HYPERTENSION
IN SOUTH AFRICA

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High blood pressure (BP) or hypertension is a common condition in South Africa and is a risk factor for heart attacks, stroke, left ventricular hypertrophy, renal disease, and blindness. People who have hypertension are usually unaware that they have the condition, unless the BP has been measured at health-care facilities. It is therefore frequently referred to as a 'silent epidemic' in South Africa. Consequently, hypertension is universally underdiagnosed and/or inadequately treated resulting in extensive target-organ damage and premature death. Furthermore, hypertension frequently co-exists with other risk factors for chronic diseases of lifestyle (CDL), such as diabetes and obesity.

These interrelationships of hypertension with other CDL risk factors and the various possible target organs that can be influenced by uncontrolled hypertension result in a diverse picture that has an impact on the different population groups within South Africa. This picture can also be influenced by the impact of socio-demographic or genetic factors in different settings.

Seedat[1] summarised the pathophysiology of hypertension and response to treatment as follows: "Black hypertensive patients in South Africa are prone to cerebral haemorrhage, malignant hypertension, kidney disease leading to uraemia and congestive heart failure, whereas coronary heart disease (CHD) is relatively uncommon. In contrast, CHD is the major outcome related to hypertension in the white and Indian communities. In black patients with hypertension, the responses to antihypertensive medication such as the beta-blockers and the angiotensin-converting enzymes (ACE) inhibitors are poor, unless these agents are combined with a thiazide diuretic. Black patients respond best to diuretics, vasodilators or calcium channel blockers."

The impact of hypertension on mortality in an African population was assessed by Kaufman *et al.*[2] in 1996. They reported that the risk of death increased by 60%, with an increase of 20 mmHg in diastolic blood pressure (BP) in rural Nigeria, and estimated that the population attributable risk (the reduction in total mortality that would have been observed if hypertension were not present) was 7%, showing the impact of hypertension on all-cause mortality in rural Nigeria.[2]

BLOOD PRESSURE LEVELS AND THE PREVALENCE OF HYPERTENSION

The most comprehensive estimates of the prevalence of hypertension in South Africa is provided by the first Demographic and Health Survey (SADHS) that was conducted in the country in 1998.[3] An adult health module was developed for this cross-sectional survey, which used hypertension as an indicator condition to assess the prevalence, determinants, and quality of care provided for hypertensive patients. A random sample of 13 802 persons 15 years and older was selected, their BP was measured electronically, some risk factors for hypertension and chronic prescribed medications were recorded, as were socio-demographic data. Table 8.1 shows the sample sizes and mean diastolic and systolic BPs from this first SADHS, and Table 8.2 provides the crude and age-adjusted prevalence rates for hypertension in the whole population and the different ethnic groups in the country.[4]

Another important cross-sectional cardiovascular disease (CVD) risk factor survey was conducted by Connor *et al.*[5] in randomly selected general practices across the country. The study population comprised 9 731 persons, 30 years or older, attending the private sector primary health-care services. Hypertension was found to be the commonest of the CVD risk factors among all the study participants, but stood out as the risk factor with the highest prevalence in the black African community. After age and gender standardisation the overall hypertension prevalence rate was 55%, with 59% of black African people (95% CI 57-61), 55% of Indian and coloured people (95% CI 52-59 and 52-58, respectively) and 50% of white people (95% CI 49-52) diagnosed with the condition. In this study, hypertension was defined as having a current BP ≥140/90 mmHg or having a history of hypertension. However, in Table 8.2, hypertension is more common in white than in black people.

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Table 8.1. Mean systolic blood pressure, diastolic blood pressure, pulse and standard errors (SE) of South African adults in 1998[3]

	Men							Women						
Age group (years)	15 - 24	25 - 34	35 - 44	45 - 54	55 - 64	> 65	Total	15 - 24	25 - 34	35 - 44	45 - 54	55 - 64	> 65	Total
Total														
Number	1842	1086	1007	701	528	557	5738	2100	1634	1390	1088	938	914	8064
Systolic blood pressure														
(SE) (mmHg)	115(0.41)	120(0.58)	123(0.69)	130(1.08)	134(1.19)	140(1.49)	123(0.37)	106(0.38)	111(0.48)	118(0.66)	126(0.72)	134(1.05)	141(1.12)	119(0.36)
Diastolic blood pressure														
(SE) (mmHg)	69(0.33)	75(0.46)	79(0.47)	83(0.62)	82(0.66)	82(0.75)	76(0.25)	67(0.29)	73(0.35)	77(0.39)	81(0.43)	82(0.53)	82(0.54)	75(0.20)
African														
Number	1493	809	737	480	359	405	4283	1709	1257	1022	773	712	701	6174
Systolic blood pressure														
(SE) (mmHg)	115(0.45)	119(0.66)	122(0.84)	127(1.41)	132(1.43)	137(1.69)	121(0.38)	106(0.41)	111(0.55)	118(0.79)	125(0.87)	134(1.26)	139(1.28)	118(0.41)
Diastolic blood pressure														
(SE) (mmHg)	68(0.38)	74(0.52)	78(0.56)	81(0.78)	82(0.82)	82(0.88)	75(0.27)	67(0.31)	73(0.41)	77(0.45)	81(0.54)	82(0.61)	82(0.63)	75(0.23)
Coloured														
Number	207	158	154	103	80	70	772	224	227	197	161	102	97	1008
Systolic blood pressure														
(SE) (mmHg)	119(0.95)	127(1.67)	128(1.72)	135(2.56)	137(2.66)	142(4.57)	128(0.91)	108(1.46)	114(1.39)	123(1.90)	131(1.86)	135(3.16)	143(3.32)	122(0.91)
Diastolic blood pressure														
(SE) (mmHg)	71(0.72)	79(1.25)	82(1.21)	85(1.53)	84(1.29)	82(2.22)	79(0.61)	70(1.10)	75(0.95)	79(1.12)	83(1.08)	82(1.88)	81(1.77)	77(0.56)
White														
Number	93	87	85	99	70	66	500	97	94	110	113	89	100	603
Systolic blood pressure														
(SE) (mmHg)	122(1.84)	125(1.57)	126(1.75)	134(2.20)	137(3.55)	152(4.19)	132(1.44)	107(1.56)	110(1.14)	112(1.21)	124(1.79)	128(2.94)	147(2.94)	121(1.32)
Diastolic blood pressure														
(SE) (mmHg)	73(1.20)	77(1.47)	80(1.37)	86(1.45)	84(1.96)	85(1.91)	80(0.86)	68(1.20)	73(0.85)	74(0.90)	81(1.12)	78(1.35)	82(1.53)	76(0.59)
Indian														
Number	49	32	31	19	19	16	183	70	56	61	41	35	16	279
Systolic blood pressure														
(SE) (mmHg)	113(1.98)	117(3.07)	118(2.48)	134(3.28)	131(4.20)	131(3.36)	122(1.41)	100(1.31)	104(2.27)	110(1.87)	129(5.07)	136(2.75)	140(4.56)	114(1.54)
Diastolic blood pressure														
(SE) (mmHg)	69(1.14)	76(2.66)	76(1.95)	86(2.42)	81(2.49)	74(2.89)	76(0.97)	66(0.94)	70(1.54)	73(1.49)	80(1.89)	81(1.22)	77(1.32)	73(0.77)

Table 8.2. Prevalence of hypertension (%) in South African adults using South African[6] and ISH/WHO[7] cut-off points and the estimated number of hypertensive patients in the country

	Crude rates		Age-adjusted rates to SA population (Census 96)[8]		Age-adjusted rates to world population [9]		Estimated number of hypertensive patients (in 1000s) using 1996 Census data[8]	
	Cut-off point ≥160/95 mmHg or medication	Cut-off point ≥140/90 mmHg or medication	Cut-off point ≥160/95 mmHg or medication	Cut-off point ≥140/90 mmHg or medication	Cut-off point ≥160/95 mmHg or medication	Cut-off point ≥140/90 mmHg or medication	Cut-off point ≥160/95 mmHg	Cut-off point ≥140/90 mmHg
Overall	**14.8**	**23.9**	**12.7**	**21.1**	**15.7**	**25.2**	**3260**	**5500**
All Males	**12.6**	**22.9**	**10.9**	**20.9**	**14.1**	**25.1**	**1340**	**2600**
All Females	**16.3**	**24.6**	**13.9**	**21.2**	**16.8**	**25.3**	**1920**	**2900**
Ethnicity								
African	13.0	22.1	11.0	19.5	14.6	24.4	2120	3800
Men	10.5	20.2	9.3	18.6	12.9	23.5	850	1700
Women	14.6	23.5	12.2	20.1	15.7	25.0	1270	2100
Coloured	18.5	27.9	15.3	23.9	19.2	28.6	359	570
Men	13.6	25.9	11.4	22.9	14.9	27.3	129	260
Women	22.4	29.5	18.4	24.7	22.7	29.6	230	310
White	23.9	32.9	21.8	30.2	19.4	27.6	748	1040
Men	24.6	38.0	21.5	34.4	20.6	33.5	355	560
Women	23.4	29.1	22.0	27.1	18.5	23.3	393	480
Indian	18.3	24.4	15.9	22.0	19.8	26.3	118	169
Men	18.7	27.9	14.9	24.8	18.7	28.0	54	90
Women	18.0	22.1	16.5	20.3	20.5	25.3	64	79

DETERMINANTS OF HYPERTENSION IN THE SOUTHERN AFRICAN POPULATIONS

The elegant Kenyan Luo migration study of Poulter *et al.*[10] was the first to show that migration of people living in traditional rural villages on the northern shores of Lake Victoria to the urban settings of Nairobi was associated with an increase in BP. The urban migrants had higher body weights, pulse rates, and higher urinary sodium/potassium ratios than those who remained in the rural areas. This suggests a marked change in the diet of the new arrivals in Nairobi with a higher salt and calorie intake along with a reduced potassium intake due to consuming less fruit and vegetables. The higher pulse rates in Nairobi participants suggest that mechanisms related to increased autonomic nervous system activity could contribute to the higher levels of BP observed.[10,11]

Some sub-Saharan African countries still maintain large urban/rural prevalence differences. However, in South Africa such differences are no longer apparent. The prevalence rates in the rural areas have indeed increased to levels similar to those found only in the cities in the past. As an example, in the early 1990s, Mollentze *et al.*[12] showed that the rural community of QwaQwa in the Free State had a prevalence rate of 29% in a sample aged 25 years and older. This was similar to the prevalence rate of 30.3% in the peri-urban community of Mangaung in the same province.[12] However, Steyn *et al.*[13] found in the black community of Cape Town, that the duration of urbanisation independently predicted the presence of hypertension.

The THUSA study conducted by the group at Potchefstroom University focused on the factors related to hypertension in a black community undergoing the health transition.[14] Van Rooyen *et al.*[14] found that the BP was highest in the group of newcomers to the urban setting, and that factors related to urbanisation were positively associated with hypertension. BP correlated positively with age, level of urbanisation, waist:hip ratio and smoking tobacco. Additional factor analyses of these data found clusters of risk factors relating to hypertension. The most important of these included a cluster of malnutrition, which included high intakes of saturated fat, animal protein, sodium, and vitamins A and B6. A second cluster that was identified had characteristics of the metabolic syndrome. A third cluster consisted of a hypercholesterolaemic and obesity group of factors which included ageing, total and LDL cholesterol, triglycerides, high body mass index (BMI) and central obesity.[15]

Stress as a precipitating factor for hypertension is frequently mentioned, however, the scientific measurement of stress presents a challenge for scientists and consequently studies on this association is seldom reported in South African literature. Edwards[16] attempted to study this relationship in Xhosa-speaking unskilled workers in the Eastern Cape with a range of psychological scales. He failed to show any association between high scores identified with the use of the Bluen and Odesnik's Township Life Events Scale, Weiman's Occupational Stress Scale and Melamed's Emotional Reactivity scale, and BP levels.

The association between hypertension and obesity has been well documented in many studies in South Africa.[12-14] Despite this clear association it has been suggested that the noxious effect of obesity in black people is less than in people from other population groups. Most of the supporting evidence for this viewpoint is based on studies carried out in African Americans in the United States. A small study in South Africa by Walker *et al.*[17] suggested similar findings. This issue can be addressed through the analyses of the determinants of hypertension on the SADHS data set described below.

Some dietary factors are related to hypertension, including increased salt (sodium) intake and the decrease in fruit and vegetables (potassium), while a higher intake of alcohol products, particularly by men, plays a role. The data on the association between high salt (sodium chloride) intake and hypertension in black people from Africa have been summarised by Seedat,[18] who suggests that black people have an abnormal transport mechanism of sodium and a low rennin activity. A high intake of sodium is common in South Africa, particularly in poor settings, as it is used to preserve food or to make food tastier. Substantial amounts of salt are added to food, while cooking and monosodium glutamate-based flavouring cubes or salts are widely used to give taste to food. In addition to a high salt intake, people in sub-Saharan Africa frequently eat small amounts of fruit and vegetables resulting in low potassium intakes. Bread is a staple food for many people in the country and contains high salt levels. Salt facilitates the baking process of bread.

Charlton *et al.*,[19] determined the habitual sodium, potassium, magnesium and calcium intake across South African population groups in 324 people in a study conducted in Cape Town. They also identified the foods that mainly contributed to sodium intake and the proportion of salt intake that is added when preparing or consuming meals (discretionary sodium intake). They found that the mean urinary Na excretion values equate to a daily salt (NaCl) intake of 7.8 g, 8.5 g and 9.5 g in black, coloured and white South Africans, respectively. Between 33% and 46% of total Na intake was discretionary, while bread was the single greatest contributor to Na intake of the non-discretionary sources in all population groups. Calcium intake differed among the groups, with black subjects having particularly low intakes.

Urban/rural differences exist regarding sources of dietary Na, with over 70% of total non-discretionary Na being provided by the bread and cereals food group in rural black South Africans, compared to 49% - 54% in urban dwellers. All ethnic groups had sodium intakes in excess of 6 g salt/day, while potassium intakes in all groups fell below the recommended 90 mmol/day.

The sample size of the SADHS was sufficiently large to allow the estimation of the socio-demographic factors and independent associations of the known hypertension risk factors by means of a series of logistic regression analyses. Table 8.3 shows these series of regression models (Steyn *et al*. unpublished).

The results of the four models for hypertension generated by the multiple logistic regression analyses for all participants are shown in Table 8.3. Model I shows the unadjusted odds ratio for hypertension (cut-off point ≥140/90 mmHg) in the different population groups. The African rural group had significantly lower risk for hypertension, while the white group had significantly higher risk for hypertension than the African groups and the Indian group.

Model II shows that adjustments for gender and age attenuated the differences between the odds ratios for hypertension among the population groups of model 1. Only the rural African group had significantly lower risk for hypertension than the other four groups. The model also shows the marked influence of increasing age on the risk for hypertension.

Model III added adjustments for socio-economic factors to the analyses and showed that the differences of the odds ratios for hypertension among the different population groups became even smaller and that with the exception of the rural African groups there was no significant differences in the risk for hypertension among the population groups. There were no significant differences in the risk for hypertension among the asset index categories, while the risk for hypertension was significantly lower for those with more than 12 years' education.

Model IV added adjustments for additional known hypertension risk factors, and shows odds ratios for hypertension after adjusting for age, gender and socio-demographic factors. The independent association of these variables with hypertension is identified. The adjusted risk for hypertension was significantly lower in women compared to men.

Regarding BMI, the adjusted risk for hypertension was about 2-fold higher in obese participants compared to those with normal weight. Interestingly, being underweight had a protective effect. A family history of stroke and of hypertension was significantly associated with the adjusted odds ratio for hypertension. Participants who used alcohol excessively (positive CAGE questionnaire) had a significantly increased adjusted risk of having hypertension compared to those who answered negatively to the CAGE questionnaire.

Table 8.3. The results of four logistic regression analyses for hypertension, adjusting for age and gender, population group, other socio-economic indicators and for known hypertension risk factors in South African 15 years and older in 1998

Socio-demographic characteristics		MODEL I		MODEL II		MODEL III		MODEL IV	
	N	Odds ratio and 95% CI:		Odds ratio and 95% CI: adjustment: model I plus age and gender		Odds ratio and 95% CI: adjustment: model II plus socio-economic factors		Odds ratio and 95% CI: adjustment: model III plus risk factors	
Population group African rural	5119	1.00	-	1.00	-	1.00	-	1.00	-
African urban	4687	1.23	1.09-1.39	1.54	1.34-1.77	1.48	1.25-1.75	1.42	1.19-1.68
Coloured	1029	1.46	1.21-1.76	1.56	1.23-1.98	1.53	1.17-1.98	1.54	1.19-2.00
White	1684	2.02	1.62-2.51	1.66	1.34-2.05	1.84	1.36-2.48	1.84	1.35-2.51
Indian	433	1.24	0.99-1.55	1.30	1.00-1.69	1.31	0.94-1.82	1.38	0.99-1.92
Gender Men	5362			1.00		1.00		1.00	
Women	7590			0.98	0.88-1.10	0.98	0.87-1.10	0.80	0.71-0.90
Age 15-14 years	3738			1.00		1.00		1.00	-
25-34 years	2534			2.24	1.81-2.76	2.30	1.86-2.85	1.88	1.51-2.35
35-44 years	2261			4.84	3.95-5.93	4.94	4.00-6.11	3.73	2.97-4.68
45-54 years	1676			10.75	8.78-13.16	10.99	8.85-13.65	8.16	6.46-10.32
55-64 years	1388			16.67	13.39-20.74	17.01	13.41-21.57	12.90	10.05-16.55
≥65 years	1355			24.53	19.63-30.65	25.18	19.55-32.42	20.85	15.96-27.23
Asset index (Quintiles) Poorest group	2119					1.00		1.00	
2nd poorest group	2659					1.04	0.83-1.29	1.01	0.81-1.26
Middle group	2762					1.15	0.93-1.42	1.09	0.88-1.36
4th poorest group	2885					1.13	0.89-1.43	1.03	0.80-1.31
Richest group	2527					1.04	0.79-1.35	0.89	0.68-1.17
Education None	1839					1.00		1.00	-
1-7 years	3763					1.10	0.94-1.30	1.05	0.89-1.25
8-12 years	6553					1.09	0.90-1.31	1.02	0.84-1.23
>12 years	797					0.69	0.51-0.92	0.63	0.47-0.84
Body mass index Obese	2456							1.97	1.68-2.31
Overweight	3020							1.37	1.19-1.58
Normal weight	6188							1.00	-
Underweight	1288							0.62	0.50-0.77
Family history of hypertension Absent	9090							1.00	-
Present	3862							1.27	1.12-1.45
Family history of stroke Absent	12040							1.00	-
Present	912							1.35	1.12-1.64
Alcohol dependence Cage negative	10527							1.00	-
Cage positive	2425							1.16	1.01-1.34

The benefit of such detailed analyses and model building is clearly illustrated when differences are found between the adjusted odds ratios for hypertension in South African population groups compared to the calculations, which only standardised for age differences among the four population groups (Figs. 1 & 2). These earlier analyses suggested that the risk for hypertension is higher in white and Indian men than in coloured and African men. Similarly, the prevalence rates reported for women suggested that African women had the lowest prevalence rates of all the groups.[1] However, after the influence of gender, education, urbanisation in the African group, BMI, family history and excessive alcohol use were shown to be associated with having hypertension, it became clear that the rural African group of participants had significantly lower risk for hypertension than urban African, coloured and white participants. This suggests that there are no inherent differences among the population groups with respect to the risk of developing hypertension.

GENETIC BASIS OF HYPERTENSION IN SUBJECTS OF AFRICAN ORIGINS*

Despite the many environmental factors related to hypertension discussed above, various studies in South Africa suggest a possible genetic contribution to the origins of hypertension in black people. Steyn *et al*. (unpublished data) found that high BP is associated with a strong family history of either hypertension or stroke. While Loock *et al*.[20] showed that a family history of hypertension occurred 4.3 times more frequently in patients who had ischaemic heart diseases (IHD) compared to a matched group of patients without the condition (odds ratio of 4.33, 95% CI 2.21-8.52). This could provide a very cost-effective opportunity to identify people who need thorough screening for hypertension. Data from Nigeria suggest that genetic factors are relevant across Africa. Rotimi *et al*.[21] used computer models and regression analyses to estimate the degree of heritability of blood pressure in Nigerian families. The heritability estimate was 45% and 43% for systolic and diastolic BP, respectively. This emphasises the interaction between environmental influences and genetic factors in the aetiology of hypertension.

To evaluate the genetic basis of hypertension both genome-wide scans and candidate gene approaches have been employed. The genome-wide scan approach has failed to provide sufficient evidence for any single locus contributing to BP. Nevertheless, genome-wide scan approaches assume that micro-satellite markers selected will not miss important genetic variants, as the rates of recombination between markers are considered small. Furthermore, the results of studies utilising genome-wide scans and assessing BP as a continuous rather than as a dichotomous trait have not been completed.

Despite a number of gene candidates being evaluated, there is really only substantial evidence to support a role for two loci to date. In groups of European ancestry, there is both linkage and association data to support a role for the angiotensin-converting enzyme (ACE) gene in contributing to BP in men,[22,23] and for the angiotensinogen (AGT) gene in contributing to the presence of hypertension in women.[24,25] The ACE gene variant is associated with ACE activity and expression, but the exact function of the ACE gene variant (an intron polymorphism) has not been described. The AGT variants examined (M235T and a micro-satellite marker) are in linkage disequilibrium with a functional promoter region variant associated with alterations in basal transcription rates (-6G→A).[26]

In populations of African ancestry, data from small case-control studies (which are considered sensitive but are limited because of the non-random nature of subject ascertainment) and a large case-control study with over 700 cases phenotyped using 24-hour ambulatory BP monitoring and 700 controls (Norton, personal communication) suggest that the ACE gene variant has little effect in contributing to hypertension. Nevertheless, gender-specific effects need to be excluded. In addition, AGT gene variants that have been associated with hypertension in Caucasian groups are not implicated in subjects of African ancestry.[27] However, an alternative functional promoter region variant of the AGT gene (-217G→A) has recently been shown to be strongly associated with hypertension in a small African-American case-control study,[28] data that have now been confirmed in a large (see above) case-control study conducted in black South Africans (Norton, personal communication). The role of the -217G→A AGT gene variant in contributing to the variance of BP within families is now being assessed in a South African study. Furthermore, an additional functional AGT gene promoter region variant (-20A→C)[29] has been shown to modify the impact of body size on BP,[27] and the -217G→A variant's effect on the risk for hypertension (Norton, personal communication) in subjects of African ancestry, thus suggesting complex genotype-genotype and genotype-phenotype interactions of the AGT gene in subjects of African origins.

Other candidate gene variants implicated in BP control or hypertension in groups of European or African ancestry, including functional or potentially functional variants found within the guanosine trisphosphate protein β3 subunit gene,[30] the sodium epithelial channel gene,[31] the α-adducin gene,[32]

* *Information provided by Prof Gavin Norton, Associate Professor; Director of the Cardiovascular Pathophysiology and Genomics Research Unit, School of Physiology, Faculty of Health Sciences, University of the Witwatersrand.*

and the β_2 receptor gene[33] have not been shown to be associated with hypertension in all studies conducted in groups of African ancestry,[34-36] or have been shown to occur with too low a frequency to contribute substantially to population-attributable risk.[37] Presently, family-based linkage studies assessing BP as a continuous variable and utilising 24-hour ambulatory BP monitoring techniques are underway in South Africa to evaluate the role for these variants as determinants of BP in groups of African ancestry further.

MALIGNANT HYPERTENSION

Malignant hypertension also occurs more frequently in black people of South Africa than in the other population groups. Milne *et al*.[38] showed this in black patients hospitalised for hypertension. This condition is frequently related to severe renal disease and hypertensive encephalopathy. Data from the South African Dialyses and Transplantation Registry have shown that hypertension was responsible for 35% of end-stage renal failure in blacks and that malignant hypertension was diagnosed in 57% of the black patients with essential hypertension.[39] Untreated malignant hypertension has been shown to have a five-year survival as low as one percent.

HYPERTENSION IN CHILDREN

The Birth-to-Ten study (BTT) is a birth cohort study that was initiated in Johannesburg-Soweto in 1990. This study provided data on the determinants of BP in Sowetan children aged 1 year.[40] They found that 29.3% of the variance of systolic BP in these children was determined by weight, upper-arm circumference, age at which formula feeds were started, length and volume of the formula. The amount of salt added to the diet approached statistical significance. In a sub-sample of children, a correlation was found between the infant's BP and that of the mother. When the BTT children were 5 years old, BP was measured in 964 of them.

The mean systolic and diastolic BPs were significantly higher in the black children compared with those of the other groups. The black and coloured children had higher rates of raised BP than those of the Indian or white children.

Table 8.4: The mean BP and prevalence of hypertension in 5-year-old children participating in the Birth-to-Ten study[41]

	All	Black	Coloured	Indian	White
Mean systolic BP (mmHg) (SD)	107(13)	108(12)*#	105(11)	110(8)*	100(11)#
Mean diastolic BP (mmHg) (SD)	62(8)	63(8)*	61(9)	59(8)	56(8)*
% with BP ≥108/70 mmHg**	45.9	48.4	37.9	10.5	17.4
% with high normal BP ≥108/70 but <115/75 mmHg**	23.6	24.5	23.9	0	13
% with significant hypertension,					
BP ≥115/74 but <124/84 mmHg**	11.6	12,5	7	10.5	0
% with severe hypertension ≥124/84 mmHg**	10.7	11.4	7	0	4.4

* & # p<0.05 when comparing two variables marked with either * or #

** BP cut-off points for children 3-5 years according to JNC V[42]

Levitt *et al*.[43] showed that the systolic BP of the children at age 5 years was inversely related to birth weight independent of current weight, height, gestational age or socio-economic status. The highest level of systolic BP at 5 years was found in the children who had a low birth weight and who had picked up the most weight since birth, while the lowest BP was recorded in those children who had a normal birth weight and had gained the least weight since birth.

In a study in the North-West province in black children aged 10-15 years conducted by Schutte *et al*.,[15] a few nutrients were identified by means of stepwise regression analysis that were significantly associated with BP parameters in boys with hypertension. These nutrients were biotin, folic acid, pantothenic acid, zinc and magnesium. In girls with hypertension energy intake, biotin and vitamin A intake were associated with BP parameters. No such associations were found in the children with normal BP levels. The intake of there nutrients were all below the recommended dietary reference intakes. In this same study population BP was recorded using the Finpres apparatus and analysed by means of the Fast Modelflow software program.[44,45]

The results of this analysis suggest that in stunted children the arterial compliance was lower compared to this measure in normal children. The early changes in the cardiovascular system of stunted children may predispose these children in later life to develop increased BP (van Rooyen *et al*., unpublished).

TREATMENT STATUS OF HYPERTENSION

The quality of hypertension care received by South Africans is reflected in the proportion of persons with hypertension that are aware of having the condition, the proportion that are taking antihypertension medication, and the proportion with BP levels below the accepted target BP level. In 1998 when the first SADHS survey was conducted, the BP cut-off point of ≥160/95 mmHg was used to identify patients with uncomplicated hypertension. However, the internationally accepted cut-off point was ≥140/90 mmHg.[7] Since then, the latter cut-off point has also been accepted in South Africa.

Fig. 1 shows the treatment status for hypertension in South Africa in 1998 for the different population groups after age-standardisation of the first SADHS data. The treatment status is shown using both the cut-off points of ≥160/95 mmHg and ≥140/90 mmHg.

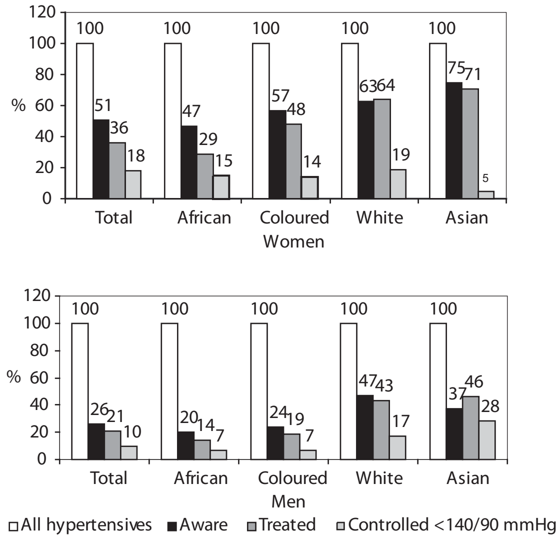

Figure 1: Treatment status of hypertensive (≥ 160/95 mmHg and/or on treatment) and controlled hypertensive (< 160/95 mmHg) South African women and men

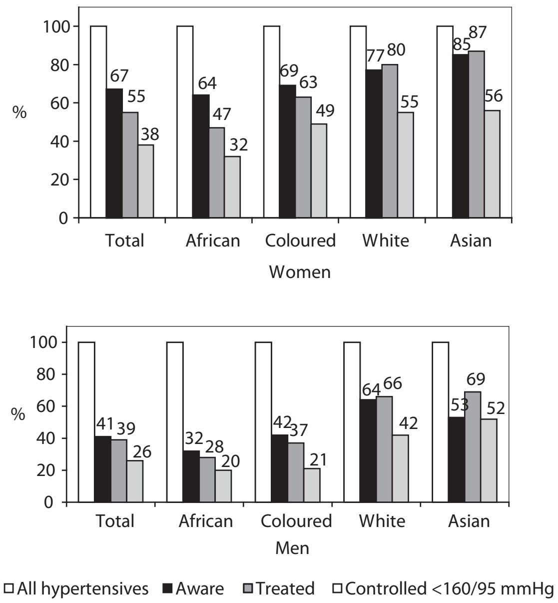

Figure 2: Treatment status of hypertensive (≥140/90 mmHg and/on treatment) and controlled hypertensive (<140/90 mmHg) South African women and men

In 1998, only 26% and 38% of men and women with hypertension, respectively, had BPs below 160/95mmHg. However, if the cut-off point of ≥140/90 mmHg is used to identify those with hypertension and who had controlled BP, only 10% of men and 18% of women had controlled BP. Such poor levels of control will contribute to the high rates of strokes and heart attacks occurring in the country.

Table 8.5. The results of a logistic regression analysis of socio-demographic variables and hypertension treatment status in South Africa in 1998 (hypertensive N=2 043)

Socio-Demographic Characteristics	Awareness of having hypertension Aware= 1183		Use of hypertension medication On medication= 1006		BP Controlled, (<160/95mmHg) Controlled= 700	
	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)	Odds Ratio	(95% CI)
Asset index (Quintiles)						
Poorest group	1.00		-1.00		-1.00	
Second poorest group	1.057	(0.665 – 1.680)	1.049	(0.614 – 1.793)	0.905	(0.517 – 1.585)
Middle group	1.691	(1.090 – 2.624)	1.750	(1.069 – 2.864)	1.276	(0.731 – 2.228)
Fourth poorest	1.621	(1.002 – 2.623)	2.149	(1.231 – 3.753)	1.591	(0.866 – 2.921)
Richest group	2.247	(1.238 – 4.079)	3.485	(1.824 – 6.660)	2.327	(1.173 – 4.616)
Education						
None	1.00		-1.00		-1.00	
1 – 7 years	1.164	(0.863 – 1.571)	1.277	(0.933 – 1.747)	1.372	(0.977 – 1.925)
8 – 12 years	1.130	(0.805 – 1.588)	1.245	(0.889 – 1.743)	1.247	(0.872 – 1.784)
> 12 years	1.552	(0.834 – 2.889)	1.632	(0.869 – 3.064)	1.326	(0.674 – 2.609)
Age						
15 – 24 years	1.00		-1.00		-1.00	
25 – 34 years	14.001	(2.060 – 95.173)	15.426	(2.433 – 97.814)	10.725	(1.850 – 62.173)
35 – 44 years	16.027	(2.531 – 101.502)	25.412	(4.530 – 142.573)	14.212	(2.637 – 76.589)
45 – 54 years	36.412	(5.742 – 230.891)	58.364	(10.433 – 326.500)	28.904	(5.475 – 152.574)
55 – 64 years	38.022	(5.824 – 248.226)	64.725	(11.464 – 365.443)	28.488	(5.367 – 151.204)
≥ 65 years	31.863	(5.025 – 202.035)	60.926	(10.826 – 342.870)	26.360	(4.916 – 141.351)
Population group						
African	1.00		-1.00		-1.00	
Coloured	1.052	(0.716 – 1.544)	1.159	(0.759 – 1.769)	1.161	(0.749 – 1.801)
White	1.155	(0.650 – 2.052)	1.295	(0.743 – 2.254)	0.957	(0.557 – 1.645)
Indian	1.313	(0.714 – 2.415)	2.808	(1.531 – 5.149)	1.764	(1.032 – 3.015)
Geographic setting						
Urban	1.00		-1.00		-1.00	
Rural	0.696	(0.529 – 0.916)	0.835	(0.612 – 1.139)	0.954	(0.617 – 1.474)
Gender						
Men	1.00		-1.00		-1.00	
Women	3.545	(2.734 – 4.595)	2.459	(1.873 – 3.229)	2.006	(1.529 – 2.631)
Medical aid						
Membership	1.00		-1.00		-1.00	
Non-membership	0.828	(0.549 – 1.247)	0.568	(0.374 – 0.862)	0.587	(0.377 – 0.914)

The awareness of hypertension, the use of hypertension medication, and the control of hypertension (cut-off point <160/95 mmHg) among subjects with hypertension increased with increasing wealth and were highest in the richest group. Interestingly, higher levels of education among the participants with hypertension added no better treatment status than that achieved by being wealthier. Older participants with hypertension were more likely to be aware, use medication, and have a controlled BP. In fact, for people with hypertension a participant above age 44 years was about 28 times more likely to have controlled BP compared with those who were between 15 and 25 years.

Indian people with hypertension were more likely to be on medication and have higher levels of control than African men and women. There were no differences in the treatment status among the African, white and coloured participants with hypertension. Although rural participants with hypertension were significantly less aware of having the condition than their urban counterparts, no differences were seen between those on medication and those with controlled BP. Women were more aware of hypertension, took more medication and their BP was more controlled compared to men. Participants with hypertension who were members of the medical aid society and received medical care from the private sector were no more aware than those who had to use the public health-care sector. However, private-sector medical aid patients with hypertension were more likely to be on medication and to have controlled BP than were their public-sector counterparts.

The finding that young people with hypertension have poor hypertension control is of particular concern as they could be exposed to high BP for many years. This will result in serious end-organ damage affecting their eyes, kidneys, and coronary and cerebral arteries. Hypertension control in men was far less than that for women, suggesting that the group of people with hypertension with the least degree of hypertension control is the young, poor men irrespective of their population group.

Table 8.6 shows the antihypertension medication used by participants with hypertension during the first SADHS in 1998.

Table 8.6. Antihypertension medication used by patients with hypertension in South Africa in 1998, the first SADHS survey

HYPERTENSION Codes C02, C03, C07, C08, C09)* – % of persons taking drugs for hypertension	**50.9**	**59.9**	**57.0**
Number of hypertensive drugs used	426	1.13	1.56
Diuretics as % of hypertension drugs	35.9	45.9	43.2
Diuretics on their own as % of hypertension drugs	29.0	41.1	37.8
Low-ceiling diuretics (thiazide, others) (C03A/B) as % of hypertension drugs	14.4	18.2	17.2
High-ceiling diuretics (C03C) as % of hypertension drugs	7.8	6.0	6.5
Potassium-sparing agents (C03D) as % of hypertension drugs	1.9	4.8	4.0
Diuretics and potassium sparing agents (C03E) as % of hypertension drugs	4.9	12.1	10.1
Diuretics in combination (C02AA52/53) as % of hypertension drugs	6.9	4.8	5.4
Reserpine / diuretic and/or vasodilator	1.8	2.2	2.1
ACE inhibitors with diuretics (C09BA) as % of hypertension drugs	3.9	1.5	2.2
Beta-blocking agents & diuretics (C07B/C/D) as % of hypertension drugs	1.2	1.1	1.1
Beta-blocking agents (C07A/B/D) as % of hypertension drugs	16.9	7.0	4.7
Calcium-channel blockers (C08)	13.6	7.7	9.3
Agents acting on renin-angiotensin system (C09) as % of hypertension drugs	24.4	16.6	18.7
Plain ACE inhibitors (C09AA) as % of hypertension drugs	20.5	15.1	16.6
ACE inhibitors with diuretics (C09BA) as % of hypertension drugs	3.9	1.5	2.2
Antiadrenergic and other agents as % of hypertension drugs	16.3	27.7	24.4
Antiadrenergic agents – central acting (C02A) as % of hypertension drugs	14.8	25.2	22.3
Reserpine (C02AA02) as % of hypertension drugs	4.1	6.1	5.5
Reserpine / diuretic and/or vasodilator (C02AA52/53) as % of hypertension drugs	1.8	2.2	2.1
Methyldopa (C02AB01) as % of hypertension drugs	8.9	17.0	14.8
Antiadrenergic agents – peripherally acting (C02C) as % of hypertension drugs	0.9	1.8	1.5
Agents acting an arteriolar smooth muscle (C02D) as % of hypertension drugs	0.6	0.7	0.6

Of the hypertension drugs used, 48.6% were diuretics on their own or in combination with other agents. β-Blocking agents in combination or on their own accounted for 5.8% of the hypertension drugs. Calcium-channel blockers were 9.3% of the drugs. Agents acting on the renin-angiotensin system were 18.7%. Antiadrenergic and other agents accounted for 24.4% of hypertension drugs, of these 7.3% of drugs contained reserpine and 14.8% contained methyldopa.

While national guidelines for the management of hypertension in the primary health-care setting have been developed and launched,[46,47] the findings of the survey suggest that these are not being widely implemented. This is reflected in the poor level of control of hypertension that was achieved across the country in this first SADHS.[3] Diuretic agents are recommended as the first-line drug for all patients with hypertension, however, these accounted for only 43% of the antihypertensive agents used. Reserpine is the cheapest second-line agent suggested in the guidelines, but only about 5.5% of the antihypertensive drugs contained reserpine. The guidelines do not recommend methyldopa for hypertension, except for pregnant women.[47] This agent is expensive and has many side effects, but still accounts for 14.8% of all antihypertensive drugs used. It was used more frequently for women and in the public sector. At the time of the survey, no generic ACE-inhibitor was available in South Africa and it was a surprising finding that these expensive agents were used equally frequent in the public and private health-care sector.

Two other large studies in the private sector health-care services have been reported in South Africa. The first was by Edwards *et al*.[48] who had access to a computerised patient data set. The level of BP control of about 12 000 patients with hypertension attending private practices with 3 503 doctors working in South Africa could be assessed. All patients were covered by medical aid health insurance. The level of BP control achieved in these patients were high with 34.7% with BP <140/90 mmHg while another 42.8% had BP between 140/90 mmHg and 160/95 mmHg. Fifty seven percent of patients needed two or more drugs to achieve this level of BP control and the pattern of drug use was predominantly the more expensive newer drugs.

The second study was conducted by Connor *et al*.[5] in 9 133 patients attending 680 private practices throughout the country. They collected data on CHD risk factors and found that hypertension was the most common risk factor in all the population groups in South Africa, standing out as the major risk factor in black African patients. The proportion of patients with hypertension that had uncontrolled BP (>140/90 mmHg) was 47%.

Although little South African data exist to show that the reduction of BP in patients with hypertension will reduce morbidity and mortality locally, it undoubtedly is clear that the need to improve the diagnoses and treatment of hypertension in the country should be a priority, particularly in the public health care setting. Skudicky *et al*.[49] showed regression of left ventricular hypertrophy in previously untreated patients with the conditions at Baragwanath Hospital when given antihypertension medication. However, Seedat[50] emphasised that BP control in black patients with hypertension does not necessarily lead to improved renal function and, therefore, he considers hypertension to continue being an important cause of end-stage renal disease in sub-Saharan Africa.

MANAGEMENT OF HYPERTENSION

The management of hypertension in a society has two elements. The first should target the whole population and should in the first instance attempt to reduce the risk factors for hypertension in the society. This would entail reducing the very high rates of obesity, particularly in women, reducing salt intake and increasing the intake of at least potassium by means of higher vegetable and fruit intake and the reduction of high alcohol consumption. The second aspect of a community-based approach is to motivate people, particularly those at high risk, to have their BP checked. It is important that the community be informed about the need for screening, and understands the impact that poorly controlled BP has on health.

The second element of hypertension management involves the early diagnoses of patients with hypertension by primary health-care services and the cost-effective management of the condition. It also involves educating patients about their condition and working with them in a way that will allow them to attain the highest possible level of compliance to their management. Health services should in addition to achieving good BP control be screening on a regular basis for possible target-organ damage in their patients. South Africa needs to improve on both these aspects of good hypertension management.

COMMUNITY-BASED INTERVENTIONS

Studies to evaluate the benefit of community-based interventions in South Africa are rare. The CORIS study was done in three towns in the south-western Cape in the white communities.[51] This study developed a model of active community-based intervention set on the principles mentioned above. This showed that the intervention towns managed to achieve better BP control than the control town after four years of intervention. Resurveys of these towns showed that eight years after the end of the active intervention period, levels of risk factors in the control town had decreased to those observed in the intervention towns. This called for an explanation why an improved level of BP control occurred in the control town. Was it the cause of repeated surveys during the study or of a background intervention effect (secular trend of intervention) that occurred through activities of organisations, such as the Heart Foundation of Southern Africa, and other community-based interventions in the country as a whole? To answer to this, the level of hypertension control in towns near to the original control town that had not previously participated in the study was surveyed. A comparison of these towns in the south-western Cape showed that the new towns had similar BP levels as those of the original control town. This finding suggested that the secular interventions that occurred in the country as a whole were as effective in reducing BP levels and other CVD risk factors as did the active intervention phase of the CORIS study. Only, these occurred at a much slower pace than the active interventions.

The successful community-based CVD risk factor intervention programme that was developed during the CORIS study for the white community was transferred to the poor working-class community of Mamre, 40 km outside Cape Town. This setting was originally a Moravian Mission station. The objective of this study was to implement the CORIS intervention model in a poor community.[52]

The broad-based CVD risk factor intervention targeting the whole Mamre community was established around a BP station staffed by trained community health workers. They provided BP measurements and advice for improved compliance to treatment, as well as advice to control other CVD risk factors. Many community-based activities were part of the 5-year intervention programme, for example, street parades on "World No Tobacco" days, posters and billboards developed in collaboration with the community with heart health messages. The intervention was widely accepted by the Mamre community and some CVD risk factors were shown to be reduced in a before-and-after study.[53]

HEALTH SERVICES FOR HYPERTENSION

Chapter 17 provides details on the status of health services research for CDL in South Africa. This section will report briefly on some relevant findings.

The poor level of hypertension control in the community has led to a small number of health service-related projects in the country. Lunt *et al.*,[54] at a public-sector community health centre (CHC) in Cape Town, found that 51.4% of the 1 098 hypertension patients who visited this facility during a one-year period had a mean BP across the clinic attendance that was ≥ 160/95 mmHg. The level of control was worse in women 65 years or older. At a similar CHC in the region Steyn *et al.*[55] found that 41.6% of patients with hypertension at a CHC in the same region had BPs above 160/95 mmHg.

Edwards *et al.*[56] reported on the pattern of prescribing for hypertension, and tested the effect of introducing treatment guidelines and restricting the availability of less cost-effective antihypertensive drugs for the control of hypertension along with the cost implications of the intervention. This intervention resulted in a mean monthly cost reduction of R1.99 (24.2%) from R8.24 to R6.25 between the first and last prescription for each patient, providing an overall annual cost saving of R75 000 for the CHC. However, this intervention did not change BP control significantly.

Appropriate knowledge of health workers is essential to manage hypertension effectively. Little is known in South Africa about the capabilities of health workers to deal effectively with hypertension. The inclusion of community health workers (CHWs) as part of the health team is being considered in many provinces. Sengwana *et al.*[57] studied the knowledge, beliefs and attitudes about hypertension among CHWs living in the black townships in the Cape Peninsula. This study revealed an enormous need to train CHWs as in contributing to the care of patients with hypertension. Many of them believed in traditional medicines and home-brewed beer as the best treatment.

A better understanding of the role of the health team for hypertension control is needed, including understanding the patients' knowledge, attitudes, and practices relating to hypertension. In addition, the structural and logistical aspects of hypertension care in the health services also need to be studied.

APPROPRIATE GUIDELINES

The first management guidelines for hypertension in Southern Africa were developed at a Heart Foundation Hypertension Consensus Symposium in 1992, and were endorsed by the Medical Research Council and the Hypertension Society of Southern Africa.[6]

These guidelines suggested a cut-off point for BP ≥160/95 mmHg to define hypertension. However, the international guidelines published soon thereafter, suggested a cut-off point ≥140/90 mmHg. This prompted the Hypertension Society to revise their proposed cut-off point to a level of ≥140/90 mmHg and to suggest further refinements of the guidelines.[46,47]

This reduction in BP cut-off points led to a doubling in the number of people in the country who would be identified as having hypertension, an increase of approximately 3 million people. The guidelines summarised best medical practice in hypertension care, however, the extensive nature of the guidelines did not receive wide acceptance within the health-care settings. Daniels *et al*.[58] found that at public sector CHC in the Western Cape that the guidelines were not systematically implemented and that individual doctors consulted the guidelines infrequently. Several barriers were identified in the application of the guidelines, including the consultation process by which the guidelines were developed, time and cost constraints, scepticism about durability of the guidelines, conflict with local practices, health-system problems and patient beliefs. Daniels *et al*.[59] concluded that passive dissemination of guidelines to health-care professionals in primary care should be reviewed to overcome the barriers to their implementation.

The treatment status of hypertension followed over time can be used to assess how well the health-care services in the country are doing in diagnosing and treating patients with hypertension. As such, this can form part of a set of adult health indicators for an ongoing health surveillance system for South Africa as suggested by Steyn and Bradshaw.[60] The second SADHS took place during 2003/4. With the release of information by the National Department of Health on the treatment status of hypertension, the analyses of the BP data can be compared to those of 1998 (see elsewhere in this chapter). This will illustrate whether the BP treatment status has improved or deteriorated among the South African populations since 1998.

INDIGENOUS DRUGS

During the last decade in South African, a keen interest in the field of pharmacology to study indigenous plants and traditional medicines for possible development of useful medications in health care has been developed. One such investigation involved the study of triperpenoids isolated from *Olea europaea*, subspecies Africana (African wild olive). The isolated triperpenoids were studied in the Dahl salt-sensitive, insulin-resistant rat genetic model of hypertension and shown to prevent the development of severe hypertension, atherosclerosis and improved insulin resistance of the experimental animals. These products could potentially provide an effective and cheap treatment of salt-sensitive hypertension in the African population.[61]

CONCLUSION

The information presented in this chapter shows that hypertension is extremely common in South Africa. It is inadequately treated and poorly controlled. It also shows that data now exist to address the problem in the country. However, as was stated by Cooper *et al*.[62] about the situation of hypertension in sub-Saharan Africa: "The condition is fully treatable, but social conditions in Africa make the implementation of blood pressure control programmes difficult. Lack of a clear strategy based on evidence has undermined these efforts." They also estimated that the reduction in population attributable risk associated with treatment might lead to 2% in Africa compared with 0.15% in the United States. 'Number needed to treat' analyses showed that the cost of drugs to prevent one death is $1800 in Africa, if the cheaper drugs are used, while it is $14 000 to $1 million in the United States, depending on which drugs are used. These findings lead to the conclusion that the treatment of hypertension should be a health priority in sub-Saharan Africa in general and in South Africa in particular.

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