

## Original Article

## Hypertension and obesity in police forces households in Khartoum, Sudan: A pilot report - part of the "Police Forces Hypertension, Diabetes, Renal Insufficiency, and Thyroid Derangements (HyDRIT) Study", Sudan)

Hasan Abu-Aisha<sup>1</sup> FRCP, Elwaleed AM Elhassan<sup>2</sup> ABIM, MACP, Ammar Hassan Khamis<sup>3</sup> PhD and Adil Abu-Elmaali<sup>4</sup> MD

<sup>1</sup> Consultant Physician and Nephrologist, National Ribat University Hospital, Khartoum, Sudan. President, National Ribat University. Khartoum, Sudan. P.O.Box: 55, Tel.: +249183263591, Fax: +249183263590, Mobile: +249912444452

<sup>2</sup> Assistant professor of Internal Medicine, Department of Internal Medicine, University of Khartoum, Khartoum, Sudan

<sup>3</sup> Associate professor of Biostatistics, Sudan University for Science and Technology, Khartoum, Sudan

<sup>4</sup> Head Department of Community Medicine, National Ribat University, Khartoum, Sudan

### Abstract:

*Premature mortality from cardiovascular diseases could be prevented by the effective control of hypertension (HTN). Excess weight is associated with increased rate of death from all-causes. Nationwide data for the status of hypertension and excess weight in the Sudanese population are not available. All the consenting 426 inhabitants of two police housing-complexes were included. Blood pressure (BP), anthropometric measurements as well as blood samples were taken. Standard interviewing procedures were used to record medical history, socio-demographic and lifestyle characteristics. The data was analysed through univariate and multivariate regressions. The overall prevalence of hypertension (based on two BP measurements) was 27%. Less than a third (29.8%) of the hypertensive subjects were aware of their disease. Pharmacotherapy among those aware of their disease was prescribed in 94.1%. However, 59.4% of them were compliant with their prescribed medicines and 28.1% attained effective BP control. Prevalence of hypertension was significantly higher in older individuals (> 50 years of age), overweight (body mass index, (BMI) > 25) and those who had better education (> 10 years of schooling). The cumulative prevalence of overweight (BMI 25-29.9 kg/m<sup>2</sup>) was 30% while that for obesity (BMI ≥ 30 kg/m<sup>2</sup>) was 19.2%. Abdominal obesity was observed in 19.5% of males and 46.2% of females. Overweight subjects were more than twice likely to be hypertensive than their non-overweight counterparts (odds ratio 2.33 [1.49-3.64]). In the sample examined, the prevalence of hypertension and excess weight seemed to be comparable to other countries; this makes them a public health priority.*

**Keywords:** Hypertension, prevalence, control, awareness, obesity, Sudan, (HyDRIT)

### Introduction

Non-communicable diseases are a major global health challenge with numerous grave complications on the human body. Nationwide data for the status of high blood pressure, diabetes, excess weight and renal Insufficiency in the adult population of Sudan is not available. Their true prevalence is not well appreciated and they are under-treated. In this article, we display the results of blood pressure and obesity survey of the "Police HyDRIT Study" in Sudan. The study was designed

to survey a limited but representative population of Greater Khartoum, Sudan, for the prevalence of some non-communicable diseases and their underlying risk factors in order to help raise the general awareness and guide future health planning. Hypertension is the third "killer" according to the World Health Organization, accounting for one in every third deaths worldwide <sup>(1)</sup>. It increases the risk of stroke, myocardial infarction, congestive heart failure, sudden cardiac death, peripheral vascular disease and renal insufficiency <sup>(2-4)</sup>.

Premature mortality from cardiovascular diseases could be prevented, to a considerable extent, by the effective control of hypertension, a major risk factor for this group of diseases <sup>(5)</sup>. Based upon some estimates, 26.4% of the world's adult population in the year 2000 had hypertension (26.6% in men and 26.1% in women, and 29.2% were predicted to have hypertension by the year 2025 (29.0% in men and 29.5% in women) <sup>6</sup>. In addition to ethnicity and age, the prevalence of increased blood pressure appears to vary by country and geographic area. In the United States, the national health and nutrition survey (NHANES III) estimated that the age-adjusted prevalence of hypertension (systolic > 140 and/or diastolic > 90 mmHg) between the years 1988 and 1991 was 32% in the non-Hispanic black population and 23% in the non-Hispanic white and Mexican-American populations <sup>(6)</sup>. The age- and sex-adjusted comparative prevalence of hypertension as assessed in sample national surveys in the 1990s, was reportedly 28 and 44% in North America (United States and Canada) and Europe (Germany, Finland, Sweden, England, Spain, and Italy), respectively <sup>(7)</sup>. Likewise, crude rates of hypertension from national surveys in countries neighbouring Sudan were 26.3%, 23.9%, 15.4%, and 31.1% for Egypt, South Africa and Cameroon, Tanzania respectively <sup>(8)</sup>. Despite the worldwide attention paid to the importance of hypertension and its associated complications, the disease is not adequately controlled. According to the latest NHANES data, only 58% of American patients with hypertension were being treated and approximately one-half of them had adequate blood pressure control, defined as a blood pressure below 140/90 mmHg <sup>(9)</sup>. Obesity is a chronic disease that has become a major health problem in many countries because of its high prevalence, causal relationship with serious medical illnesses, and economic consequences.

Excess weight, particularly, abdominal obesity, is associated with an increased risk of developing hypertension, cardiovascular disease, several forms of cancer, dyslipidemia, the metabolic syndrome and death <sup>(10-12)</sup>. The body mass index (BMI) is the most practical way to evaluate the degree of excess weight. Greater BMI was associated with increased rate of death from all-causes and from cardiovascular disease <sup>(13)</sup>. In adults with a BMI of 25 to 34.9 kg/m<sup>2</sup>, a waist circumference greater than 102 cm (40 in) for men and 88 cm (35 in) for women is considered high risk <sup>(14)</sup>. Blood pressure is often increased in obese subjects <sup>(15)</sup>. Weight loss in obese subjects is associated with a decline in blood pressure <sup>(16)</sup>. On the other hand, persistent obesity not only raises the blood pressure directly, but also makes the hypertension more difficult to control by interfering with the efficacy of antihypertensive drugs <sup>(17)</sup>.

Regarding the prevalence of obesity in Africa, wide disparities are found with the highest rates in South Africa, where mean BMI values for men and women are 22.9 kg/m<sup>2</sup> and 27.1 kg/m<sup>2</sup> respectively, but levels of central obesity among women have been assessed at 42% <sup>(18)</sup>. The South Africa Health Review 2000 indicated obesity rates from 8% among black men to 20% among white men, but among women, the rates range from 20% for Indian/Asians to 30.5% for black women. In North Africa the prevalence of obesity among women is high. Half of all women are overweight (BMI>25) with rates of 50.9% in Tunisia and 51.3% in Morocco, and obesity rates (BMI>30) in women of 23% in Tunisia and 18% in Morocco, a three fold increase over 20 years <sup>(19)</sup>.

Combating obesity requires knowledge of the incidence and the prevalence of the condition, such information is currently not available in Sudan.

The general objective of this study is to disclose insight with regards to the awareness, prevalence

and treatment adequacy of the said non-communicable diseases among a large sample of Sudanese police forces households who are representative of the whole Sudanese population. Specific objectives are to measure the prevalence of hypertension and obesity, identify their risk factors and determine the status of their awareness, treatment, and control.

### **Methods and Materials**

This is a pilot, cross-sectional, community-based study done on home visits to police forces housing complexes in Khartoum. The protocol was approved by the ethics committee of the National Ribat University. Khartoum is the capital city of Sudan with about 6 million inhabitants. Police housing complexes are scattered throughout the city. They are co-inhabited by Police officers and soldiers, their immediate, and many times, extended family members. They reflect people with average Sudanese characteristics regarding income and baseline demographics. They are entitled to free medical service that is mainly provided at the National Ribat University Hospital in Khartoum. The estimated total number of inhabitants is seven thousands residing in 26 complexes. Phase one of the study was carried out on the first two of these complexes, targeting 436 individuals. All houses were visited and all inhabitants more than 18 years of age were asked to participate. Four-hundred-and-twenty-six individuals (98%) consented and responded to the questionnaire.

The field visits were conducted by senior students of the National Ribat University Medical School during the month of October 2005. Prior to the study, students underwent directed training to follow a standardized protocol for administering the questionnaire, measuring of the blood pressure and anthropometric parameters and withdrawing blood. Experienced laboratory technicians were available to help with blood draws. Students were divided

into teams of two to fill out the questionnaire and carry out relevant tests. Monitoring of compliance with above procedures was regularly conducted by a physician and a social worker who frequently oversaw executing teams.

Informed consent was obtained from participants prior to recruitment. All participants underwent a standard interview to record demographic and lifestyle characteristics as well the presence of hypertension, diabetes, and renal failure. Study participants with hypertension, diabetes or chronic renal insufficiency were asked whether they were using, and if so, compliant with, prescribed medications.

Blood pressures were measured using sphygmomanometers with subjects seated in a chair with arm at the level of the heart. Standard mercury sphygmomanometer were used, and one of two cuff sizes (regular adult or large) were chosen on the basis of the circumference of the participant's arm. Systolic and diastolic blood pressure was considered as Korotkoff's phases 1 and 5 respectively. Two measurements were recorded with at least 2 min interval between them. The average of both systolic and diastolic blood pressures was used. For this study, hypertension was defined as systolic blood pressure (SBP)  $\geq$ 140 mmHg, or diastolic blood pressure (DBP)  $\geq$ 90 mmHg, and/or current use of antihypertensive medications. Awareness of hypertension was defined as a subject's report of a previous medical diagnosis of hypertension. Treatment of hypertension was defined as current use of a prescribed medication intended to lower blood pressure. Study participants with evidence of hypertension were asked whether they are using pharmaceutical treatment for their blood pressure. Control of hypertension was defined as SBP <140 mmHg and DBP <90 mmHg. Control could be

achieved by either pharmaceutical or non-pharmaceutical means.

To assess nutrition, anthropometric measurements were employed. Weight and length were obtained using a combined portable scale (Seca brand) with subjects wearing light clothes and bare-footed. Waist and hip circumferences were obtained using flexible tapes. For waist measurement, the tape was placed on a horizontal plane at the level of the narrowest part of the torso whereas for hip measurement, it was put around the widest part as seen from the anterior view. The BMI was calculated, and subjects were classified using the obtained parameters and standard formula. Overweight was defined as a BMI between 25 and 29.9 kg/m<sup>2</sup> and obesity as a BMI of 30 kg/m<sup>2</sup> or more.

Glomerular filtration rate (GFR) was assessed using the abbreviated MDRD Study equation. Hypercholesterolaemia was defined as random serum cholesterol of more than 200 mg/dL. Diabetes mellitus was considered present if random blood glucose was found to be equal to, or more than, 200 mg/dL<sup>(20)</sup> or current use of medications aimed at lowering the blood sugar or a combination of the two.

Subjects found to have any of the above conditions were referred to National Ribat University Hospital (RUH) for follow-up. A special clinic was arranged to accommodate the Sudan (HyDRIT) study participants and care was provided free of charge.

The computer software of SPSS version 12 was used to analyze the data by using descriptive and analytical methods. For categorical and continuous data, univariate and multivariate analyses and chi-square tests were used. P-values were calculated to test the significance (P less than 0.05).

## Results

Out of 436 individuals approached, only ten individuals declined, bringing the total number of

respondents to our questionnaire to 426 (97.7% response rate). Of these, 194 were males (45.5%) and females were 232 (54.5%). The mean age was 34.87 (SD=11.7), with a range of 16 to 87 years. 146 individuals (27.8%) came originally from the West region of Sudan, 161 from the centre (30.6%). 49 (9.3%) and 45 (8.6%) were from the North and South respectively whereas 20 (3.8%) came from the East.

Marital status: 109 (20.7%) were single whereas 312 (74.1%) were previously or currently married.

Employment: 127 (24.1%) were policemen and women, 128 (24.3%) were housewives and only 17 (3.2%) were unemployed. The remaining 68 (15.5%) had different jobs the majority working in private enterprises.

Education: 21 subjects were illiterate (4.0%), 27 (5.1%) only had 1-5 years of education, 20 (3.8%) had 6-10 years while 347 (81.6%) had more than 10 years education.

Habits: 53 out of 426 (12.5%) were current or previous smokers. Thirty one (7.3%) used tumbak (tobacco kept in the buccal mucus membranes for variable length of times), only 12 (2.8%) admitted to using alcohol but none admitted to using illicit drugs.

Only one individual had a heart attack and a stroke in the past.

Hypertension was diagnosed in 115 out of 426 individuals tested. Thus the overall prevalence rate was 27%. Out of the 115 hypertensive subjects, 58 (50.4%) were males and 57 (49.6%) were females (table 1). Among the 115 hypertensive subjects, only 34 (29.8%) were previously told by a doctor or health practitioner to have hypertension. Thus 69.6% were unaware of their diagnosis. The prevalence of pharmacologic treatment among the individuals who were previously told to have hypertension was 32 (94.1%). Regarding compliance among individuals who were prescribed

medicines, 19 (59.4%) were actually taking them (compliant in the previous four days). Only 12 out of 32 (37.5%) were told by a doctor about non-pharmacological treatment for hypertension (lowering salt-intake, losing weight and exercise); and only 5 of those who were told about such measures (41.7%) were actually compliant with them.

Nineteen (55.9%) out of the 34 subjects who knew beforehand of their hypertension had it controlled to < 140/90 by pharmacologic or non-pharmacologic measures. Among the 32 who were prescribed medications, only 9 (28.1%) had their blood pressures <140/90. Among the 19 who were compliant with their medications, only 6 (31.6%) had their blood pressures <140/90.

Regarding anthropometric parameters, out of 417 individuals who had a BMI measurement, 125 (30%) were overweight (48.8% males, 51.2% females). Eighty individuals (19.2%) were obese (22.5% males, 77.5% females) (table 1). Thirty-seven male participants (19.5% of all males) with a BMI of 25 to 34.9 kg/m<sup>2</sup> had a waist circumference greater than 102 cm while 104 (46.2% of all females) female participants had a waist

circumference of greater than 88 cm. Out of 112 hypertensive subjects evaluated by a BMI, 72 were overweight (64.3%), whereas only 40 had a normal weight (35.7%) (p < 0.001).

Out of 225 females, 126 (56%) had an excess weight - BMI of => 25- (OR = 1.828, [CI =1.236-2.703] whereas out of 191 males, 79 males (41.4%) had excess weight. Thirty-six out of 126 overweight females were hypertensive (28.6%) (OR =1.684, [CI = 0.895-3.169]. Similarly, 36 out of 79 overweight males were hypertensive (OR = 3.628, [CI = 1.869-6.942]. When the multivariate analysis by logistic regression model was used to assess the effect of sex and overweight on hypertension the odds ratio of an overweight subject to be hypertensive was found to be 2.2.479 [CI = 1.569-3.916] as adjusted by sex. When tested individually in a univariate model (table 2); more education and age of more than 50 years were significantly associated with hypertension (OR= 2.053, CI [1.274-3.308], p value = 0.003) and (OR=3.68, CI [1.75-7.742], p value = 0.001) respectively. Sex, alcohol, tobacco or tumbak intake, chronic renal insufficiency and hypercholesterolaemia were not significantly linked to high blood pressure.

**Table 1: Prevalence of Hypertension and Weight Excess among the Study Population (Police HyDRIT Study)**

	Male (%)	Female (%)	Total (%)
<b>Hypertension</b>	58 (29.9)	57(32.6)	115 (27)
<b>Overweight</b>	61(31.9)	64 (28.4)	125 (30)
<b>Obese</b>	18 (9.4)	62 (27.6)	80 ((19.2)

**Table 2: Baseline Associations and Risk Factors of Hypertension Tested with Univariate-Analysis Model among the Study Population (Police HyDRIT Study)**

	Hypertensive Subjects (total of 114)	Normotensive Subjects (total of 308)	OR	CI	P-Value
<b>Age &gt; 50</b>	17 (14.9%)	14 (4.5%)	3.68	[1.750-7.742]	0.001
<b>Alcohol</b>	1 (0.9%)	11 (3.5%)	4.18	[0.534-32.745]	0.121
<b>Smoking</b>	9 (7.8%)	34 (10.9%)	0.692	[0.321-1.491]	0.226
<b>Tumbak</b>	10 (8.7%)	21 (6.8%)	1.315	[0.600-2.885]	0.310
<b>Overweight</b>	72 (64.3%)	133 (43.6%)	2.3288	[1.487-3.643]	<0.001
<b>Diabetes mellitus</b>	10 (8.7%)	10 (2.4%)	3.819	[1.549-9.417]	0.004
<b>Chronic renal impairment</b>	5 (7.8%)	9 (4.3%)	1.883	[0.608-5.836]	0.209
<b>More than 10 years of education</b>	39 (33.9%)	61 (20%)	2.053	[1.274-3.308]	0.003
<b>Hypercholesterolaemia</b>	8 (12.1%)	22 (10.3%)	1.204	[0.509-2.847]	0.411

**Discussion**

This preliminary report of a pilot study of inhabitants of two police housing complexes is the

first in a larger study of the prevalence of non-communicable diseases in an estimated seven thousands inhabitants of all police housing

complexes in Greater Khartoum. Our results show that this sample has prevalence rates of hypertension which were close to those of neighbouring countries.

Given the considerable prevalence rate of hypertension in our sample (27%), its unawareness was high (69.6%). Only a third of hypertensive subjects knew previously about their diagnosis while most of those who did received pharmacologic treatment for it. This could either be explained by underutilization of medical care system by the studied population or failure of health practitioners to measure and inform people about their blood pressures. While the prevalence rate of hypertension is largely dependent on both biological and lifestyle components, awareness and effective control of the condition strongly depend on how effective the health care system is. Compliance was rather inadequate with about 40 % not taking their tablets regularly while only a third of those who were taking them achieved adequate treatment goals of less than 140/90. The goal of antihypertensive therapy in patients with uncomplicated combined systolic and diastolic hypertension is a blood pressure of <140/<90 mmHg; treatment goals are determined by the higher BP category. More aggressive BP lowering is warranted in patients with diabetes and chronic renal failure<sup>(21)</sup>.

There was a considerably high prevalence rate of overweight (BMI >25) in our sample (49.2%). When hypertensive patients are compared to normal individuals, one of the major differences is an increased prevalence of obesity<sup>(22)</sup>. Furthermore, weight gain appears to be a main determinant of the rise in blood pressure that is commonly seen with aging<sup>(23)</sup>. The relation between obesity and hypertension is important clinically because weight loss can lead to a significant fall in systemic blood pressure. The weight loss-induced decline in blood

pressure was perhaps best assessed in a recent meta-analysis of 25 randomized controlled trials that enrolled nearly 5000 participants. For each 1 kg of weight loss, the systolic and diastolic blood pressures each fell by approximately 1 mmHg<sup>(24)</sup>. Overweight was significantly associated with high blood pressure in our sample with an odds ratio of 2.3 (p <0.001). A third of our studied samples who received a previous diagnosis of hypertension were never told about life-style measures to decrease blood including weight loss. The strategy to cope with this problem should be directed towards raising the awareness and providing education to the public as well as primary doctors and other health care team members about life-style modifications as well as the target blood pressure goals and the consequences of not achieving these goals.

Aging and more education were significantly associated with hypertension in our sample. The prevalence of hypertension is known to increase with age. Educated subjects may have more stressful life-styles and their diets may have higher salt contents. When tested individually; sex, alcohol, tobacco or tumbak intake, chronic renal insufficiency and hypercholesterolaemia were not significantly linked to high blood pressure. Elderly and overweight patients need more careful screening, and if present, aggressive management of hypertension including pharmacologic and non-pharmacologic approaches.

Out of 115 discovered hypertensive subjects, 10 (8.7%) of them were also found to be diabetics. Diabetes was more likely present in hypertensive compared to non-hypertensive subjects (OR= 3.819 CI [1.549-9.417], p value = 0.004). Half of diabetic hypertensive individuals were treated but none had their blood pressure controlled to <130/80. Early treatment of hypertension is particularly important in diabetic patients both to prevent cardiovascular

disease and to minimize progression of renal disease and diabetic retinopathy<sup>(25)</sup>. The currently recommended goal blood pressure is less than 130/80 in all patients with diabetes<sup>21</sup>. Thus, even patients who do not fulfil the definition for hypertension (blood pressure of 130 to 139/80 to 89 mmHg) generally require antihypertensive drugs. Promoting healthy life-styles including weight control should help lowering the prevalence and incidence of hypertension, diabetes, overweight and their serious consequences in this population.

Advantages of the present pilot study are the selected sample chosen to represent average Sudanese urban individuals, the high response rate and its reliance on a standardized protocol. The whole targeted population will eventually cover a large group of inhabitants of the Police housing complexes scattered throughout the city of Khartoum. Prevalence of hypertension may have been overestimated and effective control of the condition underestimated because the two blood pressure measurements were performed on one occasion only. This, however, should have minimal effects on the results concerning the 'within the sample' comparison and it is an inherent problem of large size epidemiological investigations<sup>(26)</sup>. Individuals who had a previous diagnosis of hypertension, but are currently normotensive were excluded from the analysis and this may have underestimated the true prevalence of hypertension. In conclusion, this report of the pilot Police (HyDRIT) study on hypertension and excess weight shows that their prevalence among this average Sudanese community is comparable to that of other neighbouring and western countries. Unawareness as well as poor compliance were considerable, making prevention of hypertension a public health priority in this population. On the basis of findings concerning sociodemographic predictors of hypertension it is evident that hypertension efforts

should be concentrated among the older, overweight and more-educated population groups. Healthy life-style habits including weight control need to be massively disseminated and emphasized to help keep the current hypertension and overweight situation in check.

#### Acknowledgments

##### *Financial Disclosure:*

- The authors disclose no conflicts of interest

##### *Funding/Support:*

- This work was supported by the National Ribat University
- We are grateful for the unlimited support of the Medical Services Administration of the Sudan Police and its chief; Prof Abdelateef Ashmaig. We thank Lt Colonel Abdel Azeem Alsanosi for his invaluable assistance in coordinating the field work and Lt Colonel Idris Abdalla and his team for their dedicated laboratory support. We also extend our thanks to Dr. Ahlam Alshikeiri for her helpful hints in designing the questionnaire of this study.

#### References

1. World Health Organization. *World Health Report 2002. Reducing Risks, Promoting Healthy Life*. Geneva, Switzerland: World Health Organization. 2002.
2. Whelton PK. Epidemiology of hypertension. *Lancet*. 1994; 344(8915): 101-106.
3. MacMahon S, Peto R, Cutler J, Collins R, Sorlie P, Neaton J, et al. Blood pressure, stroke, and coronary heart disease. Part 1, Prolonged differences in blood pressure: prospective observational studies corrected for the regression dilution bias. *Lancet*. 1990; 335(8692):765-774.
4. Whelton PK, Perneger TV, Klag MJ and Brancati FL. Epidemiology and prevention of blood pressure-related renal disease. *Journal of*

- hypertension. Supplement.* 1992; 10(7): S77-S84.
5. Khot UN, Khot MB, Bajzer CT, Sapp SK, Ohman EM, Brener SJ, et al. Prevalence of conventional risk factors in patients with coronary heart disease. *Journal of the American Medical Association.* 2003; 290(7): 898-904.
  6. Burt VL, Whelton P, Roccella EJ, Brown C, Cutler JA, Higgins M, et al. Prevalence of hypertension in the US adult population. Results from the Third National Health and Nutrition Examination Survey, 1988-1991. *Hypertension* 1995; 25(3): 305-313.
  7. Wolf-Maier K, Cooper RS, Banegas JR, Giampaoli S, Hense HW, Joffres M, et al. Hypertension prevalence and blood pressure levels in 6 European countries, Canada, and the United States. *Journal of the American Medical Association.* 2003 May 14; 289(18): 2363-2369.
  8. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK and He J. Global burden of hypertension: analysis of worldwide data. *Lancet.* 2005; 365(9455): 217-223.
  9. Hajjar I and Kotchen TA. Trends in prevalence, awareness, treatment, and control of hypertension in the United States, 1988-2000. *Journal of the American Medical Association.* 2003; 290(2): 199-206.
  10. Krauss RM, Winston M, Fletcher BJ and Grundy SM. Obesity: impact on cardiovascular disease. *Circulation.* 1998; 98(14): 1472-1476.
  11. Calle EE, Rodriguez C, Walker-Thurmond K and Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. *New England Journal of Medicine.* 2003; 348(17): 1625-1638.
  12. Janssen I, Katzmarzyk PT and Ross R. Waist circumference and not body mass index explains obesity-related health risk. *American Journal of Clinical Nutrition.* 2004; 79(3): 379-384.
  13. Calle EE, Thun MJ, Petrelli JM, Rodriguez C and Heath CW Jr.. Body-mass index and mortality in a prospective cohort of U.S. adults. *New England Journal of Medicine.* 1999 341(15): 1097-1105.
  14. Janssen I, Katzmarzyk PT and Ross R. Body mass index, waist circumference, and health risk: evidence in support of current National Institutes of Health guidelines. *Archives of Internal Medicine.* 2002; 162(18): 2074-2079.
  15. Alpert MA and Hashimi MW. Obesity and the heart. *American Journal of the Medical Sciences.* 1993; 306(2): 117-123.
  16. Huang Z, Willett WC, Manson JE, Rosner B, Stampfer MJ, Speizer FE, et al. Body weight, weight change, and risk for hypertension in women. *Annals of Internal Medicine.* 1998; 128(2): 81-88.
  17. Modan M; Almog S; Fuchs Z; Chetrit A; Lusky A and Halkin H. Obesity, glucose intolerance, hyperinsulinemia, and response to antihypertensive drugs. *Hypertension.* 1991; 17(4):565-573.
  18. Puoane T, Steyn K, Bradshaw D, Laubscher R, Fourie J, Lambert V, et al. Obesity in South Africa: the South African demographic and health survey. *Obesity Research.* 2002; 10(10): 1038-1048.
  19. Mokhtar N, Elati J, Chabir R, Bour A, Elkari K, Schlossman NP, et al. Diet culture and obesity in northern Africa. *Journal of Nutrition.* 2001; 131(3): 887S-892S.
  20. Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care.* 1997; 20(7): 1183-1197.
  21. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. The Seventh

- Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *Journal of the American Medical Association*. 2003; 289(19): 2560-2572. Epub 2003 May 14.
22. Whelton PK, He J, Appel LJ, Cutler JA, Havas S, Kotchen TA, et al. Primary prevention of hypertension: clinical and public health advisory from The National High Blood Pressure Education Program. *Journal of the American Medical Association*. 2002; 288(15): 1882-1888.
23. Sonne-Holm S, Sørensen TI, Jensen G and Schnohr P. Independent effects of weight change and attained body weight on prevalence of arterial hypertension in obese and non-obese men. *BMJ*. 1989; 299(6702): 767-770.
24. Neter JE, Stam BE, Kok FJ, Grobbee DE and Geleijnse JM. Influence of weight reduction on blood pressure: a meta-analysis of randomized controlled trials. *Hypertension*. 2003 42(5): 878-884. Epub 2003 Sep 15.
25. Gaede P, Vedel P, Parving HH and Pedersen O. Intensified multifactorial intervention in patients with type 2 diabetes mellitus and microalbuminuria: the Steno type 2 randomised study. *Lancet*. 1999 353(9153): 617-622.
26. Bovet P, Gervasoni JP, Ross AG, Mkamba M, Mtasiwa DM, Lengeler C, et al. Assessing the prevalence of hypertension in populations: are we doing it right? *Journal of hypertension*. 2003; 21(3): 509-517