Res.* 48, 369-377.
- Goldberg, D.P., Gater, R., Sartorius, T.B., Ustun, T.B., Piccinelli, M., Gureje, O., Rutter, R., 1997. The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychol. Med.* 27, 191-197.
- Gottdiener, J.S., Kop, W.J., Hausner, E., McCeney, M., Herrington, D., Krantz, D.S., 2003. Effects of mental stress on flow-mediated brachial arterial dilation and influence of behavioral factors and hypercholesterolemia in subjects without cardiovascular disease. *Am. J. Cardiol.* 92(6), 687-691.
- Gray, J.A., 1990. Brain systems that mediate both emotion and cognition. *Cognition and emotion* 4, 2969-2988.

- Greenspan, F.S., Stewler, G.J., 1997. Basic and clinical endocrinology, 5th ed. Appleton & Lange, London. 823 p.
- Harms, M.P.M., Wesseling, K.H., Pott, F., Jenstrup, M., Van Goudoever, J., Secher, N.H., 1999. Continuous stroke volume monitoring by modelling flow from non-invasive measurement of arterial pressure in humans under orthostatic stress. *Clin. Sci.* 97, 291-301.
- Harshfield, G.A., Kapuku, G.K., 2004. Race differences in stress-induced pressure natriuresis and left ventricular geometry. *Am. J. Hypertens.* 17(5), 2.
- Henry, J.P., Stephens, P.M., Ely, D.L., 1986. Editorial review: Psychosocial hypertension and the defense and defeat reactions. *J. Hypertens.* 4, 687-697.
- Hinderliter, A.L., Blumenthal, J.A., Waugh, R., Chilukuri, M., Sherwood, A., 2004. Ethnic differences in left ventricular structure: relations to hemodynamics and diurnal blood pressure variation. *Am. J. Hypertens.* 17, 43-49.
- Holland, O.B., Gomez-Sanchez, C., Fairchild, C., Kaplan, N.M., 1993. Role of renin classification for diuretic treatment of black hypertensive patients. In: Fray, J.C.S., Douglas, J.G. Pathophysiology of hypertension in blacks. Oxford University Press, New York, pp. 271-232.
- Imholz, B.P.M., Wieling, W., Van Montfrans, G.A., Wesseling, K.H., 1998. Fifteen years experience with finger arterial pressure monitoring: assessment of the technology. *Cardiovasc. Res.* 38, 605-616.
- James, S.A., Kennan, N.L., Strogatz, D.S., Browning, S.R., Garret, J.M., 1992. Socioeconomic status, John Henryism, and blood pressure in black adults. *Am. J. Epidemiol.* 135, 59-67.
- Julius, S., 1999. The role of sympathetic overactivity in the pathophysiology of cardiovascular diseases. *Am. J. Hypertens.* 12(4), 2.
- Krantz, D.S., Santiago, H.T., Kop, W.J., Merz, C.N.B., Rozanski, A., Gottdiener, J.S., 1999. Prognostic value of mental stress testing in coronary artery disease. *Am. J. Cardiol.* 84, 1292-1297.
- MacArthur, J.D., MacArthur, C.T., 2003. Research network on socioeconomic status and health: laboratory tasks for cardiovascular reactivity research. (5 p.). [Web:] <http://www.macses.ucsf.edu/research/psychosocial/notebook/reactivitytable.html> [Date of access: 21 October 2003].
- Middlemost, S.J., 1999. Beyond systolic and diastolic blood pressure. *Cardiology*, 21, 28-35.
- Mufunda, J., Somova, L., Chifamba, J., 1994. Pathophysiological mechanisms of urbanization - related hypertension and the sodium pressor response in black Zimbabweans. *S. Afr. Med. J.* 83, 507-510.
- Obrist, P.A., 1981. Cardiovascular psychophysiology: a perspective. Plenum, London. 201 p.
- Opie, L.H., 2004. Heart Physiology - from cell to circulation, 4th ed. Philadelphia, Pa. : Lippincott Williams & Wilkins. 648 p.

- Seedat, Y.K., 1999. Hypertension in black South Africans. *J. Hum. Hypertens.* 13, 97-103.
- Silke, B., McAuley, D., 1998. Accuracy and precision of blood pressure determination with the Finapres: an overview using re-sampling statistics. *J. Hum. Hypertens.* 12, 403-409.
- Smith, P.A., Graham, L.N., Mackintosh, A.F., Stoker, J.B., Mary, S.G., 2004. Relationship between central sympathetic activity and stages of human hypertension. *Am. J. Hypertens.* 17(3), 217-222.
- Stapelberg, R., 1999. Psychometric characteristics of the Cope and SACS in a Setswana speaking South African group. Potchefstroom University for Christian Higher Education, Potchefstroom, (MA.). 350 p.
- Statsoft, Inc., 2000. STATISTICA for Windows (Computer program manual). Tulsa, OK, Statsoft, Inc.
- Suzuki, S., Kumano, H., Sakano, Y., 2003. Effects of effort and distress coping processes on psychophysiological stress responses. *Int. J. Psychophysiol.* 47, 117-128.
- Tennant, C.C., McLean, L., 2000. Mood disturbances and coronary heart disease: progress in the past decade. (5 p.). [Web:] <http://www.mja.com.au>. [Date of access: 23 November 2004].
- Tomaka, J., Blascovich, J., Kelsey, R.M., Leitten, C.L., 1993. Subjective, physiological, and behavioral effects of threat and challenge appraisal. *J. Pers. Soc. Psychol.* 65(2), 248-260.
- Updegraff, J.A., Gable, S.L., Taylor, S.E., 2004. What makes experiences satisfying? The interaction of approach - avoidance motivations and emotions in well-being. *J. Pers. Soc. Psychol.* 86, 496-504.
- Van Rooyen, J.M., Kruger, H.S., Huisman, H.H., Wissing, M.P., Margetts, B.M., Venter, C.S., Vorster, H.H., 2000. An epidemiological study of hypertension and its determinants in a population in transition: the THUSA study. *J. Hum. Hypertens.* 14, 779-787.
- Waldstein, R., Bachen, E.A., Manuck, B., 1997. Active coping and cardiovascular reactivity: a multiplicity of influences. *Psychosom. Med.* 59, 620-625.
- Wesseling, K.H., Jansen, J.R.C., Settels, J.J., Schreuder, J.J., 1993. Computation of aortic flow from pressure in humans using a nonlinear, three-element model. *J. Appl. Physiol.* 75, 2566-2573.
- WHO (World Health Organization), 2003. World Health Organization WHO / International Society of Hypertension (ISH) statement on management of Hypertension. *J. Hypertens.* 21, 1983-1992.
- Williams, R.B., 1986. Patterns of reactivity and stress. In: Matthews K.A., Weiss, S.M., Detré, T., Dembroski, T.M., Falkner, B., Manuck, S.B., Williams, R.B., (Eds.), *Handbook of stress, reactivity and cardiovascular disease*. Wiley, New York, pp. 109-125.
- Wissing, M.P., Van Eeden, C., 2002. Empirical clarification of the nature of psychological well-being. *S. Afr. J. Psychol.* 32(1), 32-44.


World Medical Association Declaration of Helsinki, 2000. Ethical principles for medical research involving human subjects. (10 p.). [Web:] [http://www.wma.net / c / policy / b3.htm](http://www.wma.net/c/policy/b3.htm). [Date of access: 19 April 2004].

Wright, J.T., Rahman, M., Scarpa, A., Fatholahi, M., Griffin, V., Jean-Baptiste, R., Islam, M., Eissa, M., White, S., Douglas, J.G., 2003. Determinants of salt sensitivity in black and white normotensive and hypertensive women. *Hypertension* 42, 1087.

Title: Specific coping strategies of Africans during urbanization: comparing cardiovascular, endocrine and perception of health data.

Main aim: To compare specific coping strategies with cardiovascular, endocrine and perception of health data in Africans during urbanization. All data were adjusted for age and resting cardiovascular data.

Hypotheses: A typical passive coping style in African gender groups during urbanization firstly exhibits cardiovascular dysfunction and secondly, a distressed endocrine profile as well as a perception of poorer health.



4
Manuscript 2

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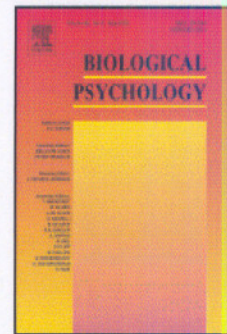
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Specific coping strategies of Africans during urbanization: comparing cardiovascular, endocrine and perception of health data.

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ABSTRACT

Specific coping strategies of Africans during urbanization were compared to and correlated with endocrine, cardiovascular and well-being data. Subjects included men (N = 286) and women (N = 360). The S-COPE (Setswana COPE) and General Health Questionnaires respectively classified subjects as active (AC) or passive (PC) copers and measured subjective perception of health. The Finapres recorded blood pressure continuously before and during application of the handgrip test. Fasting, resting serum cortisol, prolactin and testosterone values were determined with radio immuno assay methods. Variables adjusted for resting cardiovascular data and age showed that AC rural subjects indicated central cardiac responses whereas AC and PC urbanized subjects indicated greater peripheral responses and hypertension prevalence rates. Urbanized AC men and PC women showed greater prolactin and lower testosterone levels than rural subjects. Urbanized AC women reported more anxiety symptoms and PC women more depressive symptoms than their rural counterparts. In conclusion, a PC and a physiologically dissociated AC style in urbanized African men and women presented greater vascular reactivity and hypertension prevalence. Urbanized AC subjects presented a distressed endocrine profile and urbanized women a more negative perception of health.

Keywords: Africans, coping, vascular reactivity, hypertension, endocrine, perception.

Word count: 186.

†Corresponding author

Introduction

Traditional African culture is typically collectivistic in nature and affiliation and interdependency are accentuated in this group. Chang (1996) suggests that collectivism during modernization or urbanization is replaced by individualism. This change (psychosocial stress) and accompanying insecurities and disruption in African social relationships could contribute to the experiencing and perception of poor health or distress (Carels et al., 2000).

African American gender groups and African men, when exposed to stressful situations as during urbanization, exhibit exaggerated peripheral resistance responses (Fray and Douglas, 1993; Van Rooyen et al., 2002). Exposure to more chronic social and environmental stressors, which interact with biological, behavioral and psychological risk factors may cause an elevated secretion of catecholamines (Folkow, 2000; Light et al., 1998). If this is more than the metabolic needs it may lead to enhanced Na^+ retention and volume overload, resulting in morphological changes in the arterial vasculature (Fray and Douglas, 1993). This process of more stress exposure could, therefore, be detrimental to their vascular health.

The body's principal adaptive responses to stress stimuli are mediated by an intricate stress system which includes the hypothalamic-pituitary-adrenocortical (HPA) axis and the sympatho-adrenal-medullary system (SAM). Dysregulation of the HPA axis with decreased or habituated HPA responses can be caused by the cumulative burden of chronic environmental stress challenges (allostatic load) (Jaferi et al., 2003; McEwen, 2003). A heightened sensitivity of the HPA negative feedback inhibition may appear with a down-regulation of hypothalamic-corticotrophic-factor receptors and decreased levels of cortisol (Gerra et al., 2001; Hellhammer and Wade, 1993). This may contribute to the development of a variety of illnesses including hypertension, metabolic syndrome and distress (Gerin et al., 2000; VanItallie, 2002; Smith et al., 2004).

The role of active and passive coping mechanisms during chronic stress especially in individuals who are hyperreactive towards stress, needs to be investigated (DeLongis et al., 1988; Lazarus & Folkman, 1984; Van Rooyen et al., 2002). Some psychosocial stressors demand control, defensive, effortful coping and vigilance e.g., active coping (Henry et al., 1986). During active coping the influence of a β -adrenergic vasodilatory activity (β_1 and β_2) is more pronounced e.g. increases in catecholamines, small changes in corticosteroid secretion, greater increases in testosterone and increasing blood pressure via central cardiac mechanisms with increases in the cardiac output and stroke volume (Esler et al., 2001; Gerin et al., 2000; Henry et al., 1986; Obrist 1981; Opie, 2004). In contrast, passive coping could be elicited by situations in which the person has little or no control. Here the influence of an α -adrenergic

vasoconstrictory activity is more pronounced with increases in adrenocorticotrophic hormone (ACTH), greater increases in cortisol and smaller changes in catecholamines. Blood pressure is elevated via vascular or peripheral mechanisms with increases in total peripheral resistance (Gerin et al., 2000; Henry et al., 1986).

Selye's general adaptation syndrome theory postulates that prolonged, uncontrollable physical and/or psychological distress may also ultimately result in a state of exhaustion (Selye, 1956). The exhaustion preceding cardiac events is the consequence of prolonged psychological distress (Appels, 1990). Distressing situations e.g., those characterized by threat, lack of control and anticipation of aversive events are associated with an HPA axis dysregulation (Helhammer and Wade, 1993). The sympathetic nervous system - HPA axis interaction has been the topic of many studies, but according to Schommer et al., (2000), it is necessary to study the possible implications of the individual habituation profile. Literature on coping styles and the exhaustion of psychophysiological resources for psychological well-being during psychosocial stress is sparse and, therefore, motivated this research.

The hypotheses proposed are that a typical passive coping style in African gender groups during urbanization firstly exhibits cardiovascular dysfunction and secondly, a distressed endocrine profile as well as a perception of poorer health.

Methods

Study design

The THUSA study (Transition and Health during Urbanization in South Africa) is a cross-sectional comparative epidemiological project, which extended over a period of three years (1996-1998). With the assistance of a biostatistician, 37 magistrate districts or study sites in the North West Province were randomly selected representing all the health districts as well as all levels of urbanization. In the weeks preceding the collection of data the sites were visited to obtain consent from tribal chiefs, government officials and the Department of Health to work in the area and notify the local community of the visit of the research team. A convenience sample of all volunteers was recruited within each study site. Fieldworkers were recruited and trained with regard to the recruitment of subjects and to supply information to the subjects in their own language. They also had to ensure that the subjects fasted overnight prior to the day of the study. Vorster and Co-workers (2000) published the design and methodology of the THUSA study.

Subjects

A convenience sample of 821 fasting subjects was included. Subjects complying with the inclusion criteria of apparently healthy Setswana-speaking volunteers, men (286) and women

(360), aged 16 – 70 years were included. Subject characteristics are supplied in Table 1. Hereafter, the Setswana-speaking men and women will be referred to as Africans. Exclusion criteria were: pregnancy, lactation, casual visitors to the study site, body temperature above 37.5°C, inebriation, acute or chronic medication, infectious diseases (including tuberculosis), hypertension (systolic \geq 140 mmHg and/or diastolic \geq 90 mmHg, WHO, 2003), epilepsy, diabetes mellitus, malnutrition, a history of/or current psychotherapy, incomplete data set and responders to both active and passive coping scales.

Subjects were divided into two groups: (a) active coping (AC) and (b) passive coping (PC) men and women. This was done according to their responses to an †adapted and validated Setswana COPE Questionnaire (S-COPE) (Stapelberg, 1999), based on the original Carver COPE questionnaire (Carver et al., 1989). These two groups (AC and PC) were then subdivided into rural and urbanized groups. Rural subjects included subjects living in tribal areas and in farmland dwellings. Urban subjects included subjects living in informal settlements (peri-urban fringe area of the greater metropolitan area) and in established townships with full access to water and electricity.

The Ethics Committee of the North-West University, Potchefstroom Campus approved the study. The study protocol conforms to the ethical guidelines of the Declaration of Helsinki (The World Medical Association Declaration of Helsinki, 2000). Informed consent was obtained from the subjects and the parents of underaged adolescents.

Experimental procedure

Data collection was performed between 07:00 and 13:00 and each individual was occupied for approximately two hours. On arrival the fasting subjects were introduced to the experimental setup to minimise their anticipation stress (Obrist, 1981). Blood sampling was performed during the first part of the data collection period and the number of subjects undergoing the procedures was adequate to limit the effect of circadian hormonal rhythms. After the winged infusion set was inserted, resting blood samples were obtained and the heparin block started. Serum samples were prepared according to standard methods. Blood samples were centrifuged in a cooled centrifuge at 3000 rpm for 10 minutes and kept on ice until the serum and plasma were divided into aliquots. In the field, aliquots were immediately frozen with a mixture of salt and ice and placed in a standard freezer (-18 to -22°C). In the laboratory, samples were stored at -84°C.

Subjects completed the demographic and psychological questionnaires individually in a structured interview format in their home language with the aid of trained African fieldworkers under supervision of psychologists.

†A copy of the S-COPE Questionnaire can be obtained from the corresponding author.

Subsequently, the subject was connected to the Finapres apparatus and blood pressure continuously recorded whilst in a sitting position. After a resting period of at least 10 minutes, resting continuous blood pressure values of one minute were recorded. Blood pressure was regarded as resting when the systolic pressure did not change by more than 10 mmHg during the last minute of this period; otherwise the resting period was extended by a maximum of two minutes. The subject was exposed to the handgrip test at 50% of his/her maximum for one minute to challenge the cardiovascular system (Waldstein et al., 1997) and these recordings were used as task-induced values. Another blood sample was obtained for task-induced values and prepared according to standard methods.

Measuring instruments and apparatus

Psychological questionnaires

For evaluating the perception of own health the registered psychologists used the 28 item General Health Questionnaire (GHQ) (Goldberg and Hiller, 1979). The GHQ consists of 4 subscales with 7 items each. Subscales include somatic symptoms, anxiety and insomnia, social dysfunction and depressive symptoms. Subjects reported on their own perceived health pattern endured during the past few weeks. Each item was scored on a 0-0-1-1 scale (Goldberg et al., 1997). The range of the scores varied from 0 (for no symptoms) to 28 where severe pathology is present. Cronbach alpha-reliability indices for subscales varied between 0.77 and 0.84 in this study.

The COPE Questionnaire of Carver et al. (1989) is a multidimensional selfreporting questionnaire with 53 items. Each item was responded to on a 4-point Likert scale that varied from 1 (I usually don't) to 4 (I usually do). Higher scores indicated more frequent use of a particular coping mechanism. Stapelberg extracted an emic factor pattern from the original COPE through exploratory factor analysis (principal factors - maximum likelihood method of factor extraction with varimax rotation), indicating three clear and reliable factors with loadings >0.30 and eigenvalues > than 1. These factors are (1) Active outreach-to-others, (2) Surrender and resignation and (3) Overt expression of distress. Cronbach alpha-reliability values varied from 0.85 to 0.70 for subscales in the S-COPE (Stapelberg, 1999).

The first subscale was taken to indicate active coping (approach strategy with strong emphasis on engagement in active coping, actively seeking social support, commitment to tasks and controllability) (Cronbach alpha-reliability, 0.85). The second and third factors were combined for the purposes of this study to form a measure of passive coping (avoidance strategy with strong emphasis on appraisals of threat or uncontrollability and expression of distress) (Cronbach alpha-reliability, 0.75). The active coping subscale included items such as "I talk to someone who could do something helpful about the problem", "I take direct action to deal with

the problem” and “I try to find comfort in my religion”. The passive coping subscale included items such as “I reduce the amount of effort I am putting into solving the problem”, “I just give up trying to reach my goal”, and “I become upset and am very aware of my feelings”.

Participants in this study were grouped into active and passive coping groups according to the above subscales by using median splits. Subjects presenting low and high scores on both were excluded (men, N = 25; women, N = 33) and, therefore, only independent clear responders for active or passive coping were retained.

Stressor/Task

The isometric handgrip test was performed with the dominant hand (Lafayette Instrument, IN.47903). Maximum strength was determined before the onset of any recordings. Due to the magnitude of this field study, only one stressor was applied. This instrument is not culture specific and simulates physical work and endurance typical for this subject group. It normally evokes a stronger α but weaker β -adrenergic autonomic stimulation pattern. This stimulation pattern relates to specific coping mechanisms i.e. passive coping to an α -adrenergic response or active coping to a β -adrenergic response (Julius, 1999; MacArthur and MacArthur, 2003).

Blood pressure

Resting and task-induced blood pressure were recorded by the method of Peñáz (Silke & McAuley, 1998). The **FINGER-ARTERIAL-PRESSURE** device is non-invasive and monitors finger arterial blood pressure continuously (Silke & McAuley, 1998). Reactivity values (%) were calculated as changes from resting/baseline ($\% = ((X_{\text{stressor}} - Y_{\text{resting}}) / Y_{\text{resting}}) \times 100$). Reference will only be made to resting values. The resting values for systolic and diastolic blood pressure were also substantiated by means of the Riva-Rocci/Korotkoff method. The Finapres device is not ideal for obtaining absolute values but it is validated and suitable for determining relative changes in comparative studies (Wesseling *et al.*, 1993). Data were stored on magnetic tape by means of a Kyowa RTP-50A four-channel data recorder and digitized for further analysis by means of the Fast Modelflo software program. The Fast Modelflo three element model integrates the subject's gender, body mass and stature and determines an age dependent aortic flow curve from the surface area beneath the pressure/volume curve and can, therefore, additionally calculate cardiac output (CO), stroke volume (SV), total peripheral resistance (TPR) and arterial “Windkessel” compliance (Cw) of the arterial system (Wesseling *et al.*, 1993). When comparing invasive intra-arterial thermo-dilution-determined SV with the Modelflo software-determined SV, the Modelflo software determined aortic flow from non-invasively determined finger pressure during orthostasis correctly (Harms *et al.*, 1999). This technique is thus an alternative to the invasive intra-arterial measurements, without the risks and ethical questions inherent to invasive measurements (Wesseling *et al.*, 1993).

Biochemical analyses

Fasting, resting and task-induced blood samples (using a winged infusion set – 21G, with a heparin block - 0.5ml in 9ml normal saline) were obtained from the medial cubital vein or vena cephalica in the non-dominant arm by a registered nurse. All the biochemical analyses were executed in the same laboratory by using standardized methods as follows: *cortisol* (CA-1529, CA-1549) and *testosterone* (CA-1558) TM [¹²⁵I] RIA kits of Incstar, Minnesota, USA. For *prolactin* (CA-40-2165), the 100T TM [¹²⁵I] RIA kit, Nichols Institute Diagnostics, was used. The intra-assay and inter-assay coefficients of variation for cortisol were 6.6 and 9.0%, for testosterone 6.2 and 13.6% and for prolactin 3.5 and 8.0%. The assay sensitivities for cortisol were 0.21µg/dl with the method of Rodbard and Feldman (1978) and for testosterone, 0.059ng/ml, and prolactin, 0.14ng/ml, with the 2 S.D. method.

Statistical analyses

All processed data were transferred to Microsoft Excel XP and further analysed by means of the software computer package STATISTICA (Statsoft, 2004). Endocrine data were not normally distributed and, therefore, logarithmically transformed. The reliability of the S-Cope Questionnaire was determined by using Cronbach alpha (α) reliability coefficient. Partial correlation coefficients between variables, adjusted for age and resting cardiovascular data within each group were performed. Logistic regression analyses (Table 1) were performed to determine the most significant ($p \leq 0.05$) determinants contributing to specific coping mechanisms during urbanization in men and women. Urbanization was used as the dependent variable with the following independent variables: age, coping scores, cardiovascular reactivity values, hypertension prevalence rates, health perception scores and resting logarithmically transformed endocrine values (cortisol, prolactin and testosterone). Analyses of covariance (ANCOVA), adjusted for resting cardiovascular data and age for significant differences between means of active and passive coping groups were done. Results were regarded as statistically significant when $p \leq 0.05$ and as highly significant when $p \leq 0.01$.

Results

Partial correlation coefficients were calculated to evaluate the relationship between coping strategies and cardiovascular, endocrine and well-being data and no significant correlations were obtained. This was followed by a logistic regression analysis of men and women with urbanization as the dependent variable (Table 1). Using this model 73.7% of the cases in men were correctly predicted in a cross validation (Odds Ratio = 5.88), indicating the contribution of urbanization towards the physiological responses. Significant associations were obtained for Cw reactivity ($p \leq 0.01$), depression symptoms ($p \leq 0.01$), resting testosterone log ($p \leq 0.01$), hypertension prevalence ($p \leq 0.05$) and age ($p = 0.08$) values. In the women, 65.57% of the cases were correctly predicted (Odds Ratio = 3.56), indicating the contribution of urbanization

towards the physiological responses. Significant associations were obtained for Cw reactivity ($p \leq 0.01$), resting prolactin log ($p \leq 0.05$), hypertension prevalence ($p \leq 0.01$) and age ($p \leq 0.01$) values. A comparison between the two coping strategy groups with respect to the means of cardiovascular, endocrine and well-being/perception of health variables were performed by using ANCOVA's, adjusted for resting cardiovascular data and age.

Table 1: Logistic regression with urbanization as dependent variable
(Kleinbaum, 1994).

| <i>Independent variables</i> | <i>Men</i> | <i>Women</i> |
|------------------------------|--|---|
| | <i>Urbanization</i> | <i>Urbanization</i> |
| | <i>Perc.correct = 73.71%</i> <i>Odds ratio = 5.88</i> | <i>Perc. correct = 65.57%</i> <i>Odds ratio = 3.56</i> |
| Compliance reactivity | $p \leq 0.01$ | $p \leq 0.01$ |
| Depressive symptoms | $p \leq 0.01$ | NS |
| Log resting prol | NS | $p \leq 0.05$ |
| Log resting test | $p \leq 0.01$ | NS |
| HT | $p \leq 0.05$ | $p \leq 0.05$ |
| Age | $p = 0.08$ | $p \leq 0.01$ |

Where: log, logarithmically transformed; Perc.correct, percentage correctly predicted; prol, prolactin; test, testosterone; HT, hypertension prevalence; NS, not significant; $p \leq 0.05$, statistically significant; $p \leq 0.01$, statistically highly significant.

In order to evaluate coping mechanisms in rural-urban areas, the ANCOVA - adjusted mean responses of the different groups were compared, namely the rural AC men and women (Table 2; Figure 1) with the urbanized AC men and women. Subsequently the rural PC men and women (Table 2; Figure 2) were compared with their urbanized counterparts, followed by the comparison of the urbanized AC and PC men and women's responses (Figure 3).

In Table 2 descriptive statistics and endocrine data of subject groups were evaluated. The resting systolic and diastolic blood pressure values of all the subjects were within normal blood pressure ranges (WHO, 2003). The urbanized AC men exhibited higher resting systolic ($p \leq 0.05$) (SBP) and diastolic ($p \leq 0.01$) (DBP) blood pressure values than their rural counterparts, whereas only the DBP of the urbanized AC women and PC men differed significantly from their rural counterparts. All urbanized AC and PC groups presented greater hypertension prevalence values ($p \leq 0.01$; PC women, $p \leq 0.05$). When the urbanized AC and PC groups were compared, no significant differences in resting blood pressure or the endocrine variables existed (data not shown).

Table 2: A comparison of rural versus urban mean resting (95% CI) and F(dF) values of active and passive coping Africans (adjusted for age).

| MEN | AC ♂ rural (N = 59) | AC ♂ urban (N = 86) | p, F(dF) values | PC ♂ rural (N = 46) | PC ♂ urban (N = 95) | p, F(dF) values |
|---------------|--|--|---|--|--|--|
| SBP (mmHg) | 112.5^a (107, 118) | 120.65^a (116, 125) | p ≤ 0.05 <i>F</i> (1,16) = 5.31 | 110.02 (105, 115) | 117.53 (114, 121) | p = 0.14 <i>F</i> (1,115) = 5.7 |
| DBP (mmHg) | 70.79^b (68, 75) | 82.70^b (79, 86) | p ≤ 0.01 <i>F</i> (1,123) = 21.13 | 71.27^c (67, 75) | 78.73^c (76, 81) | p ≤ 0.01 <i>F</i> (1,115) = 9.53 |
| HT | 0.09^d (-0.02, 0.2) | 0.34^d (0.25, 0.44) | p ≤ 0.01 <i>F</i> (1,123) = 11.5 | 0.02^e (-0.08, 0.13) | 0.21^e (0.13, 0.27) | p ≤ 0.01 <i>F</i> (1,115) = 7.15 |
| Log cort | 1.170 (1.10, 1.23) | 1.174 (1.11, 1.22) | p = 0.93 <i>F</i> (1,95) = 0.02 | 1.18 (1.10, 1.25) | 1.19 (1.14, 1.24) | p = 0.93 <i>F</i> (1,88) = 0.10 |
| Log prol | 0.76^f (0.69, 0.84) | 0.88^f (0.811, 0.95) | p ≤ 0.05 <i>F</i> (1,105) = 5.10 | 0.82 (0.76, 0.90) | 0.91 (0.85, 0.96) | p = 0.09 <i>F</i> (1,95) = 2.92 |
| Log test | 0.72^g (0.65, 0.79) | 0.59^g (0.53, 0.65) | p ≤ 0.01 <i>F</i> (1,96) = 8.41 | 0.65 (0.57, 0.74) | 0.60 (0.55, 0.65) | p = 0.38 <i>F</i> (1,87) = 1.31 |
| WOMEN | AC ♀ rural (N = 100) | AC ♀ urban (N = 83) | p, F(dF) values | PC ♀ rural (N = 84) | PC ♀ urban (N = 93) | p, F(dF) values |
| SBP (mmHg) | 109.37 (105, 113) | 115.49 (112, 119) | p = 0.08 <i>F</i> (1,156) = 5.00 | 113.72 (109, 118) | 115.50 (111, 120) | p = 0.66 <i>F</i> (1,138) = 0.31 |
| DBP (mmHg) | 67.58^h (65, 70) | 74.42^h (72, 77) | p ≤ 0.01 <i>F</i> (1,156) = 12.58 | 69.39 (66, 72.5) | 73.65 (71, 77) | p = 0.06 <i>F</i> (1,138) = 3.55 |
| HT | 0.02ⁱ (-0.03, 0.08) | 0.15ⁱ (0.09, 0.21) | p ≤ 0.01 <i>F</i> (1,156) = 8.36 | 0.08^j (0.00, 0.16) | 0.21^j (0.12, 0.28) | p ≤ 0.05 <i>F</i> (1,138) = 3.83 |
| Log cort | 1.04 (0.99, 1.08) | 1.02 (0.97, 1.08) | p = 0.75 <i>F</i> (1,120) = 0.10 | 1.04 (0.98, 1.00) | 1.02 (0.97, 0.99) | p = 0.75 <i>F</i> (1,120) = 0.10 |
| Log prol | 0.81 (0.73, 0.87) | 0.89 (0.81, 0.96) | p = 0.09 <i>F</i> (1,132) = 2.73 | 0.80^k (0.73, 0.87) | 0.92^k (0.81, 0.96) | p ≤ 0.01 <i>F</i> (1,132) = 2.73 |
| Log test | -0.71 (-0.79, -0.63) | -0.77 (-0.87, -0.71) | p = 0.66 <i>F</i> (1,126) = 1.92 | -0.69^l (-0.79, -0.62) | -0.80^l (-0.87, -0.71) | p ≤ 0.05 <i>F</i> (1,126) = 1.92 |

95 % CI, 95 % confidence interval, F(dF), degrees of freedom; AC, active coping; PC, passive coping; ♂, men; ♀, women; N, number of subjects; SBP, systolic blood pressure; DBP, diastolic blood pressure; HT, hypertension prevalence; log, logarithmically transformed; cort, cortisol; prol, prolactin; test, testosterone. Values with the same superscript letters differ significantly; p ≤ 0.05, statistically significant; p ≤ 0.01, statistically highly significant.

The endocrine profile of the urbanized AC men compared to their rural counterparts indicated higher prolactin values ($p \leq 0.05$) and lower testosterone values ($p \leq 0.01$). No differences existed between the PC rural-urban men.

In Table 2 the greater prolactin ($p \leq 0.01$) and lower testosterone ($p \leq 0.05$) values of the urbanized PC women presented the same trend as in the urbanized AC men. The prolactin values of urban AC women and PC men were higher than their rural counterparts ($p = 0.09$). No differences in resting cortisol values existed between any of the groups. Also no significance regarding endocrine reactivity values were obtained and, therefore, only resting values were taken into account.

Firstly, in Figure 1 the cardiovascular data, degrees of freedom values $F(dF)$ values and confidence intervals 95% (CI) of AC subjects indicate that the rural AC men exhibited a greater central response e.g. higher CO ($F(1,123) = 7.05$, $p \leq 0.01$; CI: 16.0, 29.2) than their urban (CI: 5.10, 16.4) counterparts. The urbanized AC men, though, had significantly greater TPR responses ($F(1,123) = 5.48$, $p \leq 0.05$; CI: -0.51, 16.5) with larger decreases in Cw ($F(1,123) = 8.02$, $p \leq 0.01$; CI: -27.2, -20.3) than the rural AC men (respectively CI: 13.9, 28.4; CI: -33.1, -27.3). The same trend is seen in the women with the rural AC women having a larger albeit non-significant central CO response than the urban AC women. The urbanized AC women also exhibited significantly larger TPR increases ($F(1,156) = 5.21$, $p \leq 0.05$; CI: 1.81, 30.2) with larger decreases in Cw ($F(1,156) = 19.5$, $p \leq 0.01$; CI: -24.0, -34.2) and SV reactivity values ($F(1,156) = 3.54$; $p = 0.06$; CI: -8.68, 0.57). This was in comparison to the rural AC women's TPR (CI: 25.1, 55.9), Cw (CI: -34.2, -28.3) and SV (CI: -17.1, -5.59) values.

Secondly, when the rural-urban PC subjects (Figure 2) were compared, it was evident that no differences existed although both groups showed a peripheral effect. An enhanced vascular reactivity is seen in the urbanized PC men with significantly larger Cw responses ($F(1,114) = 0.49$, $p \leq 0.01$; CI: -26.5, -17.4) than in the rural PC men (CI: -35.2, -29.1). The urbanized PC women had the same peripheral pattern but no significant differences were noted.

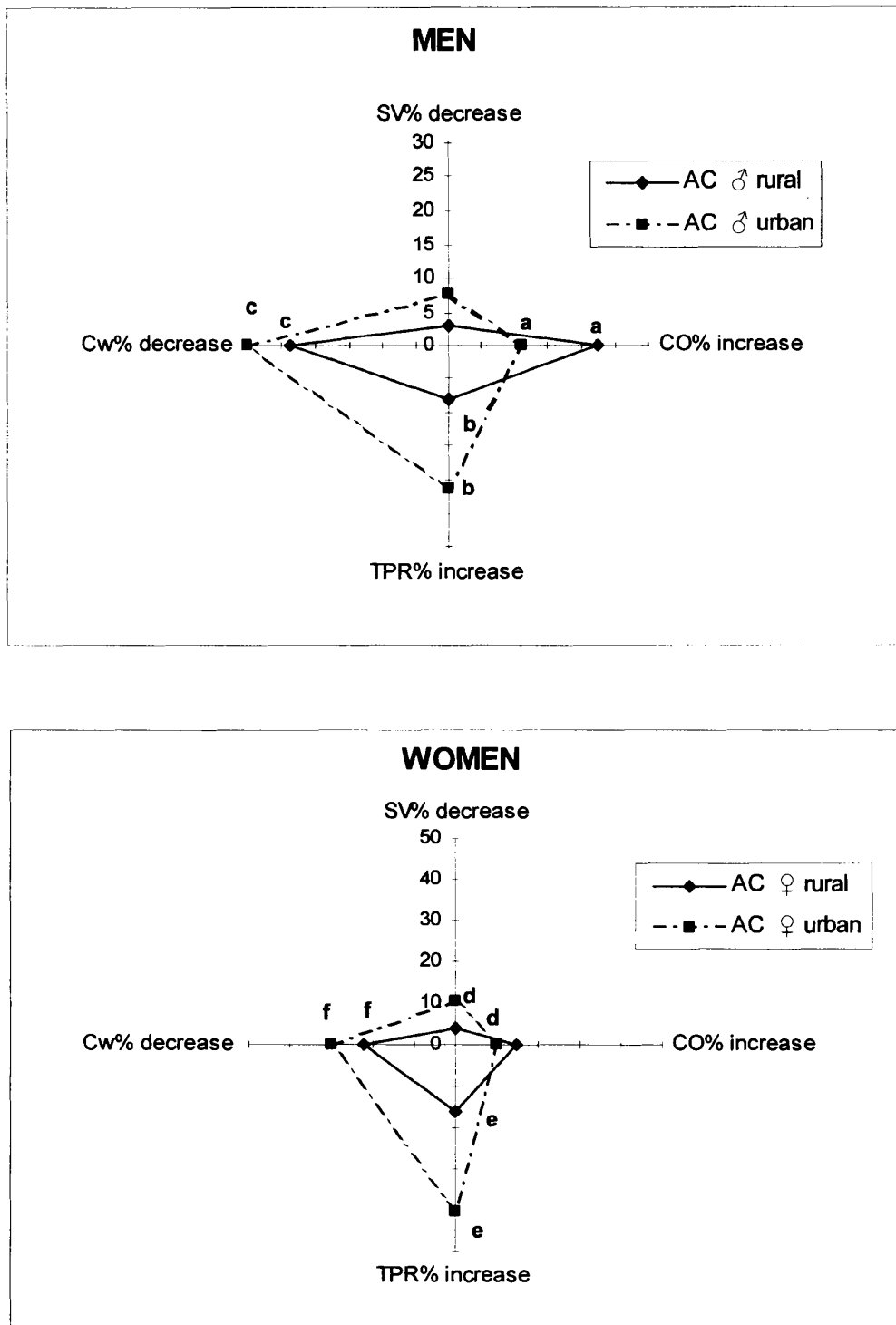


Figure 1: Comparison of central versus peripheral mean cardiovascular reactivity (CVR) values of rural active (♂, n = 59; ♀, n = 100) and urban active (♂, n = 86; ♀, n = 83) coping African men and women. CVR is expressed as % change from resting values. Variables are adjusted for resting values and age; AC, active coping; PC, passive coping; ♂, men; ♀, women; n, number of subjects, SV, stroke volume; CO, cardiac output; TPR, total peripheral resistance; Cw, arterial compliance. Values with the same superscript letters differ significantly where: a, b, $p \leq 0.01$; c, d, e, $p \leq 0.05$; f, $p = 0.06$.

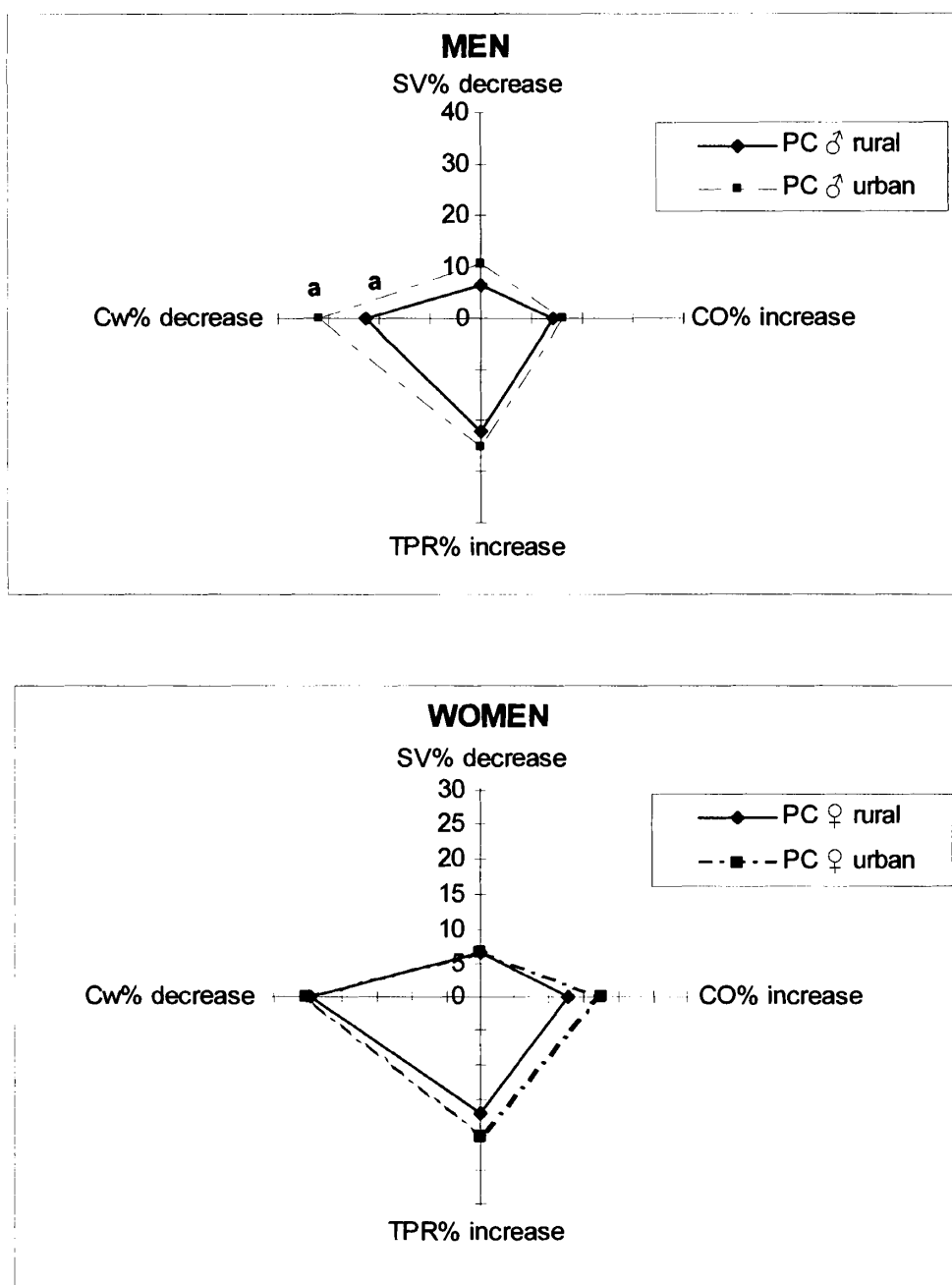


Figure 2: Comparison of central versus peripheral mean cardiovascular reactivity (CVR) values of rural passive (♂, n = 46; ♀, n = 84) and urban passive (♂, n = 95; ♀, n = 93) coping African men and women. CVR is expressed as % change from resting values. Variables are adjusted for resting values and age; AC, active coping; PC, passive coping; ♂, men; ♀, women; n, number of subjects, SV, stroke volume; CO, cardiac output; TPR, total peripheral resistance; Cw, arterial compliance. Values with the same superscript letters differ significantly where: a, $p \leq 0.05$.

Thirdly, when the urbanized AC and PC men were compared (Figure 3), no significant differences between variables were obtained. The trend in both groups was towards a peripheral reactivity pattern. The same trend in the urbanized AC and PC women (Figure 3) was apparent where they showed a shift towards a peripheral reactivity pattern with the urbanized

AC women showing a significantly greater peripheral effect. The greater TPR reactivity ($F(1,142) = 2.89$, $p = 0.09$; CI: 23.8, 56.9) in the urbanized AC women was accompanied by a larger decrease in Cw reactivity ($F(1,142) = 4.43$, $p \leq 0.05$; CI: -33.1, -27.2) in comparison to their PC counterparts' values respectively TPR (CI: 3.51, 36.8) and Cw (CI: -28.1, -22.4).

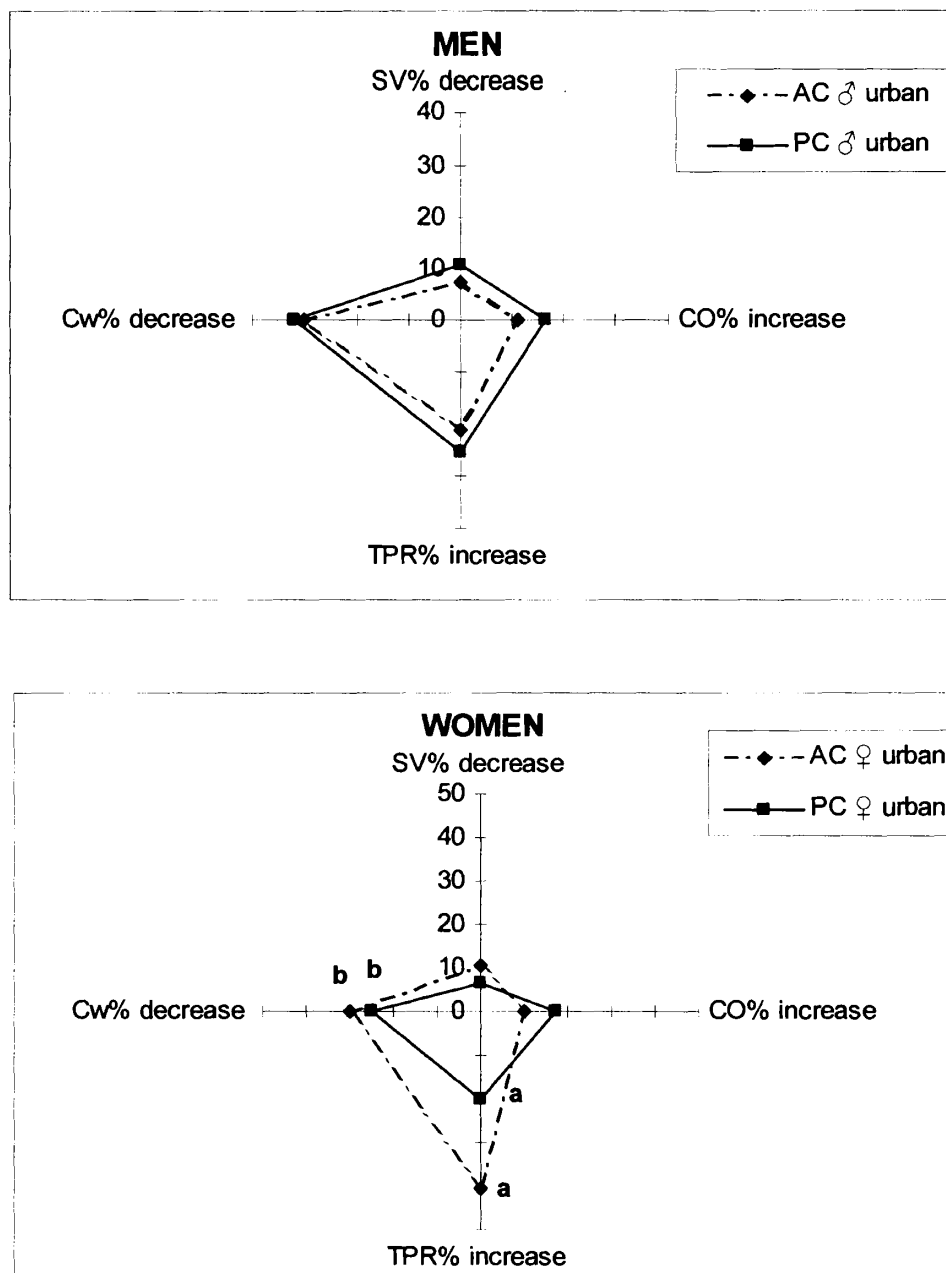


Figure 3: Comparison of central versus peripheral mean cardiovascular reactivity (CVR) values of urban active (♂, $n = 86$; ♀, $n = 83$) and urban passive (♂, $n = 95$; ♀, $n = 93$) coping African men and women. CVR is expressed as % change from resting values. Variables are adjusted for resting values and age; AC, active coping; PC, passive coping; ♂, men; ♀, women; n , number of subjects; SV, stroke volume; CO, cardiac output; TPR, total peripheral resistance; Cw, arterial compliance. Values with the same superscripts letters differ significantly, where: a, $p = 0.09$; b, $p \leq 0.05$.

In Figure 4 the health perception index of the different subject groups is provided. The urbanized AC women complained more about anxiety symptoms ($F(1,217) = 0.51$, $p \leq 0.05$; CI: 2.31, 3.11) than their PC counterparts (CI: 2.14, 2.90). The urbanized PC women reported more symptoms of depression ($F(1,217) = 9.65$, $p \leq 0.01$; CI: 2.12, 2.72) than urbanized AC women (CI: 1.21, 1.94).

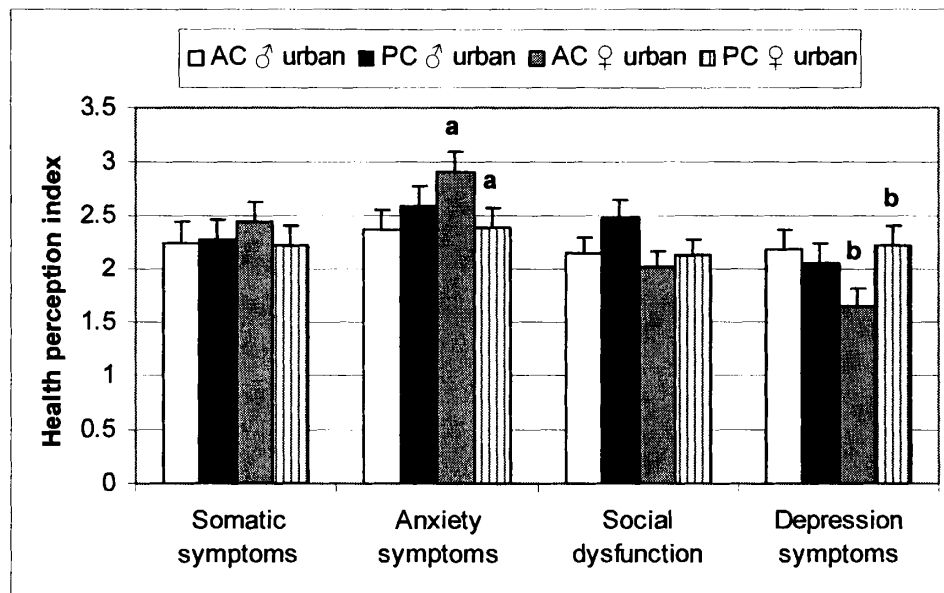


Figure 4: Health perception index means (\pm SEM) of urban active (δ , $n = 86$; δ , $n = 83$) coping versus urban passive (δ , $n = 95$; δ , $n = 93$) coping African men and women. SEM, standard error of means; AC, active coping; PC, passive coping; δ , men; δ , women; n , number of subjects. Values with the same superscript letters differ significantly, a, $p \leq 0.05$; b, $p \leq 0.01$.

Discussion

From the literature it is known that Africans (Van Rooyen et al., 2002) and African Americans respond with heightened vascular reactivity when exposed to stress (Fray and Douglas, 1993; Gerin et al., 2000; Hinderliter et al., 2004; Suarez et al., 2004). In this study of Africans though, another perspective is emerging. In Figure 1 it is clear that when divided into groups according to active or passive coping mechanisms and levels of urbanization, the AC men and women in rural areas responded to the handgrip test with a more typical central cardiac reaction than urban AC subjects. The urbanized AC men and women showed a peripheral vascular response with increases in TPR and decreases in compliance. The rural PC, urbanized AC and PC groups responded according to a typical PC peripheral vascular pattern (Figure 2). This accentuates the observation that during urbanization, an atypical physiological AC cardiovascular reaction pattern occurs.

A propensity to perceive daily events as stressful might result in an increase in perceived stress symptoms and psychological distress. This may be associated with a heightened cardiovascular activation (Appels, 1990). This is evident especially in the urbanized AC subjects' significantly greater resting systolic and diastolic blood pressure and apparent distressed resting endocrine levels. The urbanized AC men indicated significantly higher prolactin and lower testosterone levels than rural AC men. Malan and co-workers (1996) found the same results in Venda-speaking African urbanized men. The greater prolactin secretion of the urbanized AC men could inhibit testosterone secretion (Gala, 1990) and low levels of testosterone are reported to enhance vascular responsiveness (Heim et al., 2000). This endocrine profile may disturb the balance between vasoconstriction and vasodilatation in favor of vasoconstriction (Huisman et al., 2002) and is emphasized by the greater decrease in compliance reactivity in the urbanized AC and PC men. These findings were supported by partial correlation and regression analyses where the chances of urbanized men to have disturbed compliance and testosterone levels as well as anxiety and depressive symptoms were 5.88 greater than in rural men.

The urbanized women with higher levels of prolactin (AC and PC) and lower testosterone (PC) with a perception of more anxiety (AC) and depressive (PC) symptoms resemble uncontrolled stress (Tennant and McClean, 2000; Zhao and Li, 1998). This could indicate that they are apparently challenging the stress but are experiencing it as uncontrollable. This endocrine profile of apparent lower testosterone and higher prolactin levels has been associated with adrenocortical habituation (HPA-axis dysregulation) of repeated stress and passive coping (Greenspan and Strewler, 1997; Heim et al., 2000; Henry, 1993; Kasckow et al., 2001). It implies that individuals who are repeatedly exposed to the same stressor can exhibit decreased or habituated HPA axis responses (Jaferi et al., 2003). The higher prolactin levels in the urbanized AC men and PC women compared to their rural counterparts could indicate that they are experiencing acute stress (Gala, 1990). Furthermore, prolactin acts as a cortisol antagonist (Gala, 1990) and these findings could possibly be associated with dysregulation of the HPA-axis. A regression analysis supported these findings and showed that the chances of urbanized women having disturbed compliance and prolactin levels are 3.56 greater than in rural women. Additionally the low testosterone levels or testosterone suppression of the urban subjects can be associated with the exhaustion phase in Selye's adaptation syndrome theory (Selye, 1956) adding to a depressive state. No differences between the urbanized AC and PC resting blood pressure, resting and reactivity endocrine values could indicate that urbanization is equally stressful or not at all.

It appears that the cardiovascular (men and women) and endocrine (men) responses of the urbanized AC subjects are dissociated from the "normal" typical AC physiological responses (β -adrenergic) and are exhibited as typical PC physiological (α -adrenergic) responses. Even

though the mean resting blood pressures of all groups were still within normotensive ranges, vascular reactivity responses are associated with the development of hypertension (Hinderliter et al., 2004). In all urbanized subjects greater hypertension prevalence rates with an enhanced vascular reactivity were observed independent of whether they were AC or PC. This emphasizes the possible development of cardiovascular dysfunction in PC and physiologically dissociated AC styles. The urbanized AC men and women with their AC style (behaviorally), enhanced vascular responses, distressed endocrine profile and perceived anxiety are, therefore, prone to develop cardiovascular dysfunction.

The dissociation of the AC subjects' physiological responses and their resemblance to the PC urbanized subjects' responses indicate an habituation or exhaustion of certain physiological systems. This occurs in a traditionally African collectivistic culture context with less support from traditional extended families and communities. Unchangeable stressors (e.g. urbanization) as well as the intensity and duration of the stress the urbanized subjects encounter could be associated with habituation/adaptation or exhaustion of physiological resources. Diseases can result from uncontrollable threats causing changes because the body could not cope successfully with or adapt to the challenge (Rosch, 2002). Rapid sociocultural changes occurring during modernization or urbanization with resultant lower social support lead to loss of cohesive group activities and achievements that promote a sense of stability and togetherness. Secretions of stress related hormones where a decrease in the cortisol–prolactin antagonistic effect appears might indicate associated HPA-axis dysregulation with lower resistance to diseases and resultant lower control of change (Helhammer and Wade, 1993). The results accentuate the influence of the environment regarding coping with stress and possible behavioral interventions on coping strategies during formative years are suggested.

A typical physiological PC style and typical PC (behavioral and physiological) were associated with these changes. Therefore, the hypotheses could only be partially accepted as not only a typical PC style but also a physiologically dissociated AC style, both with an enhanced alpha adrenergic stimulation pattern, are associated with these changes. Limitations of the study were that only one stressor was used and adjustments for alcohol, smoking and physical inactivity were not made due to unavailability of results.

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References

- Al'Absi, M., Arnett, D.K., 2000. Adrenocortical responses to psychological stress and risk for hypertension. *Biomed. Pharmacother.* 54, 234-244.
- Appels, A., 1990. Mental precursors of myocardial infarction. *Br J Psychiatry* 156, 465-471.
- Carels, R.S., Blumenthal, J.A., Sherwood, A., 2000. Emotional responsivity during daily life: relationship to psychosocial functioning and ambulatory blood pressure. *Int. J. Psychophysiol.* 36(1), 25-33.
- Carver, C.S., Scheier, M.F., Weintraub, J.K., 1989. Assessing coping strategies: a theoretically base approach. *J. Pers. Soc. Psychol.* 57(2), 267-283.
- Chang, E.C., 1996. Cultural differences in optimism, pessimism, and coping: predictors of subsequent adjustment in Asian American and Caucasian American college students. *J. Couns. Psychol.* 43(1), 113-123.
- Delongis, A., Folkman, S., Lazarus, R.S., 1988. The impact of daily stress on health and mood: psychological and social resources as mediators. *J. Pers. Soc. Psychol.* 54(3), 486-495.
- Esler, M., Rumantir, M., Kaye, D., Lambert, G., 2001. The sympathetic neurobiology of essential hypertension: disparate influences of obesity, stress and noradrenalin dysfunction. *Am. J. Hypertens.* 14, 138S-146S.
- Folkow, B., 2000. Perspectives on the integrative functions of the 'sympatho-adreno-medullary system'. *Auton. Neurosci.* 83, 101-115.
- Fray, J.C.S., Douglas, J.G., eds., 1993. *Pathophysiology of hypertension in blacks*. Oxford University Press, New York, pp. 217-232.
- Gala, R., 1990. The physiology and mechanisms of the stress-induced changes in prolactin secretion in the rat. *Stress Medicine* 8, 213-218.
- Gerin, W., Pickering, T.G., Glynn, L., Christenfield, N., Schwartz, A., Carroll, D., Davidson, K., 2000. An historical context for behavioral models of hypertension. *J. Psychosom. Res.* 48, 369-377.
- Gerra, G., Zaimovic, A., Mascetti, G.G., Gardini, S., Zambelli, U., Timpano, M., Raggi, M.A., Brambilla, F., 2001. Neuroendocrine responses to experimentally-induced psychological stress in healthy humans. *Psychoneuroendocrinology* 26(1), 91-107.
- Goldberg, D.P., Gater, R., Sartorius, T.B., Ustun, T.B., Piccinelli, M., Gureje, O., Rutter, R., 1997. The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychological. Medicine* 27, 191-197.
- Greenspan, F.S., Strewler, G.J., 1997. *Basic and clinical endocrinology*, fifth ed. Appleton & Lange. London, pp. 95-434.
- Harms, M.P.M., Wesseling, K.H., Pott, F., Jenstrup, M., Van Goudoever, J., Secher, N.H., 1999. Continuous stroke volume monitoring by modelling flow from non-invasive measurement of arterial pressure in humans under orthostatic stress. *Clinical. Science* 97, 291-301.

-
- Heim, C., Ehlert, U.M., Helhammer, D.H., 2000. The potential role of hypocortisolism in the pathophysiology of stress-related bodily disorders. *Psychoneuroendocrinology* 25, 1-35.
- Helhammer, D.H., Wade, S., 1993. Endocrine correlates of stress vulnerability. *Psychother. Psychosom.* 25, 608-617.
- Henry, J.P., 1993. Psychological and physiological responses to stress: the right hemisphere and the hypothalamo-pituitary-adrenal axis. An inquiry into problems of human bonding. *Integrative physiological and behavioral science: the official journal of the Pavlovian Society* 28, 368-386.
- Henry, J.P., Stephens, P.M., Ely, D.L., 1986. Editorial review: Psychosocial hypertension and the defense and defeat reactions. *J. Hypertens.* 4, 687-697.
- Hinderliter, A.L., Blumenthal, J.A., Waugh, R., Chilukuri, M., Sherwood, A., 2004. Ethnic differences in left ventricular structure: relations to hemodynamics and diurnal blood pressure variation. *Am. J. Hypertens.* 17, 43-49.
- Huisman, H.W., Van Rooyen, J.M., Malan, N.T., Eloff, F.C., Malan, L., Laubscher, P.J., Schutte, A.E., 2002. Prolactin, testosterone and cortisol as possible markers of changes in cardiovascular function associated with urbanization. *J. Hum. Hypertens.* 16, 829-835.
- Jaferi, A., Nowak, N., Bhatnagar, S., 2003. Negative feedback functions in chronically stressed rats: role of the posterior paraventricular thalamus. *Physiol. Behav.* 78, 365-373.
- Julius, S., 1999. The role of sympathetic overactivity in the patho-physiology of cardiovascular diseases. *Am. J. Hypertens.* 12(4), 2.
- Kasckow, J.W., Baker, D., Geraciotti, T.D., 2001. Corticotropin-releasing hormone in depression and post-traumatic stress disorder. *Peptides* 22(5), 845-851.
- Kaufman, J.S., Tracy, J.A., Durazo-Arvizu, R.A., Cooper, R.S., 1997. Lifestyle, education, and prevalence of hypertension in populations of African origin. *Ann. Epidemiol.* 7(1), 22-27.
- Kleinbaum, D.G., 1994. *Logistic regression: a self learning text.* Springer, New York, 282 p.
- Lazarus, R. S., Folkman, S., 1984. *Stress, appraisal and coping.* Springer, New York, pp. 15-20.
- Light, K.C., Kothandapani, R.V., Allen, M.T., 1998. Enhanced cardiovascular and catecholamine responses in women with depressive symptoms. *Int. J. Psychophysiol.* 28, 157-166.
- MacArthur, J.D., MacArthur, C.T., 2003. Research network on socioeconomic status and health: laboratory tasks for cardiovascular reactivity research. [Web:] <http://www.macses.ucsf.edu/research/psychosocial/notebook/reactivitytable.html> [Date of access: 21 October 2003].
- Malan, N.T., Brits, J.S., Eloff, F.C., Huisman, H.W., Kruger, A., Laubscher, P.J., Pretorius, P.J., 1996. The influence of acculturation on endocrine reactivity during acute stress in urban black males. *Stress Medicine* 12, 55-63.
- McEwen, B., 2003. Mood disorders and medical illness: mood disorders and allostatic load. *Biol. Psychiatry* 54, 200-207.


- Obrist, P.A., 1981. Cardiovascular psychophysiology: a perspective. Plenum, London. pp. 22-32.
- Opie, L.H., 2004. Heart Physiology - from cell to circulation, fourth ed. Philadelphia, Pa. : Lippincott Williams & Wilkins. 648 p.
- Rodbard, D., Feldman, Y., 1978. Kinetics of two-site immunoradiometric ('sandwich') assays—I : Mathematical models for simulation, optimization, and curve fitting. *Mol. Immunol.* 15(2), 71-76.
- Rosch, P.J. (Ed.), 2002. Stress, obesity, diabetes and the deadly quartet. *Health and Stress, Newsletter of the American Institute of Stress* 5, 1-8.
- Saab, P.G., Llabre, M.M., Schneiderman, N., Hurwitz, B.E., McDonald, P.G., Evans, J., Wohlgenuth, P., Hayashi, P., Klein, B., 1997. Influence of ethnicity and gender on cardiovascular responses to active coping and inhibitory-passive coping challenges. *Psychosom. Med.* 59(4), 434-446.
- Schommer, N.C., Kuhr, M., Helhammer, D.H., Luedke, R., Rothe, U., Kirschbaum, C., 2000. Differences in habituation to psychosocial stress between the HPA-axis, the cardiovascular system and peripheral catecholamines. *Psychoneuroendocrinology* 25(1), S53.
- Selye, H., 1956. The stress of life. Longmans Green, London. pp. 32-55.
- Silke, B., McAuley, D., 1998. Accuracy and precision of blood pressure determination with the Finapres: an overview using re-sampling statistics. *J. Hum. Hyper.* 12, 403-409.
- Smith, P.A., Graham, L.N., Mackintosh, A.F., Stoker, J.B., Mary, S.G., 2004. Relationship between central sympathetic activity and stages of human hypertension. *Am. J. Hypertens.* 17(3), 217-222.
- Stapelberg, R., 1999. *Psigometriese eienskappe van die Cope en SACS by 'n groep Setswana-sprekende Suid-Afrikaners/Psychometric characteristics of the Cope and SACS in a Setswana-speaking South African group.* Potchefstroom University for Christian Higher Education, Potchefstroom, (MA). 200 p.
- Statsoft, Inc., 2004. *STATISTICA for Windows (Computer program manual).* Tulsa, OK, Statsoft, Inc.
- Suarez, E.C., Saab, P.G., Llabre, M.M., Kuhn, C.M., Zimmerman, E., 2004. Ethnicity, gender, and age effects on adrenoceptors and physiological responses to emotional stress. *Psychophysiology*, 41, 450-460.
- Tennant, C.C., McLean, L., 2000. Mood disturbances and coronary heart disease: progress in the past decade. (5 p.). [Web:] <http://www.mja.com.au>. [Date of access: 26 November 2003].
- Tomaka, J., Blascovich, J., Kelsey, R.M., Leitten, C.L., 1993. Subjective, physiological, and behavioral effects of threat and challenge appraisal. *J. Pers. Soc. Psychol.* 65(2), 248-260.
- VanItallie, T.B., 2002. Stress: a risk factor for serious illness. *Metabolism* 51(6, part 2), 40-45.

- Van Rooyen, J.M., Huisman, H.W., Eloff, F.C., Laubscher, P.J., Malan, L., Steyn, H.S., Malan, N.T., 2002. Cardiovascular reactivity in black South-African males of different age groups: the influence of urbanization. *Ethn.Dis.* 12(1), 69-75.
- Vorster, H.H., Wissing, M.P., Venter, C.S., Kruger, H.S., Kruger, A., Malan, N.T., De Ridder, J.H., Veldman, F.J., Steyn, H.S., Margetts, B.M., MacIntyre, U.E., 2000. The impact of urbanization on physical and mental health of Africans in the North West Province of South Africa: The THUSA study. *S.A. J. Science* 96, 505-514.
- Waldstein, R., Bachen, E.A., Manuck, B., 1997. Active coping and cardiovascular reactivity: a multiplicity of influences. *Psychosom. Med.* 59, 620-625.
- Wesseling, K.H., Jansen, J.R.C., Settels, J.J., Schreuder, J.J., 1993. Computation of aortic flow from pressure in humans using a nonlinear, three-element model. *J. Appl. Physiol.* 74, 2566-2573.
- WHO (World Health Organization), 2003. World Health Organization WHO / International Society of Hypertension (ISH) statement on management of hypertension. *J. Hypertens.* 21, 1983-1992.
- World Medical Association Declaration of Helsinki, 2000. Ethical principles for medical research involving human subjects. (10 p.). [Web:] <http://www.wma.net/c/policy/b3.htm>. [Date of access: 19 April 2004].
- Williams, R.B., 1986. Patterns of reactivity and stress, in: Matthews K.A., Weiss, S.M., Detré, T., Dembroski, T.M., Falkner, B., Manuck, S.B., Williams, R.B. (Eds.), *Handbook of stress, reactivity and cardiovascular disease*. Wiley, New York, pp. 109-125.
- Wissing, M.P., Van Eeden, C., 2002. Empirical clarification of the nature of psychological well being. *S.A. J. Psych.* 32(1), 32-44.
- Zhao-, S-P., Li, X-P., 1998. The association of low plasma testosterone level with coronary artery disease in Chinese men. *Int. J. Cardiol.* 63(2), 161-164.

Title: Specific coping mechanisms, perception of health, vascular reactivity and metabolic syndrome indicators in Africans during urbanisation: The THUSA study.

Main aim: To compare specific coping mechanisms of Africans in different age groups during urbanisation regarding vascular reactivity, metabolic syndrome (MS) indicators and perception of health data. Data were corrected for cardiovascular resting values.

Hypothesis: A typical passive coping mechanism in younger and older urbanised Africans exhibits enhanced vascular reactivity, metabolic syndrome indicators and a perception of poorer health.



5
Manuscript 3

JOURNAL OF HYPERTENSION - AUTHOR GUIDELINES

1. Manuscripts sent: Professor Alberto Zanchetti, Editor, Journal of Hypertension, Centro di Fisiologia Clinica e Ipertensione, University of Milan, Ospedale Maggiore, Via F. Sforza 35, 20122 Milan, Italy. Tel: +39 02 551 80130; Fax: +39 0255180350; e-mail: zanchett@mailserver.unimi.it. Submissions should consist of **four copies**, three of which may be **photocopies**. Authors must also supply **three copies of all figures and tables**.

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3. Structured abstract: Abstract on second page not exceeding 250 words. **Objective(s)**: primary objective of the paper, **Design**: principal reasoning for the procedures, **Methods**: procedures used, **Results**: main results of the study - numerical data a minimum, **Conclusions**: conclusions drawn from the data given. List wordcount at the end of the abstract.

4. Keywords: The abstract should be followed by a list of 3-10 keywords from Medical Subject Headings list of the *Index Medicus*.

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6. Acknowledgments: substantial contributors to the study.

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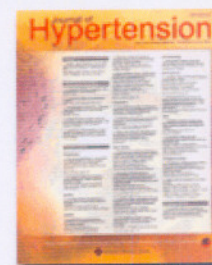
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Submitted to *Journal of Hypertension*

Specific coping mechanisms, perception of health, vascular reactivity and metabolic syndrome indicators in Africans during urbanisation: The THUSA study.

†Leoné Malan, Aletta E. Schutte, Nicolaas T. Malan, Maria P. Wissing, Hester H. Vorster, Johannes M. van Rooyen, Hugo W. Huisman.

ABSTRACT:

Objective: Comparing specific coping mechanisms of Africans in different age groups during urbanisation regarding vascular reactivity, metabolic syndrome (MS) indicators and perception of health data. **Design:** Cross-sectional comparative field study of transition and health during urbanisation (THUSA). **Methods:** The subjects consisted of 646 apparently healthy Africans (men = 286; women = 360). General Health and adapted S-COPE (Setswana COPE) Questionnaires respectively measured subjective perception of health and classified subjects as active (AC) or passive (PC) copers. Subjects were subdivided into rural-urban, younger (≤ 40) and older (≥ 45) age groups. The Finapres recorded blood pressure before and during application of the handgrip test. Blood pressure responses, MS indicators, serum cortisol and plasma fibrinogen values were compared and correlated with psychological variables. Separate analyses were performed for each gender and age group. **Results:** Firstly, rural-urban effects of different age groups were compared. All AC rural subjects exhibited typical AC central cardiac responses. Rural PC and all urbanised subjects (AC and PC) exhibited peripheral vascular responses. All younger urbanised women showed greater fibrinogen values than their rural counterparts. Secondly, younger and older urban subjects were compared. Younger AC women showed the same increased vascular reactivity, abdominal obesity, increased levels of TG and perception of poorer health as PC men and women. These older groups (AC women, PC men and women) indicated greater hypertension prevalence than the younger subjects. **Conclusions:** The physiological AC responses of urbanised women are dissociated from the “normal” physiological AC reaction and now exhibit typical PC vascular physiological responses. Enhanced vascular reactivity, perception of poorer health and MS indicators are more prevalent in younger urbanised African dissociated AC and PC men and especially women, than in older subjects. **Keywords:** Africans, coping, urbanisation, age, metabolic syndrome, perception of health, cortisol. **Running head:** Coping and metabolic syndrome. **Word count:** 279.

†Corresponding author

Introduction

Lifestyle in high socio-ecological stress or urban areas is usually associated with an elevated risk for essential hypertension in African Americans [1, 2]. African subjects living in urban areas which are characterized by high levels of criminal offences, few job opportunities, changed dietary patterns and low social support, also showed systolic (22.8%) and diastolic (20.7%) blood pressure values above 140/90 mmHg [3, 4].

However, the role of coping mechanisms is not clear in this process. The fundamental aim of any coping strategy is to eliminate, reduce or control the internal and external demands of the individual-environment interaction [5]. The individual with less positive social relationships will experience this interaction as being particularly stressful [6]. When chronically challenged they will endure the resulting cost of a high allostatic load [7].

The type of coping style used, age and gender, as well as the well-being or perception of health of subjects can affect health outcomes, particularly in the context of life transitions [6, 8]. The acceptance of a stressor as reality is a prerequisite for problem-focused or active coping (AC) [9]. A resistance to stress can be increased by an integration of AC and the positive use of social resources [10]. Normally, an AC mechanism characterized by controllability of stressors evokes a β -adrenergic stimulation pattern with a central cardiac response. A passive coping (PC) mechanism is characterized by low control over problems and usually evokes an α -adrenergic stimulation pattern with increases in peripheral resistance [12]. It includes behaviour of denial, submissiveness, surrendering and helplessness [10]. A PC mechanism may also impair the receipt of social support thereby reducing the ability to cope successfully with stressful events [11]. An enhanced α -adrenergic vasoconstriction with increases in vascular reactivity in Africans during stress may cause acceleration of the development of hypertension [4].

There are two possible major pathways of the stress response that may be activated by certain coping behaviours or distressing events namely, the sympathetic nervous system (SNS) and the hypothalamus-pituitary-adrenal (HPA) axis [13]. Stress-induced activation of the SNS and the HPA axis over time leads to cardiovascular adjustments that increase hypertension risk [14]. According to Opie [15] and Björntorp [16], chronic SNS stimulation and cortisol increases, which regulates adipose-tissue differentiation and distribution, may be responsible for causing visceral obesity. Therefore, it could play a major role in causing obesity-induced hypertension. Furthermore, persistent psychosocial stress could result in a disruption of central regulatory systems leading to less coping ability, an increase in insulin resistance, visceral obesity, deficient fibrinolysis [17] and the development of cardiovascular diseases [15].

It is also known that enhanced vascular reactivity with increasing age is a risk factor in the development of hypertension [2]. However, the role of psychosocial stress in different age groups during urbanisation in the development of hypertension and the metabolic syndrome (MS) is not clear. During recent years there has been an awareness of indications of increasing levels of obesity, especially in women, as well as the development of the MS [18]. This accentuates the need to explore the dynamics of coping styles of Africans on health indicators such as vascular reactivity, MS and perception of health during psychosocial stress or urbanisation.

The *hypothesis* proposed is that a typical passive coping mechanism in younger and older urbanised Africans exhibits enhanced vascular reactivity, metabolic syndrome indicator values and a perception of poorer health.

Methods

Study design

The THUSA study (Transition and Health during Urbanisation in South Africa) is a cross-sectional comparative epidemiological project, which extended over a period of three years (1996-1998). With the assistance of a biostatistician, 37 magistrate districts or study sites in the North-West Province were randomly selected representing all the health districts as well as all levels of urbanisation. In the weeks preceding the collection of data the sites were visited to obtain consent from tribal chiefs, government officials and the Department of Health to work in the area and notify the local community of the visit of the research team. A convenience sample of all volunteers was recruited within each study site. Fieldworkers were recruited and trained with regard to the recruitment of subjects and to supply information to the subjects in their own language. They also had to ensure that the subjects fasted overnight prior to the day of the study. Vorster and Co-workers [19] published the design and methodology of the THUSA study.

Subjects

A convenience sample of fasting subjects complying with the inclusion criteria of apparently healthy Setswana-speaking volunteers, men (N = 286) and women (N = 360), aged 16 – 70 years were included. Subject characteristics are supplied in Table 2. Hereafter, the Setswana-speaking men and women will be referred to as Africans.

Exclusion criteria were: pregnancy, lactation, casual visitors to the study site, body temperature above 37.5°C, inebriation, acute or chronic medication, infectious diseases (including tuberculosis), hypertension (systolic \geq 140 mmHg and/or diastolic \geq 90 mmHg, [2]), epilepsy, diabetes mellitus, malnutrition, a history of/or current psychotherapy, incomplete data set and responders to both active and passive coping scales.

Subjects were divided into two groups: (a) active coping (AC) and (b) passive coping (PC) men and women. This was done according to their responses to an †adapted and validated Setswana COPE Questionnaire (S-COPE) [20], based on the original Carver COPE questionnaire [21]. These two groups (AC and PC) were then subdivided into rural and urbanised groups as well as age groups (≤ 40 years and ≥ 45 years) [22, 23]. Rural subjects included subjects living in tribal areas and in farmland dwellings. Urban subjects included subjects living in informal settlements (peri-urban fringe area of the greater metropolitan area) and in established townships with full access to water and electricity.

The Ethics Committee of the North-West University, Potchefstroom Campus approved the study. The study protocol conforms to the ethical guidelines of the Declaration of Helsinki [24]. Informed consent was obtained from the subjects and the parents of underaged adolescents.

Experimental procedure

Data collection was performed between 07:00 and 13:00 and each individual was occupied for approximately two hours. On arrival, the fasting subjects were all introduced to the experimental setup to minimise their anticipation stress [25]. Blood sampling was performed during the first part of the data collection period and the number of subjects undergoing the procedures was adequate to limit the effect of circadian hormonal rhythms. After the winged infusion set was inserted, resting blood samples were obtained and the heparin block started. Serum samples were prepared according to standard methods. Blood samples were centrifuged in a cooled centrifuge at 3000 rpm for 10 minutes and kept on ice until the serum and plasma were divided into aliquots. In the field, aliquots were immediately frozen with a mixture of salt and ice and placed in a standard freezer (-18 to -22°C). In the laboratory, samples were stored at -84°C.

Subjects completed the demographic and psychological questionnaires individually in a structured interview format in their home language with the aid of trained African fieldworkers under supervision of psychologists. Subsequently, the subject was connected to the Finapres apparatus and blood pressure continuously recorded whilst in a sitting position. After a resting period of at least 10 minutes, resting continuous blood pressure values of one minute were recorded. Blood pressure was regarded as resting when the systolic pressure did not change by more than 10 mmHg during the last minute of this period; otherwise the resting period was extended by a maximum of two minutes. The subject was exposed to the handgrip test at 50% of his/her maximum for one minute to challenge the cardiovascular system [26], while blood pressure was still continuously recorded and these recordings were used as task-induced values. Another blood sample was obtained for task-induced values and prepared according to standard methods.

†A copy of the S-COPE Questionnaire can be obtained from the corresponding author.

*Measuring instruments and apparatus**Psychological questionnaires*

For evaluating the psychological perception of own health the registered psychologists used the 28 item General Health Questionnaire (GHQ) [27]. The GHQ consists of 4 subscales with 7 items each. Subscales include somatic, anxiety and insomnia, social dysfunction and depressive symptoms. Subjects had to report on their own perceived health pattern endured during the past few weeks. Each item was scored on a 0-0-1-1 scale [28] where “end-users” (1 and 4) and “middle-users” (2 and 3) are reduced. The value of response possibilities one (1) and two (2) are equal to nil (0) and three (3) and four (4) equal to one (1). The range of the scores varied from 0 (for no symptoms) to 28 where severe pathology is present. Cronbach alpha-reliability indices for subscales varied between 0.77 and 0.84 in this study.

The COPE Questionnaire of Carver *et al.* [21] is a multidimensional selfreporting questionnaire with 53 items. Each item was responded to on a 4-point Likert scale that varied from 1 (I usually don't) to 4 (I usually do). Higher scores indicated more frequent use of a particular coping mechanism. Stapelberg extracted an emic factor pattern from the original COPE through exploratory factor analysis (principal factors - maximum likelihood method of factor extraction with varimax rotation), indicating three clear and reliable factors or subscales forming the Setswana speaking COPE (S-COPE) with loadings >0.30 and eigenvalues > than 1. These subscales are (1) Active outreach-to-others, (2) Surrender and resignation and (3) Overt expression of distress. Cronbach alpha-reliability values varied from 0.85 to 0.70 for subscales in the S-COPE [20].

The first subscale was taken to indicate active coping (approach strategy with strong emphasis on engagement in active coping, actively seeking social support, commitment to tasks and controllability) (Cronbach alpha-reliability = 0.85). The second and third factors were combined for the purposes of this study to form a measure of passive coping (avoidance strategy with strong emphasis on appraisals of threat or uncontrollability and expression of distress) (Cronbach alpha-reliability = 0.75). The active coping subscale included items such as “I talk to someone who could do something helpful about the problem”, “I take direct action to deal with the problem” and “I try to find comfort in my religion”. The passive coping subscale included items such as “I reduce the amount of effort I am putting into solving the problem”, “I just give up trying to reach my goal”, and “I become upset and am very aware of my feelings”.

Participants in this study were grouped into active and passive coping groups according to the above subscales by using median splits. Subjects presenting low and high scores on both were excluded (i. e. men, N = 25; women, N = 33) and, therefore, only independent clear responders for active or passive coping were retained.

Stressor/Task

The isometric handgrip test was performed with the dominant hand (Lafayette Instrument, IN.47903). Maximum strength was determined before the onset of any recordings. Due to the magnitude of this field study only one stressor was applied. This instrument is not culture specific and simulates physical work and endurance typical for this subject group. It normally evokes a stronger α but weaker β -adrenergic autonomic stimulation pattern. This stimulation pattern relates to specific coping mechanisms i.e. passive coping to an α -adrenergic response or active coping to a β -adrenergic response [29, 30].

Blood pressure

Resting and stressor blood pressure were recorded by the method of Peñáz [31]. The **FINger-Arterial-PRESSure** device is non-invasive and monitors finger arterial blood pressure continuously [31] and is validated and suitable for determining relative changes in comparative studies [32]. Reactivity values (%) were calculated as changes from resting ($\% = ((X_{\text{stressor}} - Y_{\text{resting}}) / Y_{\text{resting}}) \times 100$). The resting values for systolic and diastolic blood pressure were also substantiated by means of the Riva-Rocci/Korotkoff method. Data were stored on magnetic tape by means of a Kyowa RTP-50A four-channel data recorder and digitized for further analysis by means of the Fast Modelflo software programme. The Fast Modelflo three element model integrates the subject's gender, body mass and stature and determines an age dependent aortic flow curve from the surface area beneath the pressure/volume curve and can, therefore, additionally calculate cardiac output (CO), stroke volume (SV), total peripheral resistance (TPR) and arterial "Windkessel" compliance (Cw) of the arterial system [33]. When comparing invasive intra-arterial thermo-dilution-determined SV with the Modelflo software-determined SV, the Modelflo software determined aortic flow from non-invasively determined finger pressure during orthostasis correctly [34]. This technique is thus an alternative to the invasive intra-arterial measurements, without the risks and ethical questions inherent to invasive measurements [33].

Anthropometric measurements

Trained biokineticists performed all the anthropometric measurements and subjects were examined wearing only their underwear. Subjects were standing upright with the head in the Frankfort plane. Waist circumference was measured at the midpoint between the lower rib margin and the iliac crest and the hip measurement at the maximal circumference of the buttocks with a 7 mm wide flexible steel tape (Holtain). Waist-to-hip ratio (WHR) was calculated from waist and hip circumferences.

Blood samples and biochemical analyses

Fasting resting and task-induced blood samples (using a winged infusion set – 21G, with a heparin block - 0.5 ml in 9 ml normal saline) were obtained from the medial cubital vein or vena

cephalica in the non-dominant arm by a registered nurse. The biochemical analyses were executed in independent laboratories by using standardized methods: Serum high density lipoprotein with the Merck Bench Method, serum triglycerides and glucose with the DAX method - Technicon Omnipak, serum cortisol (CA-1529)™ [¹²⁵I] RIA kit of Incstar, Minnesota, USA and plasma fibrinogen with the Claus method - Instrumentation Laboratories, ICL, Milan, Italy. Cortisol intra-assay and inter-assay coefficients of variation were 6.6 and 9.0% and assay sensitivities were 0.21 µg/dl [35].

Statistical analyses

All processed data were transferred to Microsoft Excel XP and further analysed by means of the software computer package STATISTICA [36]. The reliability of the S-COPE Questionnaire was determined by using Cronbach alpha (α) reliability coefficient. Analyses of covariance (ANCOVA) adjusted for resting cardiovascular data for significant differences between means of AC and PC groups were done. Partial correlation coefficients between coping, cardiovascular, metabolic syndrome (MS) indicators (glucose, high density lipoprotein (HDL), triglycerides (TG), waist-to-hip ratio (WHR), hypertension prevalence), cortisol, fibrinogen and perception of health were performed. Results were regarded as statistically significant when $P \leq 0.05$ and as highly significant when $P \leq 0.01$.

Results

Firstly, the rural-urban effects in different age groups (≤ 40 years, younger and ≥ 45 years, older) were compared (Figures 1 and 2). Only statistically significant cardiovascular reactivity values (CVR) which are typically influenced during active and passive coping styles are shown (including cardiac output (CO), diastolic blood pressure (DBP), total peripheral resistance (TPR) and compliance (Cw) [12]. No significance in other relevant cardiovascular reactivity values were obtained. In Figures 1 and 2, the central cardiac and peripheral vascular reactivities of the subjects after exposure to the handgrip test are compared. The rural AC subjects' responses to the handgrip test included significantly greater CO (younger women; older men, $P \leq 0.01$) with smaller DBP and TPR increases than the urban AC subjects.

Rural PC (non-significant) and urbanised subjects (AC and PC) exhibited statistically significant opposite effects than rural AC subjects i.e. greater increases in DBP, younger AC men ($P \leq 0.01$), younger ($P \leq 0.05$) and older ($P \leq 0.01$) AC women and TPR, AC younger and older men, AC younger women ($P \leq 0.01$) and decreases in Cw, AC ($P \leq 0.05$) and PC ($P \leq 0.01$) younger men and AC younger women ($P \leq 0.01$).

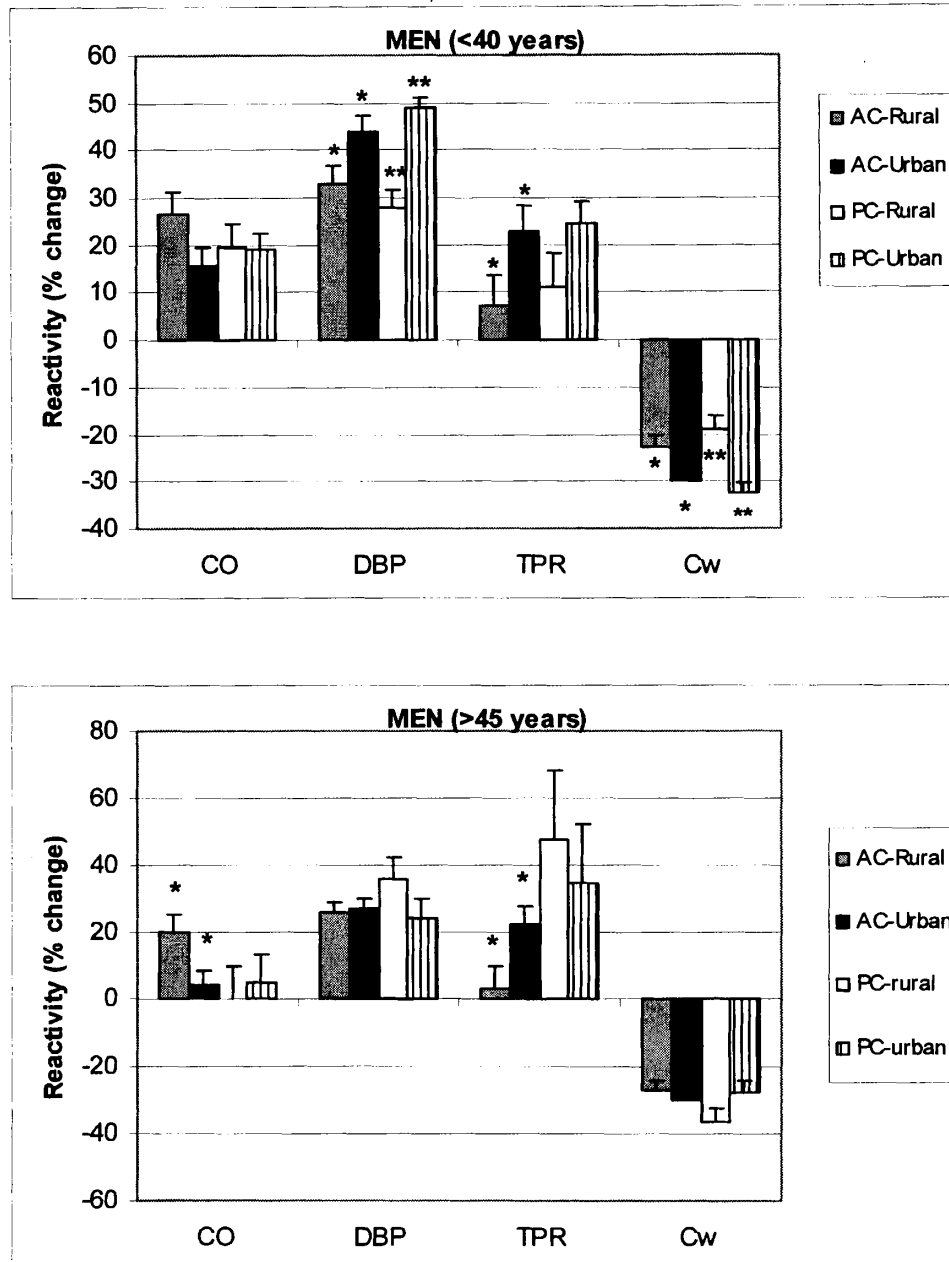


Figure 1: Comparison of the mean cardiovascular reactivity (CVR) values (\pm standard error of mean) of rural and urban active and passive coping (≤ 40 and ≥ 45 years) African men. CVR is expressed as % change from resting values. Variables are adjusted for resting values; AC, active coping; PC, passive coping; CO, cardiac output; DBP, diastolic blood pressure; TPR, total peripheral resistance; Cw, arterial compliance. Values with the same asterisks differ significantly, where: *, $P \leq 0.05$; **, $P \leq 0.01$.

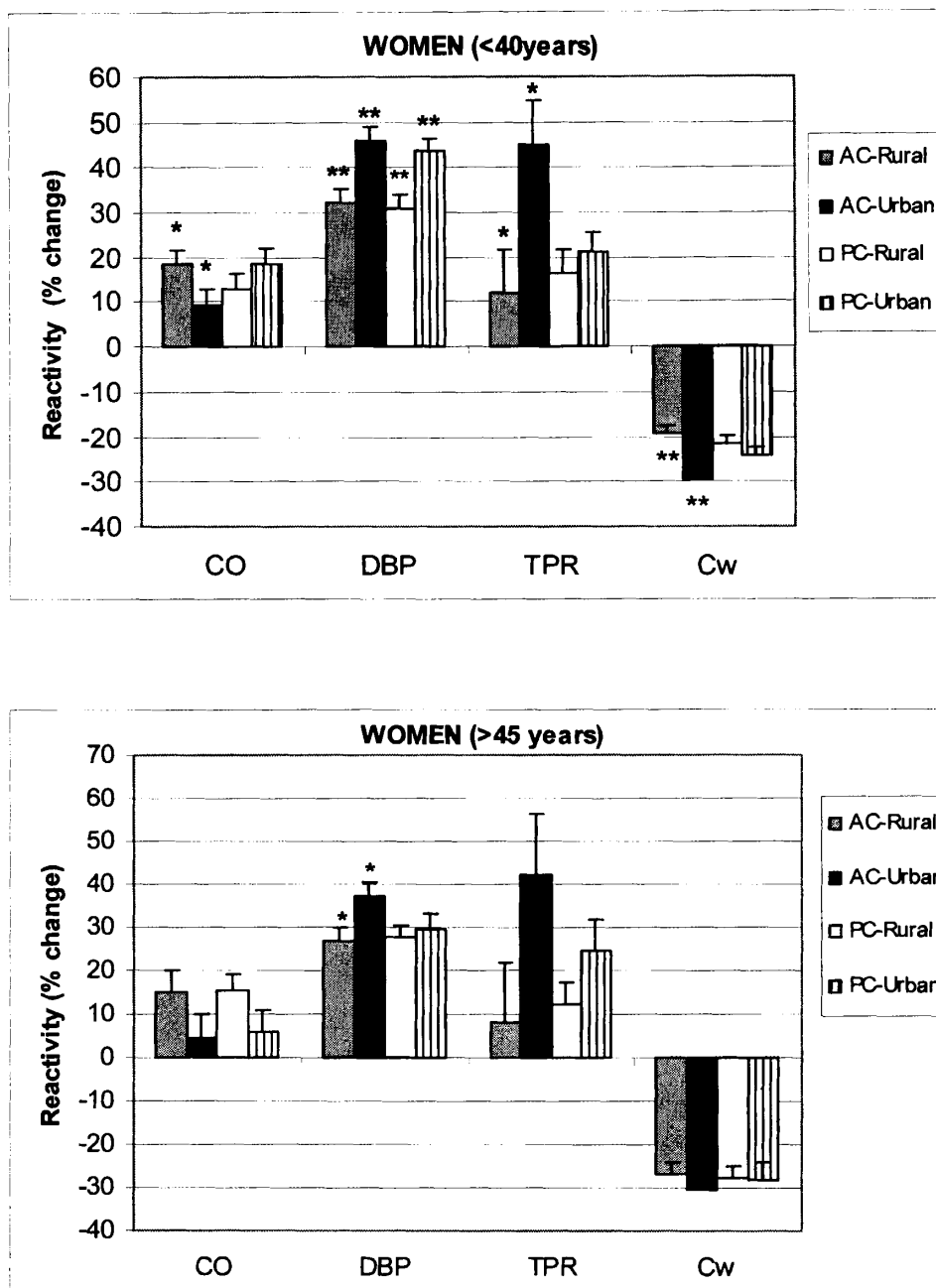


Figure 2: Comparison of the mean cardiovascular reactivity (CVR) values (\pm standard error of mean) of rural and urban active and passive coping (≤ 40 and ≥ 45 years) African women. CVR is expressed as % change from resting values. Variables are adjusted for resting values; AC, active coping; PC, passive coping; CO, cardiac output; DBP, diastolic blood pressure; TPR, total peripheral resistance; Cw, arterial compliance. Values with the same asterisks differ significantly, where: *, $P \leq 0.05$; **, $P \leq 0.01$.

In Table 1, the fibrinogen, glucose and hypertension prevalence values of younger urbanised subjects are presented. In all younger urbanised women (AC and PC), increased plasma fibrinogen values were evident when compared to their rural counterparts (AC and PC, $P \leq 0.05$). In comparison to AC rural men, significantly increased glucose levels ($P \leq 0.01$) and hypertension prevalence ($P \leq 0.01$) were observed only in the AC urbanised men. No significance with regard to older groups or to other MS indicators (high density lipoprotein (HDL), triglycerides (TG) and waist-to-hip ratios (WHR)) were obtained (data not shown).

Secondly, the above results encouraged further exploration of data to compare the age effect of urbanised subjects between the different age groups (≤ 40 versus ≥ 45) [22,23]. In Table 2, when focusing on the PC subjects first, it became clear that the younger groups (men and women) expressed more increased levels ($P \leq 0.05$) of glucose (only women), TG, WHR, resting systolic blood pressure (SBP) and DBP, cortisol levels and a perception of poorer health than the older PC men and women. Whereas the older PC men and women showed a greater prevalence of hypertension ($P \leq 0.01$) and lower levels of HDL ($P \leq 0.01$) than younger PC men and women.

In contrast, the AC men and women showed somewhat different results when gender are compared (Table 2). The younger AC men did not differ from the older men regarding fasting glucose, HDL, TG, hypertension prevalence, resting blood pressure or cortisol levels. The only differences between younger and older AC men were significantly higher abdominal obesity (WHR, ($P \leq 0.01$) and a perception of poorer health ($P \leq 0.01$) in the younger. Although the younger AC women also showed similar results for fasting glucose, resting DBP and cortisol levels than the older women, they did show significantly higher TG ($P \leq 0.05$), WHR ($P \leq 0.01$), resting SBP ($P \leq 0.01$) and a perception of poorer health ($P \leq 0.05$) than the older women. Whereas the older AC women showed a greater prevalence of hypertension ($P = 0.09$) and lower levels of HDL ($P \leq 0.01$) than their younger counterparts.

Significant correlation coefficients for younger urbanised men indicated positive correlations ($P < 0.05$) between age and WHR ($r = 0.61$), DBP ($r = 0.40$) and age was negatively correlated to Cw ($r = -0.43$). In younger urbanised women positive correlations occurred between age and WHR ($r = 0.41$), HDL ($r = 0.33$), TG ($r = 0.33$) and social dysfunction symptoms ($r = 0.32$) and between CO and Cw ($r = 0.35$). No significant correlations in the older subjects were obtained.

Table 1: Comparison of mean (\pm standard error of mean) fasting, resting fibrinogen, glucose and hypertension prevalence values of young (≤ 40 years) active and passive coping men and women in rural and urban areas.

| | AC MEN | | PC MEN | | AC WOMEN | | PC WOMEN | |
|-------------------------|---------------|--------------------------------|-------------|-------------------------|--------------|------------------------------|--------------|-------------------------------|
| | Rural | Urban | Rural | Urban | Rural | Urban | Rural | Urban |
| Fibrinogen (g/L) | 2.83 (0.22) | 3.19 (0.19) P = 0.21 | 2.9 (0.20) | 3.02 (0.20) P = 0.63 | 3.22 (0.16)* | 3.7 (0.17)* P \leq 0.05 | 3.01 (0.21)* | 3.68 (0.19)* P \leq 0.05 |
| Glucose (mmol/l) | 4.49 (0.11)** | 4.92 (0.11)** P \leq 0.01 | 4.81 (0.21) | 4.62 (0.13) P = 0.42 | 4.71 (0.09) | 4.85 (0.09) P = 0.28 | 4.51 (0.10) | 4.47 (0.09) P = 0.83 |
| Hypertension prevalence | 0.03 (0.06)** | 0.31 (0.06)** P \leq 0.01 | 0.04 (0.13) | 0.12 (0.04) P = 0.21 | 0.02 (0.03) | 0.08 (0.03) P = 0.16 | 0.02 (0.04) | 0.11 (0.34) P = 0.09 |

AC, active coping; PC, passive coping; hypertension prevalence, SBP ≥ 140 mmHg and DBP ≥ 90 mmHg (WHO, 2003). Values with the same asterisks differ significantly.

Table 2: Comparison of mean (\pm standard error of mean) fasting, resting values of metabolic syndrome indicators, blood pressure, cortisol, perception of health profile between urbanised subjects of different age groups.

| URBAN Age (N) | ACTIVE COPING MEN | | PASSIVE COPING MEN | | ACTIVE COPING WOMEN | | PASSIVE COPING WOMEN | |
|----------------------------------|--------------------------------|----------------|----------------------------------|----------------|---------------------------------|-----------------|----------------------------------|-----------------|
| | ≤ 40 (48) | ≥ 45 (30) | ≤ 40 (73) | ≥ 45 (30) | ≤ 40 (59) | ≥ 45 (21) | ≤ 40 (67) | ≥ 45 (17) |
| Glucose (mmol/l) | 5.17 (0.18) P = 0.25 | 4.91 (0.14) | 5.05 (0.74) P = 0.18 | 4.62 (0.14) | 4.89 (0.16) P = 0.85 | 4.85 (0.09) | 5.02 (0.21) P \leq 0.05 | 4.47 (0.10) |
| HDL (mmol/l) | 1.17 (0.08) P = 0.83 | 1.15 (0.06) | 1.5 (0.12)** P \leq 0.01 | 1.11 (0.06)** | 1.23 (0.06)** P \leq 0.01 | 1.02 (0.04)** | 1.17 (0.08) P = 0.11 | 1.02 (0.04) |
| TG (mmol/l) | 1.3 (0.22) P = 0.46 | 1.07 (0.17) | 1.38 (0.11)** P \leq 0.01 | 0.89 (0.05)** | 1.26 (0.13)* P \leq 0.05 | 0.88 (0.08)* | 1.16 (0.12)** P \leq 0.01 | 0.83 (0.05)** |
| WHR (cm/cm) | 0.90 (0.01)** P \leq 0.01 | 0.82 (0.01)** | 0.88 (0.01)** P \leq 0.01 | 0.81 (0.01)** | 0.78 (0.01)** P \leq 0.01 | 0.72 (0.01)** | 0.81 (0.02)** P \leq 0.01 | 0.74 (0.01)** |
| Hypertension prevalence | 0.31 (0.08) P = 0.92 | 0.32 (0.09) | 0.12 (0.05)** P \leq 0.01 | 0.54 (0.10)** | 0.08 (0.04)** P = 0.09 | 0.22 (0.07)** | 0.11 (0.05)* P \leq 0.05 | 0.33 (0.10)* |
| Resting SBP (mmHg) | 125.35 (4.3) P = 0.21 | 118.42 (4.28) | 134.11 (4.62)** P \leq 0.01 | 113.8 (2.07)** | 125.6 (4.05)** P \leq 0.01 | 110.79 (2.36)** | 128.18 (5.59)** P \leq 0.01 | 110.82 (2.63)** |
| Resting DBP (mmHg) | 83.07 (2.73) P = 0.56 | 81.02 (2.19) | 90.88 (3.19)** P \leq 0.01 | 76.24 (1.41)** | 73.38 (2.62) P = 0.87 | 73.86 (1.53) | 80.76 (3.97)* P \leq 0.05 | 70.96 (1.87)* |
| Cortisol (μ g/dl) | 20.93 (2.62) P = 0.15 | 15.82 (2.32) | 21.7 (2.43)* P \leq 0.05 | 15.62 (1.3)* | 15.48 (1.61) P = 0.15 | 11.41 (1.62) | 15.33 (1.36)** P \leq 0.01 | 10.35 (0.76)** |
| GHQ index | 12.2 (1.17)** P \leq 0.01 | 6.96 (0.91)** | 13.4 (1.26)** P \leq 0.01 | 8.45 (0.61)** | 10.0 (1.21)* P \leq 0.05 | 6.73 (0.71)* | 12.44 (1.32)** P \leq 0.01 | 7.26 (0.64)** |

≤ 40 , under 40 years of age; ≥ 45 , over 45 years of age; N, number of subjects; WHO, WHO definition, insulin resistance or impaired fasting glucose / glucose tolerance and 2 other risk factors are required [37]; glucose, ≥ 6.1 mmol/l; HDL, < 0.9 mmol/l high density lipoprotein; TG, ≥ 1.7 mmol/l triglycerides; WHR, > 0.90 (men), > 0.85 (women) waist-hip-ratio; HDL, high density lipoprotein; TG, triglycerides; hypertension prevalence (SBP ≥ 140 mmHg and DBP ≥ 90 mmHg); SBP, systolic blood pressure; DBP, diastolic blood pressure; GHQ index, somatic, anxiety and sleeplessness, social dysfunction and depression symptoms. Values with the same asterix differ significantly.

Discussion

The main aim of this study was to explore the association of specific coping mechanisms with cardiovascular function, metabolic syndrome (MS) indicators and perception of health in rural-urban Africans. Firstly, when comparing rural-urban effects in the different age groups in Figures 1 and 2, it is clear that all AC rural subjects reacted with a more typical physiological active coping mechanism [37]. This implies a greater central cardiac reactivity (increases in CO) due to a beta-adrenergic stimulation pattern. The AC urbanised subjects, however, exhibited opposite effects showing an enhanced vascular reactivity (alpha-adrenergic stimulation pattern) with increases in DBP and TPR. This pattern is usually associated physiologically with a typical passive coping pattern and is prevalent in all AC urbanised subjects, but more accentuated in the younger groups. Also all the rural and urban PC subjects reacted with a typical alpha-adrenergic stimulation pattern with a heightened vascular reactivity [12]. This response is accentuated in the younger groups and additionally, these PC men reacted with decreases in vascular compliance (Cw).

Results show that younger urban subjects are more vulnerable to cardiovascular disease than their rural counterparts with reference to increased fibrinogen [38, 39], fasting glucose levels and hypertension prevalence rates. Additional analyses were then performed to compare younger and older urban subjects to determine whether this vulnerability increases with increasing age, especially since it is well known that prevalence of cardiovascular risk factors increases with increasing age [40]. Surprisingly results show that the younger urban subjects who exhibited a PC strategy had significantly greater increases in their cardiovascular risk factors and MS indicators than older PC subjects (Figure 1 and 2; Table 2). Furthermore, younger groups were significantly positively associated with WHR, DBP, TG and social dysfunction and negatively with compliance. Most of these parameters are associated with the metabolic syndrome. The question could be asked whether a PC strategy predisposes one to the development of the metabolic syndrome.

In the AC urban subjects, who also displayed an enhanced vascular reactivity, another perspective emerges. Both the younger and older AC urban men displayed very similar cardiovascular risk factors and MS indicator values. When comparing the AC urban men with their rural counterparts, the urban men exhibit higher glucose and hypertension prevalence rates. Between age groups though, the only differences were those of the younger men with their higher WHR levels accompanied by a perception of poorer health. The resemblance in their other values might indicate that AC younger urbanised men are already developing MS at a younger stage and, therefore, no differences with regard to the older groups were obtained.

The younger AC women showed greater responses than older AC women with regard to values of the MS indicators, including increased WHR, TG, hypertension prevalence rates and resting SBP values. Of all the women, the AC women showed the most powerful vascular reactivity pattern accompanied by a perception of poorer health. Cardiac output and vascular compliance were positively associated ($P < 0.05$) in these younger urbanised women, which might be explained by the protective action of steroid hormones [16] and HDL [39] on the vascular system at this age. With chronic stress situations, gonadal hormone secretions are inhibited and additionally this may also contribute to the development of hypertension at a later age as shown in this study [16]. Most variables excepting hypertension prevalence and WHR values are within normal ranges but the trend exists for possible future development of the metabolic syndrome. Although all subjects were clear responders to the AC or PC subscales (S-COPE), the AC urbanised groups showed typical PC cardiovascular responses as well as a resemblance to the MS indicator values such as found in the PC groups. If a defense or active coping reaction on a long-term basis becomes untenable because the situation is judged as “no way out”, a shift towards a defeat or passive coping reaction is common [41]. This implies a physiological defeat reaction with an enhanced vascular reactivity. The AC urban women still have an AC strategy (behaviourally), but with a physiological reaction typical of a PC strategy. The “normal” physiological reaction pattern changes where an active coping strategy is dissociated from the normal physiological reaction and is exhibited as a typical physiological PC reaction. This pattern could indicate a physiological adaptation process where these Africans move from a collectivistic cultural context towards an individualistic cultural environment and where anticipated support is not forthcoming and stress is exacerbated [6]. In addition, their perception of poorer health may imply cumulative effects of stress that could result in a high allostatic load and eventually incident cardiovascular disease [7].

Defeat reactions are also dominated by enhanced and prolonged ACTH-glucocorticoid secretion, which can lead to the gradual induction of some of today's “Disorders of Lifestyle” such as hypertension and the metabolic syndrome [16]. The urbanised PC men and women also exemplified this defeat or stress reaction with a significant perception of poorer health and greater cortisol values, adding to possible symptoms of distress and greater abdominal obesity [42]. Stress or increased sympathetic nervous system stimulation, implicating norepinephrine secretion and an alpha-adrenergic stimulation, with its synergistic effect on cortisol, may further impact on both depression and obesity via the HPA axis. The later development of hypertension in the older groups supports the above physiological adaptation process.

In conclusion, the physiologically active coping profile of younger AC urbanised subjects, especially women, shows a dissociation from the normal AC physiological reaction pattern. This sets the stage where a dissociated AC style and a PC style at a younger age with a summation

of an enhanced vascular reactivity, abdominal obesity, increased levels of TG and cortisol with a perception of poorer health could imply changes in the cardiovascular system and also the development of MS. Therefore, the hypothesis could only be partially accepted as not only a typical PC style but also a physiologically dissociated AC style, both with an enhanced alpha-adrenergic stimulation pattern, are associated with these changes in younger subjects. With increasing age these changes could precipitate into higher hypertension prevalence rates. The data confirm that it is not age *per se* that induces a cardiovascular dysfunction in Africans but rather the possible effect of a psychosocial stressor and a physiologically PC style that might cause changes in the physiological reaction patterns, adding to cardiovascular dysfunction, distress and ultimately hypertension.

Weaknesses of this study include: the duration of abdominal obesity and the duration of stay in urbanised areas were not available [43], groups were too small for more significant differences to prevail, only one stressor was used and no adjustments were made for alcohol, smoking or physical inactivity due to unavailability of results.

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References

1. Collins R, Winkleby MA. African American women and men at high and low risk for hypertension: a signal detection analysis of NHANES III, 1988-1994. *Prev Med* 2002; **35**(4):303-312.
2. WHO (World Health Organization). World Health Organization WHO / International Society of Hypertension (ISH) statement on management of hypertension. *J Hypertens* 2003; **21**:1983-1992.
3. Somova LI, Connolly C, Diara K. Psychosocial predictors of hypertension in black and white Africans. *J Hypertens* 1995; **13**(2):193-199.
4. Van Rooyen JM, Huisman HW, Eloff FC, Laubscher PJ, Malan L, Steyn HS, *et al.* Cardiovascular reactivity in black South-African males of different age groups: the influence of urbanization. *Ethn Dis* 2002; **12**(1):69-75.
5. Lazarus RS. Coping theory and research: past, present, and future. *Psychosom Med* 1993; **55**:234-247.
6. Ryff CD, Singer B. From social structure to biology. In: Snyder, CR, Lopez SJ. *Handbook of positive psychology*. New York: Oxford University Press; 2002, pp. 541-555.
7. McEwen B, Stellar E. Stress and the individual: mechanisms leading to disease. *Arch Intern Med* 1993; **153**:2093-2101.
8. Kaplan HB. Psychosocial stress from the perspective of self theory. In: Kaplan HB. *Psychosocial stress: perspectives on structure, theory, life-course, and methods*. New York: Academic Press; 1996, pp. 180-197.
9. American Psychiatric Association. Diagnostic and statistical manual of mental disorders, fourth ed. Washington; 1995, pp. 25.
10. Aldwin CM. Stress, coping and development: an integrative perspective. New York: Guilford Press; 1994, pp. 20-25.
11. Taylor SE, Aspinwall LG. Mediating and moderating processes in psychosocial stress. In: Kaplan HB, *Psychosocial stress: perspectives on structure, theory, life-course, and methods*. New York: Academic Press; 1996, pp. 84-98.
12. Suzuki S, Kumano H, Sakano Y. Effects of effort and distress coping processes on psychophysiological stress responses. *Int J Psychophysiol* 2003; **47**:117-128.
13. Appels A. Mental precursors of myocardial infarction. *Brit J Psychiatry* 1990; **156**:465-471.
14. Rosmond R. Role of stress in the pathogenesis of the metabolic syndrome. *Psychoneuroendocrinology* 2005; **30**:1-10.
15. Opie LH. Heart physiology - from cell to circulation, fourth Ed. Philadelphia, Pa.: Lippincott Williams & Wilkins; 2004, pp. 16-648.

16. Björntorp P. Do stress reactions cause abdominal obesity and comorbidities? *Obesity reviews* 2001; **2**:73-86.
17. Steptoe A, Owen N, Kunz-Ebrecht SR, Brydon L. Loneliness and neuroendocrine, cardiovascular, and inflammatory stress responses in middle-aged men and women. *Psychoneuroendocrinology* 2003; **29**:593-611.
18. Misra A, Vikram MD. Insulin resistance syndrome (Metabolic syndrome) and obesity in Asian Indians: evidence and Implications. *Nutrition* 2004; **20**:482-491.
19. Vorster HH, Wissing MP, Venter CS, Kruger HS, Kruger A, Malan NT, *et al.* The impact of urbanisation 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.
20. Stapelberg R. Psychometric characteristics of the Cope and SACS in a Setswana-speaking South African group. Potchefstroom: PU for CHE; (Dissertation (MA.) 1999; pp. 25-200.
21. Carver CS, Scheier MF, Weintraub JK. Assessing coping strategies: a theoretically base approach. *J Pers Soc Psychol* 1989; **57**(2):267-283.
22. Bunker CH, Ukoli FA, Nwankwo MU, Omene JA, Currier GW, Holifield-Kennedy I, *et al.* Factors associated with hypertension in Nigerian civil servants. *Prev Med* 1993; **21**:710-722.
23. Nelson TL. Obesity and associated coronary heart disease risk factors in a population of low income African American and white women: the North Carolina WISEWOMAN Project. *Prev Med* 2002; **35**:1-6.
24. World Medical Association Declaration of Helsinki. Ethical principles for medical research involving human subjects. (10. p.). [Web:] [http://www.wma.net / c / policy / b3.htm](http://www.wma.net/c/policy/b3.htm) 2000. [Date of access: 19 April 2004].
25. Obrist PA. Cardiovascular psychophysiology: a perspective. Second edition: Plenum; 1981. pp. 2-28.
26. Waldstein R, Bachen EA, Manuck B. Active coping and cardiovascular reactivity: a multiplicity of influences. *Psychosom Med* 1997; **59**:620-625.
27. Goldberg DP, Hiller VF. A scaled version of the General Health Questionnaire. *Psychol Med* 1979; **9**:139-145.
28. Goldberg DP, Gater R, Sartorius TB, Ustun TB, Piccinelli M, Gureje O, *et al.* The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychol Med* 1997; **27**:191-197.
29. Julius S. The role of sympathetic overactivity in the pathophysiology of cardiovascular diseases. *Am J Hypertens* 1999; **12**(4):2.
30. MacArthur JD, MacArthur CT. Research network on socioeconomic status and health: laboratory tasks for cardiovascular reactivity research. (5 p). [Web:] [http:// www](http://www).

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- macses. ucsf.edu / research / psychosocial / notebook / reactivitytable.html [Date of access: 21 October 2003].
31. Silke B, McAuley, D. Accuracy and precision of blood pressure determination with the Finapres: an overview using re-sampling statistics. *J Hum Hypertens* 1998; **12**:403-409.
 32. Imholz BM, Wielingh W, Van Montfrans GA, Wesseling KH. Fifteen years experience with finger arterial pressure monitoring: assessment of the technology. *Cardiovasc Res* 1998; **38**:605-616.
 33. Wesseling KH, Jansen JRC, Settels JJ, Schreuder JJ. Computation of aortic flow from pressure in humans using a nonlinear, three-element model. *J Appl Physiol* 1993; **75**:2566-2573.
 34. Harms MPM, Wesseling KH, Pott F, Jenstrup M, Van Goudoever J, Secher NH. Continuous stroke volume monitoring by modelling flow from non-invasive measurement of arterial pressure in humans under orthostatic stress. *Clin Sci* 1999; **97**:291-301.
 35. Rodbard, D., Feldman, Y., 1978. Kinetics of two-site immunoradiometric ('sandwich') assays—I : Mathematical models for simulation, optimization, and curve fitting. *Mol. Immunol*, 1978; **15**(2), 71-76.
 36. Statsoft Inc. STATISTICA for Windows (Computer program manual). Tulsa, OK, Statsoft, Inc; 2004.
 37. Gerin W, Pickering TG, Glynn L, Christenfield N, Schwartz A., Carroll D, *et al.* An historical context for behavioural models of hypertension. *J Psychosom Res* 2000; **48**:369-377.
 38. Vorster HH. Fibrinogen and women's health. *Thromb Res* 1999; **95**:137-154.
 39. James S, Vorster HH, Venter CS. Nutritional status influences plasma fibrinogen concentration: evidence from the THUSA survey. *Thromb Res* 2000; **98**:383-394.
 40. Suarez EC, Saab PG, Llabre MM, Kuhn CM, Zimmerman E. Ethnicity, gender, and age effects on adrenoceptors and physiological responses to emotional stress. *Psychophysiology* 2004; **41**:450-460.
 41. Folkow B. Perspectives on the integrative functions of the 'sympatho-adreno-medullary system'. *Auton Neurosci* 2000; **83**:101-115.
 42. Stunkard AJ, Faith MS, Allison KC. Depression and obesity. *Biol Psychiatry* 2003; **54**:330-337.
 43. Janssen I, Katzmarzyk PT, Ross R. Duration of overweight and metabolic health risk in American men and women. *Ann Epidemiol* 2004; **14**:585-591.
 44. Grundy MS, Brewer HB, Cleeman JI, Smith S., Lenfant C. Definition of metabolic syndrome. Report of the National Heart, Lung, and Blood Institute/American Heart Association Conference on Scientific Issues related to Definition. *Circulation* 2004; **109**:433-438.
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A decorative wooden cross with intricate carvings and a central circular panel featuring a complex geometric pattern. The cross is made of light-colored wood and has a central circular panel with a complex, repeating geometric pattern. The cross arms are decorated with white, interlocking knotwork designs. The background is a light, textured surface.

6

General Findings and Conclusions

6.1 INTRODUCTION

In this chapter, a summary of the main findings from the three manuscripts in this thesis will be given. The results from each manuscript will be discussed, interpreted, elucidated and compared to the relevant literature in the separate chapters. Recommendations to health professionals will be made from these findings. The general discussion in this chapter will, therefore, focus on the compatibility of the main findings and recommendations following from each manuscript in order to identify specific coping mechanisms and provide involved factors and possible risk markers for the development of cardiovascular dysfunction/hypertension in Africans.

6.2 SUMMARY OF THE MAIN FINDINGS

The salient findings of the three manuscripts reported in this thesis were:

6.2.1 *Coping mechanisms, perception of health and cardiovascular function in Africans (Chapter 3).*

In complying with the aim of this manuscript, initially the responses on the handgrip test showed that active (AC) and passive coping (PC) African men and women overall reacted with an enhanced vascular response. However, the PC men indicated significantly greater increases in peripheral resistance (TPR), smaller increases in cardiac output (CO) and larger decreases in stroke volume (SV) than the AC men.

With further investigation the greater vascular responses and plasma renin activity (PRA) pattern in the PC men in contrast to AC men indicated increased sympathetic nervous system activity with a typically PC α -receptor stimulation pattern. These responses were accompanied by a subjective perception of poorer health in PC men.

Interestingly, the opposite results were obtained in the women's responses where the AC women showed non-significantly greater vascular responses than PC women, which is contradictory to the literature on a typical physiological AC response. This made it clear that the AC women's cardiovascular results were not according to typical AC physiological responses, maybe obscured by some unknown factor. The PC women indicated a perception of poorer health and presented the lowest resting PRA values that, according to the literature, have been associated with low renin hypertension in African American women. In addition, the younger PC women showed a higher rate of hypertension prevalence than AC women.

6.2.2 Specific coping strategies of Africans during urbanisation: comparing cardiovascular, endocrine and perception of health data (Chapter 4).

The contradictory results obtained from the first manuscript with regard to typical physiologically AC and PC stimulation patterns in African women necessitated the follow-up manuscript. As an individual's coping mechanisms are greatly influenced by his/her environment, the effect of the environment/urbanisation, therefore, as a psychosocial stressor could have an impact on specific coping strategies. In addition, the subjects from rural and urban areas were compared aiding towards an explanatory interpretation of the womens' atypical AC responses.

The aim of this manuscript was to determine the effect of urbanisation on AC and PC subjects' responses with regard to their endocrine, cardiovascular and perception of health profiles. In contrast to the first manuscript where all the African subjects responded with enhanced vascular reactivity on the handgrip test, in the context where the rural-urban effect was tested, all AC rural subjects indicated more typical active coping central cardiac responses. The AC and PC urbanised subjects, though, indicated greater peripheral responses e.g. increased peripheral resistance and hypertension prevalence rates with decreases in vascular compliance.

The urbanised AC men and PC women also showed larger prolactin and lower testosterone levels. This endocrine profile disturbs the balance between vasoconstriction and vasodilatation in favour of vasoconstriction adding to a greater vascular effect. Additionally, AC urbanised women showed larger prolactin levels with more anxiety symptoms than AC rural women. It could imply that the AC individuals who are constantly exposed to the same stressor (urbanisation) can exhibit associated decreased or habituated HPA axis responses. The cardiovascular responses of the urbanised AC men and women showed a physiologically α -adrenergic stimulation pattern and suggest a dissociation from the "normal" typical active coping central cardiac stimulation or β -adrenergic stimulation pattern. The urbanised AC (behaviourally) men and women and PC women with their enhanced vascular responses, endocrine profile implying distress (only AC men and PC women) and more negative perception of health are, therefore, prone to develop cardiovascular dysfunction. This is in contrast to their rural counterparts.

6.2.3 Specific coping mechanisms, perception of health, vascular reactivity and metabolic syndrome indicators in Africans during urbanisation: The THUSA study (Chapter 5).

The results from Manuscript Two of a dissociated physiological AC stimulation pattern resembling a physiological PC stimulation pattern raised the question whether this pattern also exists between different age and gender groups in urbanised Africans. As urbanisation has been implicated in the higher rates of hypertension and abdominal obesity in Africans (Kruger *et*

al., 2001) the vascular reactivity and the metabolic syndrome (MS) indicators of younger (≤ 40 years) and older (≥ 45 years) subjects were further scrutinized and integrated with their perception of own health or well-being values.

The same pattern in Manuscript Two emerged where rural-urban cardiovascular effects were compared, namely a trend where most rural AC subjects responded with a typically AC central cardiac stimulation pattern (increases in cardiac output). All the urbanised subjects (AC and PC) though responded with a typically enhanced vascular PC stimulation pattern (increases in peripheral resistance and/or diastolic blood pressure and decreases in compliance) accentuated in the younger groups.

Unexpectedly the younger and older AC urban men displayed very similar cardiovascular and MS indicator values. When comparing the AC urban men with their rural counterparts, the urban men exhibited higher glucose and hypertension prevalence rates. Between age groups though, the only differences were in their WHR levels accompanied by a perception of poorer health or well-being. Younger AC and PC urbanised women showed higher fibrinogen values compared to their rural counterparts, implying a greater risk for cardiovascular disease. In addition the younger AC urbanised women also presented greater vascular responses than their older counterparts with regard to values of the MS indicators including increased WHR, triglycerides and hypertension prevalence rates ($p = 0.09$). These results also resemble the physiological profile of the younger PC men and women accentuating the dissociation of the “normal” physiological AC stimulation pattern and the presentation of a physiological PC stimulation pattern or profile.

All the results were accentuated in the younger groups and the summation of an increased vascular reactivity, abdominal obesity, increased levels of TG and cortisol with a perception of poorer health could imply early changes in the cardiovascular system. With increasing age this pattern could precipitate in higher hypertension prevalence rates and possible MS. The data confirm that it is not age *per se* that induces a cardiovascular dysfunction in Africans but rather other factors including the effect of a psychosocial stressor and specific coping styles that could cause changes in the cardiovascular system, possibly resulting in dysfunction and later into hypertension.

6.3 COMPARISON TO RELEVANT LITERATURE

When the results from this study (Figure 6.1) are compared to results found in the literature (as presented in Chapter 2) it is evident that certain findings confirmed those found in the literature.

The results from Manuscript One confirmed the findings for men where Van Rooyen and co-workers (2002) showed that African men exhibited an enhanced vascular response independent of environmental influences. Unfortunately this approach was not tested in African women (Van Rooyen *et al.*, 2002). In this study (Manuscript One) an enhanced vascular response was only accentuated in PC men, whereas the PC women accentuated a contradictory finding with no significance between AC and PC women responses. However, the trend of AC women indicating a greater vascular response existed.

From the literature it was confirmed that African Americans and Africans respond with enhanced vascular patterns to a stressor (Anderson & McNeilly, 1993; Fray & Douglas, 1993; Van Rooyen *et al.*, 2002). In this study the effect of psychosocial stress or urbanisation on coping mechanisms presented findings where rural AC subjects exhibited more typical central cardiac responses and rural PC subjects typical peripheral vascular responses. When urbanised though, all subjects responded with enhanced vascular stimulation patterns. This was especially true for the AC subjects. These results could not be confirmed in the literature. Surrendering and resigning are more typical PC coping strategies often used by Africans (Stapelberg, 1999), but only the urbanised African subjects presented more typical PC coping stimulation patterns on a physiological but not a behavioural level.

Normally African Americans and Africans as ethnic groups exhibit greater plasma renin activity and hypertension prevalence rates (Carels *et al.*, 2000; Cooper & Borke, 1993; Van Rooyen *et al.*, 2002). In this study an integrative approach with coping styles showed that it is actually a PC style in men that was accompanied with greater plasma renin activity levels and a perception of poorer health. PC women with the lowest plasma renin activity values and perception of depressive symptoms showed significantly higher hypertension prevalence rates when compared to younger AC women.

The endocrine profile for urbanised subjects with lower testosterone and higher prolactin values (Gala, 1990) as indicators of stress was substantiated in the work of Huisman and co-workers (2002) on Africans. This study emphasized that specific coping mechanisms in urbanised subjects (AC men and PC women) could actually be responsible for exhibiting this pattern. It strengthens the input of urbanisation on coping mechanisms where dissociation or habituation of physiological systems appear and this adds a new perspective.

Metabolic syndrome (MS) indicators, which included waist-to-hip ratio, triglycerides, fibrinogen (African women), cortisol values and hypertension prevalence rates in Africans when urbanised, are confirmed from literature (Huisman *et al.*, 2002; Kruger *et al.*, 2001; Van Rooyen *et al.*, 2002; Vorster, 1999). Certain results in this study though were not evident in literature. These

included MS indicators, which were integrated with coping styles in younger and older urbanised subjects. The results accentuated greater values of MS indicators and a perception of poorer health or well-being in younger AC and PC urbanised subjects. The AC subjects responded with a dissociated physiological AC stimulation pattern resembling a typical physiological PC pattern. A resemblance of a typical physiological AC stimulation pattern (central cardiac) to a physiological PC stimulation pattern (vascular) indicates a dissociation of the “normal” AC style where a possible physiological adaptation/habituation occurs. This could happen to these Africans when moving from a collectivistic environment towards an individualistic one accompanied by less social support, and more insecurity could exacerbate their stress (Folkow, 2000). All the above reactions were enhanced in women (AC and PC). Increasing levels of obesity and the metabolic syndrome (Misra & Vikram, 2004) have been observed in women and this study confirms the enhanced reactions in women. No coping related results with regard to the MS could be found in the literature. The appearance of the above results in younger urbanised subjects (AC and PC) emphasizes the necessity for future research of changes in the cardiovascular system at a younger age, including parameters such as endothelial function and arterial stiffness.

Findings of Van der Wateren (1997) indicating that older Africans make use of more PC strategies could not be confirmed in this study. A more or less even distribution between the choice of coping strategies of AC and PC subjects was made in younger and older groups. The role of the environment (urbanisation) has shown a dissociation of a typical physiologically AC reactivity towards a typical physiologically PC reactivity. Subjects did not actually prefer using a PC strategy to an AC strategy. The reader must be reminded that the actual division into AC and PC groups was a behavioural choice while completing the S-COPE. The only differences occurred in their physiological responses. The duration of stay in urbanised areas could possibly alter this statement.

Discrepancies between the results of this study and the literature might be explained by racial differences, since some of the research in the literature refers to Caucasian or African American populations. It must be emphasized that literature regarding an interaction between coping mechanisms and cardiovascular dysfunction in Africans is to a great extent lacking.

6.4 DISCUSSION AND FINDINGS

6.4.1 Chance and confounding

Chance: Before the main findings of this study are discussed, it is important to reflect critically on some important factors that may have affected the results. There are some

methodological issues that could have caused weaknesses in this study and therefore, may have influenced the different outcomes.

Firstly, the number of subjects included in this study could be questioned, especially the number of subjects in the last manuscript (Chapter 5) of the older AC and PC women respectively $n = 21$ and $n = 17$. A power analysis determined that 15 subjects would be sufficient and this was determined by using blood pressure. Concerning the results, the possibility of **chance** should be taken into account. By using partial correlations, statistics have indicated that one out of twenty significant correlations may be because of chance.

Confounding factors:

Confounders such as smoking, alcohol intake, levels of physical activity, HIV-status, socio-economic status (education, social support) and psychological characteristics could have influenced the results by causing over or under estimation of the associations between cardiovascular function and the various variables investigated in this study. Age, resting cardiovascular and plasma renin activity data, as possible confounders, were addressed by adjusting statistically.

In the interpretation of the results in this thesis, it was attempted to interpret statistical results from a physiological standpoint at all times, while keeping in mind that a statistical significance does not necessarily mean physiological significance, and *vice versa*.

6.4.2 Weaknesses of study

Weaknesses of this study included:

- (a) No statistical adjustments were made for alcohol, smoking and physical inactivity variables due to unavailability of results;
- (b) Duration of obesity and stay in urbanised areas were not known, which could influence adaptation/habituation of physiological resources;
- (c) In some instances groups were too small for more significant differences to prevail;
- (d) More than one stressor should have been applied i.e. an additional task that typically produces a more myocardial or central β -adrenergic stimulation pattern.

6.4.3 Highlighted comparisons of this study

When comparing the main findings of this study (Figure 6.1) to results found in the literature the following comparisons are especially highlighted:

- ❖ Urbanisation-coping comparison;
- ❖ Age and urbanisation-coping comparison;
- ❖ MS, cardiovascular dysfunction and urbanisation-coping comparison.

6.4.3.1 Urbanisation-coping comparison

During active coping (AC) the influence of a β -adrenergic vasodilatory activity is more pronounced by increasing blood pressure via central cardiac mechanisms (Gerin *et al.*, 2000; Esler *et al.*, 2001, Obrist, 1981; Opie, 2004). In contrast, passive coping (PC) is elicited by situations in which the person has the perception of little or no control – mediated by α -adrenergic pathways e.g. elevating blood pressure via vascular or peripheral mechanisms (Opie, 2004; Williams, 1986).

According to Van Rooyen *et al.* (2002), African men responded with enhanced vascular reactivity on exposure to a stressor. This finding was also obtained in other ethnic gender groups (Fray & Douglas, 1993; Hinderliter *et al.*, 2004; Saab *et al.*, 1997; Suarez *et al.*, 2004). Interestingly, in this study when AC and PC rural and urban men and women were compared with regard to their responses on the handgrip test, another perspective emerged. When examining the AC rural subjects, more typical active coping central cardiovascular responses were exhibited, whereas AC style urbanised subjects exhibited greater peripheral responses, namely an increased vascular reactivity. The PC subjects in rural and urban areas showed, according to a typical physiological PC stimulation pattern, a trend of increased vascular reactivity.

Urbanisation implies that when a collectivistic group (such as Africans) are moving towards an individualistic environment and where anticipated support is not forthcoming, stress is exacerbated (Ryff & Singer, 2002). A perception of own poorer health and a distressed endocrine profile additionally implies an effort of apparently challenging the stress but it is experienced as uncontrollable. A typical “normal” physiological AC pattern with an AC (behavioural) strategy dissociates from the typical physiological AC central cardiac stimulation pattern. This pattern then exhibits a response resembling a typical PC physiological response/pattern with an increased vascular reactivity. The influence of a psychosocial stressor (urbanisation) emphasizes the impact thereof on Africans’ coping mechanisms and could be detrimental to their health.

6.4.3.2 Age and urbanisation-coping comparison

It is known that age with increased vascular reactivity are risk factors in the development of hypertension (WHO, 2003). The role of psychosocial stress as experienced in an urban environment or coping styles, rather than age, may have the larger effect in the possible development of cardiovascular dysfunction and the metabolic syndrome (MS).

In this study it was the younger urbanised subjects who showed a preliminary development of a possible pathological interaction between the cardiovascular, metabolic and nervous systems. A

dissociated physiological AC pattern and a PC pattern with enhanced vascular reactivity, abdominal obesity, increased levels of TG and cortisol with a perception of poorer health could imply changes in the cardiovascular system at a younger age. With increasing age this could precipitate in higher hypertension prevalence rates. The data confirm that it is not age *per se* that induces a cardiovascular dysfunction in Africans, but rather other possible factors such as a psychosocial stressor and specific coping styles at a younger age. This psychosocial stressor may cause changes in the physiological reaction patterns adding to cardiovascular dysfunction, distress and ultimately a higher prevalence of hypertension, especially in subjects with a typical PC stimulation pattern.

6.4.3.3 Metabolic syndrome, cardiovascular dysfunction and urbanisation-coping comparison

The type of coping style used during stress can affect health outcomes (Rosmond, 2005; Kaplan, 1996). Chronic or persistent psychosocial stress as in urbanisation could result in a disruption of central regulatory systems (Steptoe *et al.*, 2003). This could lead to a dissociation of typical physiological AC patterns, followed by an increase in abdominal obesity and deficient fibrinolysis. During recent years indications of increasing levels of obesity, especially in women, as well as the development of the MS have been found. An AC style (behaviourally) with a dissociated physiological pattern implies that although their normal AC style (behavioural or seeking social support) is still in place, they report on a perception of own poorer health. This is accompanied by an atypical physiological AC response with an enhanced vascular reactivity, abdominal obesity and increased levels of TG.

The increased levels of cortisol in younger PC men and women support a typical defeat or surrendering PC coping style. A summation of all the above symptoms can lead to the gradual induction of some of today's "Disorders of Lifestyle" such as hypertension and the metabolic syndrome.

6.5 GENERAL CONCLUSIONS

The results of this study complied with the aims, objectives and hypotheses stated in Chapter 2.

Hypotheses

MANUSCRIPT 1: Firstly, a passive or avoidance-focused coping strategy in Africans is associated with cardiovascular dysfunction or prevalence of hypertension. Secondly, a passive or avoidance-focused coping strategy in Africans is associated with a perception of poorer health.

MANUSCRIPT 2: A typical passive coping mechanism in African gender groups during urbanisation firstly exhibits cardiovascular dysfunction and secondly, a distressed endocrine profile as well as a perception of poorer health.

MANUSCRIPT 3: A typical passive coping mechanism in younger and older urbanised Africans exhibits enhanced vascular reactivity, metabolic syndrome indicator values and a perception of poorer health or well-being.

A conclusive schematic presentation of the main findings from the results in the three manuscripts, namely Chapters 3, 4 and 5 is given in Figure 6.1 and is summarized as follows: Where: 1, Manuscript 1; 2, Manuscript 2; 3, Manuscript 3 (in Chapters 3, 4 and 5 respectively), green, AC groups, blue, PC groups, orange, possible pathology :

- The typical heightened vascular reactivity in all Africans (AC and PC) when exposed to stress (1) was only observed when environmental influences (namely urbanisation) (2, 3) were not taken into account. The role of specific coping mechanisms influences the typical cardiovascular reaction patterns (1) and is also related to cardiovascular dysfunction and hypertension prevalence (1, 2, 3). Only younger PC women presented an increased prevalence of hypertension compared to younger AC women (1) and, therefore, the hypotheses were partially accepted (Manuscript 1). A typical PC style was associated with a perception of poorer health and the second hypothesis was accepted (1). Enhanced plasma renin activity (in PC men), as an example of heightened stimulation of the sympathetic nervous system, plays a supporting role in the process (1).
- In rural AC style subjects (2, 3) a more typical AC response was elicited, namely a β -adrenergic central cardiac pattern, whilst in rural PC style subjects a more typical PC response was elicited, namely an α -adrenergic peripheral vascular pattern. The role of the environment, namely urbanisation, as a psychosocial stressor (2, 3) could be associated with an enhanced vascular reactivity (2, 3), distressed endocrine profile (2), perception of poorer health (2, 3) and higher hypertension prevalence rates (2) in subjects. Although behaviourally AC in style, an apparent dissociation from a typical physiological AC stimulation pattern (β -adrenergic) now resembling a typical physiological PC pattern (α -adrenergic), is evident (2, 3). Therefore, a physiologically dissociated AC style (physiological PC style) AND a typical PC style (behavioural and physiological) were associated with these changes (2) and the hypotheses in Manuscript 2 could only be partially accepted.
- A physiological dissociated AC style and a typical PC style in younger Africans (3) indicate changes towards the development of cardiovascular dysfunction, the metabolic syndrome, distressed endocrine profile (only younger PC subjects) and a more negative perception of health. The hypotheses of Manuscript 3 could, therefore, only be partially accepted as a physiological dissociated AC style as well indicated these changes in younger subjects. With increasing age (3) these changes could precipitate in higher hypertension prevalence rates as seen in older PC subjects.

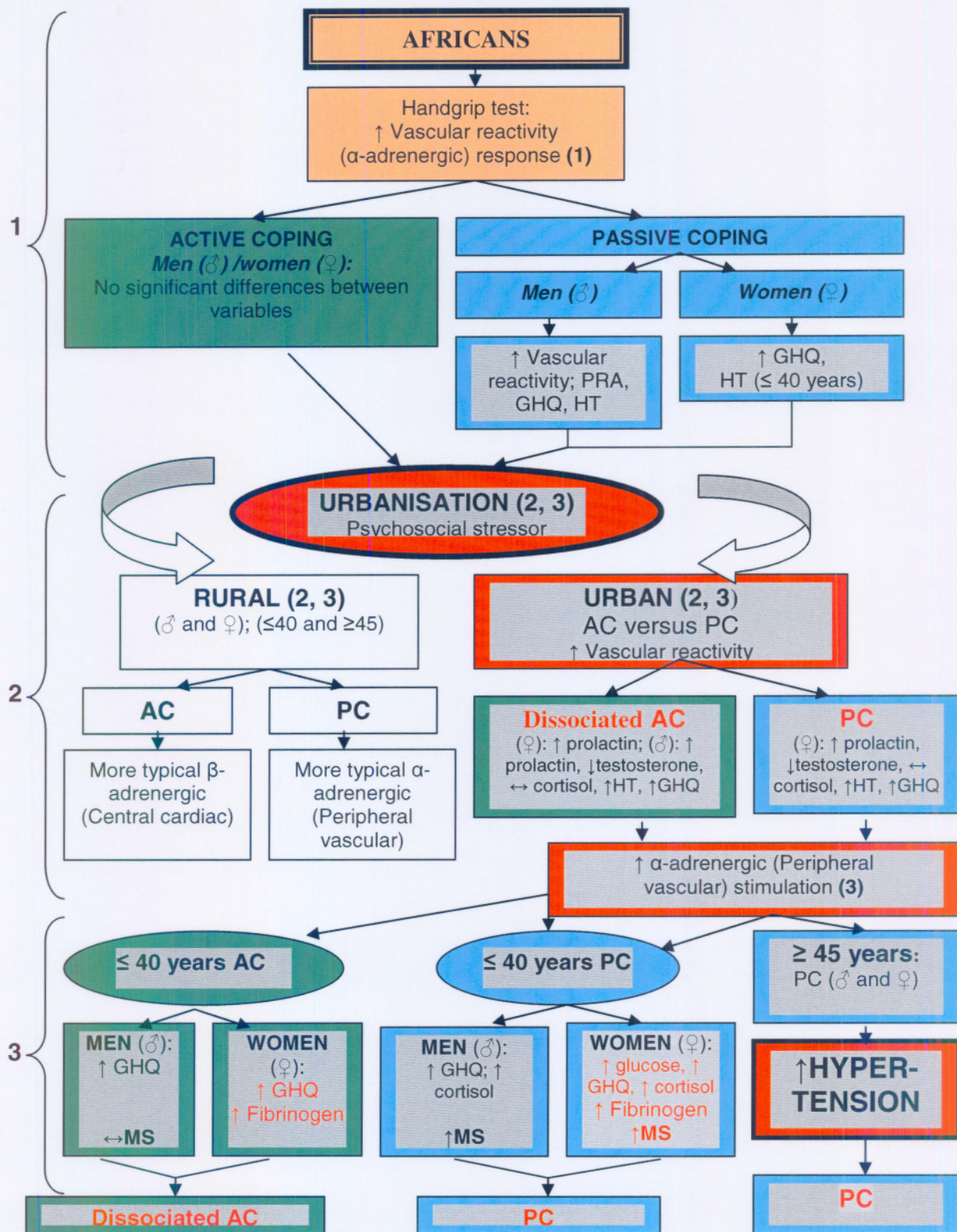


Figure 6.1: Schematic presentation of the significant differences between coping mechanisms in Africans and cardiovascular, metabolic syndrome indicators and perception of health data. Where: 1, Manuscript 1; 2, Manuscript 2; 3, Manuscript 3; ↑, increase; ↓, decrease; ↔, no significant differences; AC, active coping (green), PC, passive coping (blue), Orange background, possible pathology, ♂, men, ♀, women, HT, hypertension prevalence, PRA, plasma renin activity, MS, metabolic syndrome indicators (waist-to-hip ratio; triglycerides; HT); GHQ, General Health Questionnaire (including somatic, anxiety, social dysfunction and depressive symptoms).

- The changes that take place in younger AC Africans when urbanised (3) imply that behaviourally they are apparently challenging the stress but with supposedly less social support and more insecurities, they respond with a dissociated physiological AC pattern. Their response and that of the PC subjects imply that they present a typical PC defeat reaction pattern (3). This is accompanied by a perception of poorer health, which in future could be detrimental to their health.

□ *Finally, a physiologically dissociated AC style and a typical PC style (or alternatively a typical physiological PC style and a typical PC (behavioural and physiological)) (2) in younger Africans (3) show a trend towards the development of cardiovascular dysfunction/hypertension (1, 2, 3), the metabolic syndrome (3), a distressed endocrine profile (2, 3) and a perception of poorer health or well-being (1, 2, 3). Most of these changes are occurring in younger urbanised Africans (3) and enhanced reactions are especially observed in women (1, 2, 3). Coping style could, therefore, be a possible risk marker in the development of cardiovascular dysfunction and the metabolic syndrome.*

6.6 CONTRIBUTIONS OF THE STUDY

The contributions of this study lie especially in the results of the urbanised subjects' responses after exposure to the handgrip test. Firstly, the psychological and physiological interaction influences the outcome of hypertension prevalence rates. Specific coping styles were associated with higher hypertension prevalence rates. Literature on this interaction with regard to Africans is to a great extent lacking.

Secondly, the role of coping mechanisms in the development of cardiovascular dysfunction, hypertension and the metabolic syndrome indicators in Africans adds a new perspective to the psychological input in the development of these diseases.

Thirdly, all of the significant results concerning cardiovascular dysfunction and indicators of the metabolic syndrome were found in younger urbanised men and women. This emphasizes the changes that occur at a younger age, which might, with increasing age, precipitate in hypertension.

Fourthly, another factor is that the changes (vascular reactivity/hypertension, the metabolic syndrome, a distressed endocrine profile, perception of poorer health) that have been observed are exacerbated in urbanised women. These changes associated with specific coping styles

add a new perspective to increasing levels of hypertension, abdominal obesity and metabolic syndrome indicators in ethnic women.

Finally, the heightened vascular reactivity after exposure to a stressor as found by other researchers of ethnic groups has not been conclusively substantiated in this study. The role or impact of coping mechanisms in this process alters this observation and is especially different and atypical when a psychosocial stressor (urbanisation) is involved.

This population group has its own unique characteristics, religious and cultural beliefs, lifestyle and apparent coping styles in a stressful situation. Research on Westernised Caucasians is abundant, but this group with its own uniqueness makes extrapolation of information difficult and may impede the task of the researchers and health professionals in South Africa. Therefore, the results of this study add valuable information concerning the lifestyle of Africans as well as to related factors influencing the development of cardiovascular dysfunction and the metabolic syndrome.

6.7 RECOMMENDATIONS

Results from the three manuscripts reported in this thesis led to the formulation of the following recommendations that can be used by policy makers, health professionals and researchers:

- Social support and socio-economic evaluations are necessary for a better understanding of the psychological AC and PC profiles of urbanised subjects.
- The occurrence of the obtained results in younger AC and PC urbanised subjects emphasizes the necessity for future research of changes in the cardiovascular system of Africans. This includes parameters such as coping styles, endothelial function and arterial stiffness.
- The influence of coping mechanisms on the plasma renin-angiotensin-aldosterone system in urbanised African individuals needs attention. This system is implicated in chronic sympathetic nervous system stimulation or stress in Africans with its contributory effect on the development of cardiovascular dysfunction.
- Health professionals should focus on stress management and weight loss strategies in order to prevent the high prevalence of abdominal obesity. The precise relationship between coping processes and stress responses is unknown. If it is understood how a particular coping style may be associated with factors (psychosocial) that maintain and aggravate psychosomatic diseases, effective stress coping and management programmes for preventing such diseases can be developed. The results urge the need of programmes as part of an educational programme from the early stages of life.

6.8 REFERENCES

- ANDERSON, N.B. & MCNEILLY, M. 1993. Autonomic reactivity and hypertension in blacks: toward a contextual model. (*In* Fray J.C.S. & Douglas, J.G. Pathophysiology of hypertension in blacks. New York : Oxford University Press. p. 104-125.)
- CARELS, R.S., BLUMENTHAL, J.A. & SHERWOOD, A. 2000. Emotional responsivity during daily life: relationship to psychosocial functioning and ambulatory blood pressure. *International journal of psychophysiology*, 36(1):25-33.
- COOPER, R.S. & BORKE, J.L. 1993. Intracellular ions and hypertension in blacks. (*In* Fray, J.C.S. & Douglas, J.G. Pathophysiology of hypertension in blacks. New York : Oxford University Press. p. 12-13.)
- ESLER, M., RUMANTIR, M., KAYE, D. & LAMBERT, G. 2001. The sympathetic neurobiology of essential hypertension: disparate influences of obesity, stress and noradrenalin dysfunction. *American journal of hypertension*, 14:138S-146S.
- FOLKOW, B. 2000. Perspectives on the integrative functions of the 'sympatho-adrenomedullary system'. *Autonomic Neuroscience*, 83:101-115.
- FRAY, J.C.S. & DOUGLAS, J.G., eds. 1993. Pathophysiology of hypertension in blacks. New York : Oxford University Press. 299 p.
- GALA, R. 1990. The physiology and mechanisms of the stress-induced changes in prolactin secretion in the rat. *Stress medicine*, 8:213-218.
- GERIN, W., PICKERING, T.G., GLYNN, L., CHRISTENFIELD, N., SCHWARTZ, A., CARROLL, D. & DAVIDSON, K. 2000. An historical context for behavioural models of hypertension. *Journal of psychosomatic research*, 48. 369-377.
- HINDERLITER, A.L., BLUMENTHAL, J.A., WAUGH, R., CHILUKURI, M. & SHERWOOD, A. 2004. Ethnic differences in left ventricular structure: relations to hemodynamics and diurnal blood pressure variation. *American journal of hypertension*, 17:43-49.
- HUISMAN, H.W., VAN ROOYEN, J.M., MALAN, N.T., ELOFF, F.C., MALAN, L., LAUBSCHER, P.J. & SCHUTTE, A.E. 2002. Prolactin, testosterone and cortisol as possible markers of changes in cardiovascular function associated with urbanisation. *Journal of human hypertension*, 16:829-835.
- KAPLAN, H.B. 1996. Psychosocial stress from the perspective of self theory. (*In* Kaplan, H.B. Psychosocial stress: perspectives on structure, theory, life-course, and methods. New York: Academic Press. p. 180-197.
- KRUGER, H.S., VENTER, C.S. & VORSTER, H.H. 2001. Obesity in African women in the North West Province, South Africa is associated with an increased risk of non-communicable diseases: the THUSA study. *British journal of nutrition*, 86(6):733-740.

- MISRA, A. & VIKRAM, N.K. 2004. Insulin resistance syndrome (Metabolic syndrome) and obesity in Asian Indians: evidence and Implications. *Nutrition*, 20:482-491.
- OBRIST, P.A. 1981. Cardiovascular psychophysiology: a perspective. London : Plenum. 201 p.
- OPIE, L.H. 2004. Heart physiology: from cell to circulation. 4th ed. Philadelphia, Pa. : Lippincott Williams & Wilkins. 648 p.
- ROSMOND, R. 2005. Role of stress in the pathogenesis of the metabolic syndrome. *Psychoneuroendocrinology*, 30:1-10.
- RYFF, C.D. & SINGER, B. 2002. From social structure to biology. (In Snyder, C.R. & Lopez, S.J. Handbook of positive psychology. New York : Oxford University Press. p. 541-555.)
- SAAB, P.G., LLABRE, M.M., SCHNEIDERMAN, N., HURWITZ, B.E., MCDONALD, P.G., EVANS, J., WOHLGEMUTH, P., HAYASHI, P. & KLEIN, B. 1997. Influence of ethnicity and gender on cardiovascular responses to active coping and inhibitory-passive coping challenges. *Psychosomatic medicine*, 59(4):434-446.
- SOLOMON, R. 1996. Coping with stress: a physician's guide to mental health in aging. *Geriatrics*, 51:46-51.
- STEPTOE, A., OWEN, N., KUNZ-EBRECHT, S.R. & BRYDON, L. 2003. Loneliness and neuroendocrine, cardiovascular, and inflammatory stress responses in middle-aged men and women. *Psychoneuroendocrinology*, 29:593-611.
- SUAREZ, E.C., SAAB, P.G., LLABRE, M.M., KUHN, C.M. & ZIMMERMAN, E. 2004. Ethnicity, gender, and age effects on adrenoceptors and physiological responses to emotional stress. *Psychophysiology*, 41:450-460.
- SUZUKI, S., KUMANO, H. & SAKANO, Y. 2003. Effects of effort and distress coping processes on psychophysiological stress responses. *International journal of psychophysiology*, 47:117-128.
- VAN ROOYEN, J.M., HUISMAN, H.W., ELOFF, F.C., LAUBSCHER, P.J., MALAN, L., STEYN, H.S. & MALAN, N.T. 2002. Cardiovascular reactivity in black South-African males of different age groups: the influence of urbanisation. *Ethnicity and disease*, 12(1): 69-75.
- VORSTER, H.H. 1999. Fibrinogen and women's health. *Thrombosis research*, 95:137-154.
- WHO **see** WORLD HEALTH ORGANIZATION
- WILLIAMS, R.B. 1986. Patterns of reactivity and stress. (In Matthews, K.A., Weiss, S.M., Detré, T., Dembroski, T.M., Falkner, B., Manuck, S.B. & Williams, R.B., eds. Handbook of stress, reactivity and cardiovascular disease. New York : Wiley. p. 109-125.)

WORLD HEALTH ORGANIZATION. 2003. World Health Organization (WHO) / International Society of Hypertension (ISH) statement on management of hypertension. *Journal of hypertension*, 21:1983-1992.