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REVIEW

The risk factors for elevated blood pressure and how to address cardiovascular risk factors: a review in paediatric populations

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This paper examines the epidemiology of hypertension and management strategies of cardiovascular diseases (CVDs) in paediatric populations in sub-Saharan Africa and other parts of the world in the 21st century. A computerized literature search was carried out using Medline, Evidence-Based Child Health (A Cochrane Review Journal), the Cochrane Library and Cochrane Child Health Field. A manual search in the African Journal for physical, health education, recreation and dance, the South African Journal for Research in Sports, Physical Education and Recreation and a few individuals in the area were requested to send some of their recent unpublished and published reports in the field. High prevalence rates and high odds ratios for high blood pressure (BP) were recorded in children aged 5–17 years. There is a need for health ministries to improve the public health sector so as to close the gap between the rich and the poor. Although personal and parental responsibility remain crucial, it also falls on the government to help control powerful environmental factors that are leading our children to premature ill-health and mortality. Equally, health professionals are increasingly recognized that they have a significant role to play in delivering medical treatment of hypertension in children.
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Introduction

Childhood and adolescence are the greatest periods of change throughout the lifetime of an individual.[1,2] During this period, body shape changes, an independent and abstract cognitive process begins, and the adolescent's transition to the social values and roles of adulthood take place.[3] Although childhood and adolescence can be marked by new discoveries and opportunities, they can also produce anxiety and turmoil. Biological and hormonal changes, together with a complex of social issues that these children face, often overshadow the development of non-communicable diseases.[4] The risk factors for these non-communicable diseases are thought to be dietary (particularly high levels of saturated fats and excess salts), lack of physical activity, obesity, psychosocial stress and smoking, all of which are identified with biological, hormonal and social changes. Furthermore, family history, age, sex, traffic noise, occupational stress, socioeconomic status and social stress are further purported to be risks for the development of arterial hypertension.[5]

Hypertension is causing a major health hazard today. It appears to contribute to cardiovascular diseases (CVDs) mortality in African Americans both by accelerating the development of coronary atherosclerosis and by inducing more severe left ventricular hypertrophy.[6] In the United States of America, CVDs were regarded as the leading causes of death in 2001, as heart diseases accounted for 29.9% of total deaths and cerebrovascular diseases for an additional 6.8%,[7] while in South Africa they were among the top ten leading causes of death.[8] The epidemiology and management strategies of hypertension and CVDs ought to be revisited to improve the current status. Therefore, this review paper is aimed at examining the description of the frequencies of elevated blood pressure (BP) in children in sub-Saharan countries compared to other countries in the world and the ways to address cardiovascular risk factors in these paediatric populations.

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Materials and methods

Literature search

A computerized literature search for peer-reviewed articles was carried out using Medline, Evidence-Based Child Health (A Cochrane Review Journal), the Cochrane Library and Cochrane Child Health Field. A manual search in the African Journal for Physical, Health Education, Recreation and Dance, the South African Journal for Research in Sport, Physical Education and Recreation and a few individuals in the area were requested to send some of their recent unpublished and published reports in the field. Search terms for the identification of the studies were BP, hypertension prevalence and the incidence rate of hypertension. Studies on paediatric hypertension patients, self-reported hospital subjects, dietary intake, pregnancy, maternal tobacco usage, alcohol, malnutrition, birth weight, obesity, dislipidaemia, diabetic and poor BP measurements were excluded.

Normal population studies between the age span of 0–25 years were selected for prevalence/incidence of hypertension. The probability of children having high elevated BP during their lifetime was investigated using the term odds ratio of hypertension. Very few studies recorded the odds ratio in children. Selection for studies in this category was based on study design, which was mostly prospective cohort studies and national studies that included children aged 15 years and above.

Hypertension is as old as human beings. The 21st century is characterized by high industrialization, high economic growth in most parts of the world and global warming,[9,10] with English as the most convenient language used by many people in the world. Only studies published in English from 1 January 2000 to 30 September 2007 were included. A total of 270 studies were found and only 39 studies that met the above-mentioned criteria were used. Selected studies were categorized by the regions (sub-Saharan Africa, Asia, United States, Europe and Latin America).

Hypertension could not be treated in isolation for its management strategies. Therefore, the search of hypertension management strategies was also expanded to the intervention to reduce cardiovascular risk factors in children.

Subjects

The number of children involved in the reviewed studies varied considerably. The largest sample studied consisted of 3923 [11] and 1902 children,[12] whereas Addo *et al.*[13] and Smith and Rinderknecht[14] studied the smallest sample, 67 children aged below 25 years and 156 children aged 5–18 years, respectively.

The measurement of BP in children is known to be difficult, mainly as a result of a large intraindividual variance.[15,16] This is largely because this period is characterized by the growth and maturation process, which affects BP.[17–20] Therefore, the protocol for measuring BP is important so that similar studies could be reviewed to avoid bias in the interpretation and wrong conclusions that could be drawn. In general, in the selected studies, an automated electronic device was used to measure systolic blood pressure (SBP) and diastolic blood pressure (DBP) at an interval of 5 min apart, after the child had been seated for 5 min or longer[15,16] with the cuff that covers at least two-thirds of the upper arm and encircles at least one-half of the left or right upper arm. A few studies reported that well-trained nurses used a mercury sphygmomanometer or a random zero sphygmomanometer with the cuff that covers at least two-thirds of the upper arm and encircles at least one-half of the left or right upper arm to measure blood pressure. SBP was the first Korotkoff sound, whereas DBP was based either on the fourth or fifth Korotkoff sounds.[13,15]

In general, hypertension was defined as the occurrence of SBPand DBP levels greater or equal to the 95th percentile of height and sex-adjusted reference levels.[15,16] Al-Sendi *et al.*[21] based their definition of high BP on the recommendation of the WHO Expert Committee on Hypertension Control.[22] In their recommendation, hypertension was defined as SBP and/or DBP greater or equal to the 95th percentile for age, and normal BP status was defined as SBP and/or DBP less than 95th percentile for age. Van der Sande *et al.*[23] defined hypertension following the 1993 WHO guidelines as BP greater than 160/95 mm Hg. Frontini *et al.*[24] and Barger and Muldoon[25] classified subjects as hypertensive, if they had SBP higher than 140 mm Hg and DBP higher than 90 mm Hg.

Statistical analysis

Descriptive statistics for BP were presented in all selected studies. Generally, logistic regression was used to calculate the age-adjusted odds ratio for hypertension and the 95% confidence interval (CI).[21–24,26–28] Maffeis *et al.*[29] performed a multivariate logistic regression analysis with backward stepping of variables and an evaluation of the model using three goodness of fit X^2 statistics, whereas Addo *et al.*[13] used both univariate and multivariate regression models to calculate the odds ratio for hypertension. Barger and Muldoon[25] used the ordinal regression model, the cumulative odds model to evaluate differences in self-rated health as a function of hypertension status, labelling which further provides an extension of logistic regression for determining the odds ratios.

Results

Table 1 presents the prevalence of hypertension in selected population studies in sub-Saharan Africa

Table 1 The prevalence of hypertension in boys and girls in selected population studies in sub-Saharan Africa and other parts of the world

Reference	*Country*	*Sample size*			*Mean age (age range in years)*		*Prevalence of hypertension*		
		Boys	*Girls*	*Total*	*Boys*	*Girls*	*Boys*	*Girls*	*Total*
Sub-Saharan Africa									
Steyn *et al.*[30]	South Africa	—	—	964	5	5	—	—	22.3
Schutte *et al.*[31]	South Africa	321	379	700	12.5 (10–15)	12.6 (10–15)	12.5	21.2	17.2
Schutte *et al.*[32]	South Africa	321	374	695	12.5 (10–15)	12.6 (10–15)	12.2	21.5	17.2
Addo *et al.*[13]	Ghana	—	—	67	NG (<25)	NG (<25)	NG	NG	6
Monyeki *et al.*[33]	South Africa	967	917	1884	NG (6–13)	NG (6–13)	0–5.8	3.1–11.4	NG
Makgae *et al.*[12]	South Africa	980	922	1902	NG (6–13)	NG (6–13)	3.2	12.2	7.5
Asia									
Misra *et al.*[19]	New Delhi	691	523	1214	16.2 (14–25)	16.1 (14–25)	20	13.2	NG
USA									
Moore *et al.*[34]	Anadarko, Southwestern Oklahoma	—	—	769	NG (<18)	NG (<18)	NG	NG	2.8
Smith and Rinderknecht[15]	South Minneapolis	76	80	156	NG (5–18)	NG (5–18)	13.2	7.5	10.3
Frontini *et al.*[24]	Bangalusa, Louisiana	—	—	1454	NG (5–17)	NG (5–17)	NG	NG	7.9
Europe									
Barba *et al.*[24]	Italy	1986	1937	3923	8.71 (6–11)	8.73 (6–11)	9.9	13.9	NG
Agirbasli *et al.*[35]	Turkey	121	79	200	15 (NA)	15 (NA)	8	6	NA
		129	98	227	16 (NA)	16 (NA)	10	4	NA
		139	74	213	17 (NA)	17 (NA)	7	4.1	NA
Al-Sendi *et al.*[21]	Bahrain	249	255	504	NG (12–17)	NG (12–17)			

Abbreviations: NA, not applicable; NG, not given.

and other parts of the world. The prevalence of hypertension in sub-Saharan Africa ranged 0–12.5% for boys and 0–21.5% for girls (Table 1). The highest prevalence rate recorded was 21.5%[31] for girls and 12.5% for boys,[32] whereas Steyn *et al.*[30] recorded the highest total prevalence rate of 22.3% for both boys and girls in urban South African children. Misra *et al.*[19] recorded the highest (20.0%) prevalence of BP for boys in the Asian region followed by Smith and Rinderknecht[14] in the United Staes (13.2%). Europe recorded a prevalence rate of between 2–13.9% for both boys and girls.[21,24,35]

Table 2 presents the odds ratio and 95% CI for the development of hypertension in selected studies in sub-Saharan Africa and other parts of the world. Monyeki *et al.*[26] reported the highest odds ratio (13.7 95%CI 3.6–51.7) for Ellisras rural South African children aged 11–14.4 years, whereas Frontini *et al.*[24] reported an odds ratio of 5.05 95%CI 1.4–14.7 for Bangalusa, LA, USA.

Evidence from different sources suggests that both physician's non-adherence to recommended guidelines[36] and patient non-compliance are contributory to the unsuccessful management strategy of hypertension.[37] Figure 1 shows the schema for societal level pathways and strategies for prevention of CVDs. The target population included individuals with no knowledge or information of CVDs, individuals with information of CVDs and illiterate and ignorant individuals. All these groups of individuals are affected by hypertension and other risk factors for CVDs, sometimes during their life circle. The onset of these diseases affects mostly the different vital organs of the body including the heart, brain and kidneys, which lead to mortality with the leading cause being heart attack, heart failure, stroke and others. Kaplan[39] proposed that the dividing line between normal and high BP should be the level of BP at which the benefits of action exceed the risk and cost of inaction and should be part of the registration information.

Table 3 provides an example of indicators to be included in the hypertension registration information. Registry data offer insights into disease patterns, medication use and resource utilization over time and allow for assessment of adherence to practice guidelines. However, the limitations of registry data include heterogeneous definitions of diagnoses and cohorts, potential selection biases of included institutions, differences in patience care and selective outcome reporting. Analysis of large controlled clinical trial data could offer additional insight into regional management and outcome differences in individuals with hypertension. It is important for the management strategies to cover intervention with a preventative focus on illiterate and ignorant individuals with no information or knowledge of the diseases, whereas the focus strategy for the individual with knowledge or information of the diseases should be focused on the sociopolitical factors (Figure 1). The outcome or success of these pathways will be noted by the

Table 2 OR and 95 % CI for the development of hypertension in selected population studies in sub-Saharan Africa and other parts of the world

References	*Country*	*Age range (years)*	*OR*	*95%CI*	
Sub-Saharan Africa					
Addo *et al.*[13]	Ghana	<18	1	—	—
Van der Sande *et al.*[23]	Ghambia	<15	1.7	1.3	2.2
Monyeki *et al.*[26]	South Africa	7.5–10.9	1.8	0.3	9.3
		11.0–14.4	13.7	3.6	51.7
Asia					
Facchini *et al.*[27]	Kazakhstan	7–18	1.11	1.08	1.14
Israeli *et al.*[28]	Israeli Defense force Staff Periodic examination centre	>25	1.30	1.22	1.39
USA					
Frontini *et al.*[24]	Bangalusa, Louisiana	5–17	5.05	1.4	14.7
Barger and Muldoon[25]	NHANES III	Above 17	1.26	1.09	1.46
Europe					
Al-Sendi *et al.*[21]	Bahrain	12–17	4.3	1.4	13.3
Maffeis *et al.*[29]	Italy	3–11	2.3	1.41	3.72

Abbreviations: CI, confidence interval; NHANES III, the third National Health and Nutritional Examination Survey; OR, odds ratio.

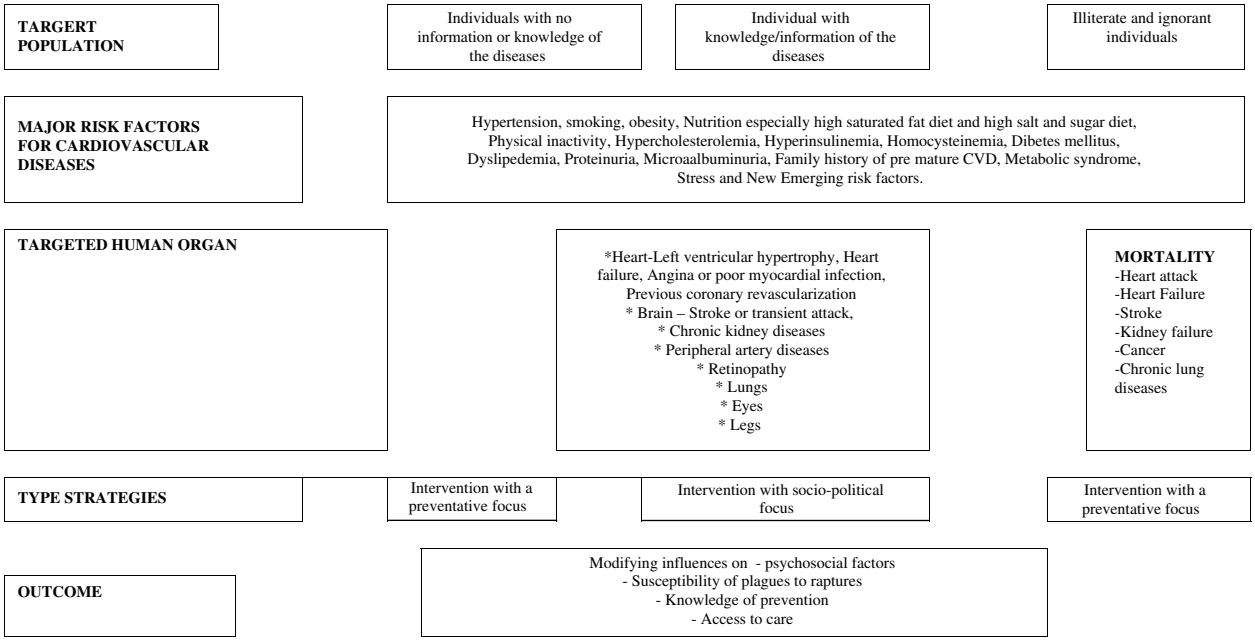

Figure 1 Schema for societal level pathways and strategies for the prevention of the cardiovascular diseases.[8,20,38]

modifying influence on psychological factors, with everybody being aware of the knowledge of prevention and access to care (Figure 1).

The relationship between BP values and the risks of cardiovascular mortality and morbidity is consistent and continuous.[40] The higher the BP, the greater the chances of myocardial infarction, heart failure, stroke and renal diseases across the entire BP range (Figure 1).[41]

Table 4 presents the lifestyle modification and clinical considerations to manage CVDs. The lifestyle modification and recommendation starts from birth to adulthood. It is important for individuals with knowledge of the diseases, for individuals without the knowledge, for the illiterate and ignorant individuals to familiarize themselves with the information contained in the table as it provides an entry point for all individuals. For example, from birth up to 3 years, parents should apply the growth charts to monitor the growth of the child and introduce healthy diet and healthy snacks for the children. As the child grows (3–6 years), in addition to applying the growth chart, healthy diet, the BP chart should be introduced. Furthermore, at this stage, the child should be encouraged to lower salt intake and to take part in physical activities. For individuals who are ignorant or illiterate and diagnosed with high BP, they should receive advice

Table 3 Indicators for managing hypertension using the expanded information model[15,16,20,30,39]

Phase	*Indicators*
Prevention	% People who are obese
	% People who smoke
	% People with diabetic mellitus
	% People with less physical activity
	% People who take alcohol
	% People with less than two of the above
	% People with more than two of the above
Inputs	% Clinics with display of hypertensive therapeutic guidelines
	% Examination facilities with small, normal and large cuff for measuring blood pressure
Process	% Hypertensive patient with sufficient medication
	% Hypertensive patient files with recorded urine test for proteinuria
	% Adult below 25 years with recorded blood pressure taken at least for 12 months
	% Adult above 25 years with recorded blood pressure taken at least for 12 months
Outputs	% Registered hypertensive patients who received medication in the previous month
Impact	The probability of a person below 25 years dying before 65 years of age

on life modification. Lower dose Aspirin (75 ml) is recommended for secondary prevention of ischaemic CVDs and for primary prevention in people aged over 50 years. In the Heart and Estrogen/Progestine Replacement Study, the outcome of the twofold increase was reported in black women who had a higher rate of diabetes, hypertension and hypercholesterolaemia, but who were less likely to receive aspirin or statin drugs and were less likely at follow-up to have optimal BP or low density lipoprotein-cholesterol (LDL-C) control.[36]

Discussion

Blood pressure is a well-known, modifiable risk factor for CVDs. The dividing line between normal and high BP is based on epidemiological data. A high-prevalence rate of elevated BP was recorded in children aged 5–17 years, with the highest prevalence of 22.3% recorded at age 5 years in sub-Saharan Africa (South Africa) and 10.3% of the sample aged 5–18 years in the United States[15] in the 21st century.

The major problem in paediatric hypertension studies is the measurement of BP, given the well-documented intraindividual variance. Rosner *et al.*[45] reported greater than 75% of total variability of DBP, whereas Kemper *et al.*[46] noted that as a result of the low test–retest reproducibility, the prevalence of BP remained high. However, Zinner *et al.*[47] reported that electronic devices are reliable for use in population studies as they minimized observer error. Furthermore, there is a high correlation between BP and growth of stature, weight and sexual maturity.[28,48,49] Voors *et al.*[50] emphasize the need to define hypertension on several basal BP values as related to body weight and body dimensions rather than by age. Katz *et al.*[51] reported that the variation of BP is closely related to growth and maturation in adolescents and children. In general, the studies cited in this review classified the children as hypertensive based on the the guidelines for hypertension.[12,13,31,32,30,33–35] Frontini *et al.*[24] and Barger and Muldoon[25] classified children as hypertensive based on the 140/90 mm Hg recommendation of the WHO. It is clear from the cutoff point of these two studies together with the study of van der Sande *et al.*[22] who used 160/95 mm Hg that the situation might be worse than it is reported in their respective area.

Children are an important target group for health intervention. It is increasingly recognized that the occurrence of adult CVDs are influenced by factors operating throughout the life course.[52] Increased risk may start in infancy or even before birth and will continue to be influenced by health-related behaviour during adulthood. There is clear evidence, for example, from the Bogalusa Heart Study that cardiovascular risk factors are identifiable in childhood and are predictive of future cardiovascular risk. The level of CVD risk factors track over time and confirm a lifelong burden of cardiovascular risk. Such risk factors are usually found in constellation with obesity and insulin resistance underlying conditions of hypertension, thrombosis and dyslipidaemia among others.[53] Furthermore, the constellation of metabolic syndrome variables at low levels in childhood is associated with a lower measure of cardiovascular risk in adulthood.[54]

Kemper[55] has shown that less intake of salt reduces the BP level. The mobile populations are moving to the cities in large numbers and consuming fast food predisposing them to high levels of hypertension. People of African descent have been found to exhibit a strong tendency towards salt sensitivity and hypertension,[56] which could be a possible explanation to the high prevalence of hypertension in urban South African children. Furthermore, the excessive use of alcohol is a risk factor for hypertension. In South Africa, people from 15 years to retirement have the highest rate of excessive alcohol use as do those with little or no education.[8] However, very little control of the promotion of alcohol sale is continuing worldwide, whereas a national policy regarding the use of salt is long overdue in many regions.

Successful health education is characterized by efforts to increase self efficacy, to promote self reflection, self-awareness and autonomy, to improve decision-making skills and to provide training in personal skills.[42,43,55] Some of the health benefits that have been demonstrated in the intervention group have included: total reduction of cholesterol; increased high density lipoprotein-cholesterol

Table 4 Lifestyle modification and clinical consideration to manage cardiovascular diseases[42–44]

Modification	*Recommendations*	*Clinical considerations*
Birth	If family history is positive for early cardiovascular diseases or hyperlipidaemia, introduce risk factor. Get the information on parental usual dietary food consumed, smoking history, smoking cessation referral. Apply the growth charts to monitor the growth of the child Determine parents' lipid levels and initiate nutrition counselling	All people with high blood pressure, borderline or high normal blood pressure should receive advice on life modification Initiate antihypertensive drug therapy, if sustained blood pressure is high for stature, age and gender Initiate treatment, if cardiovascular diseases or other target organ damage present. For example, for chronic kidney diseases, use ACE1 or ARB usually in combination with a diuretic; for isolated systolic hypertension, use low-dose thiazide or thiazide-like diuretic or long-acting CCB; for angina, use β-blocker; for prior myocardial infection, use β-block and Verapamit, for left ventricular hypertrophy; use ARBor ACE-1 and for diabetes type 1 and 2 with or without evidence of microalbuminuria or proteinuria, use ACE-1 or ARB usually in combination with diuretic Most people with high blood pressure will require at least two blood pressure lowering drugs to achieve the recommended goal Low-dose aspirin (75 ml) is recommended for secondary prevention of ischaemic cardiovascular diseases and for primary prevention in people over the age of 50 years For heart failure, use ACE-1 and certain β-blockers and aldosterone antagonist Statins are recommended for all people with high blood pressure complicated by cardiovascular diseases, irrespective of baseline concentrations of total cholesterol or low density lipoprotein cholesterol. Statins are also recommended for primary prevention in people with high blood pressure who have a 10-year risk of cardiovascular diseases greater than 20%
Up to 3 years	Apply growth charts to monitor the growth of the child. Introduce information about healthy diet to the parents. Recommend healthy snacks	
3–6 years	Apply growth charts to monitor the growth of the child. Information on healthy diet is important. Use low fat milk. Introduce blood pressure chart. Lower salt intake. Parents should actively play with the children by running or walking. Lipid determination in children with a positive family history or if the parents' cholesterol level is above 240 mg 100 ml ($>6.20\,mmol\,l^{-1}$)	
6–10 years	Continue with both growth charts and blood pressure charts. Complete cardiovascular health profile with child, determine family history, smoking history, blood pressure percentile, physical activity level. Measure height, weight, triceps and subscapular skinfolds, finger stick cholesterol. Emphasize healthy diet. Begin anti-smoking and alcohol counselling. Encourage sports participation on both intramural and extramural programmes. Provide information on TV watching the principle of energy intake and energy usage and what happen in obesity	
Weight reduction	Maintained normal body weight. Consider obtaining a lipid profile and review the cardiovascular health status	
Adopt good eating habits	Consume a diet rich in fruits, vegetables and low fat dairy products with a reduced content of saturated fat and total fat. Make starchy food the basis of most meals, Eat dry beans, peas, lentils and soya regularly, Chicken, fish, milk, meat or eggs can be eaten daily. Drink lots of clean safe water	
Dietary sodium reduction	Reduce dietary sodium intake to no more than $100\,mEq\,l^{-1}$ (2.4 g sodium or 6 g sodium chloride	

Table 4 *Continued*

Modification	*Recommendations*	*Clinical considerations*
Physical activity	Engage in regular aerobic physical activity such as brisk walk (at least 30 min a day for 3 or 4 days a week)	
Moderation of alcohol consumption	Limit consumption to no more than two drinks a day (30 ml ethanol) in most men and not more than one drink a day in women and lighter weight persons Pregnant women should not take any drinks	
Tobacco usage	Stop the usage of tobacco product in any form.	
Diabetes mellitus	Use food and drinks containing sugar sparingly and not between meals	

Abbreviations: ACE, angiotensin converting enzyme inhibitors; ARB, angiotensin II receptor blockers; CCB, calcium channel blockers.

(HDL-C), reduction in percentage body fat, increased health knowledge (diet, activity and smoking), aerobic power and physical activity outside school, improved diet with decreased fat and saturated fat intake; decreased prevalence of obesity; improved school meals; decreased risk factors for obesity and TV watching time.[8,30] South Africa implemented very strong tobacco control legislation. This resulted in a drop in tobacco consumption in South Africa by 21.6% from 43.6 to 34.2 million kg of tobacco leaf since 1998.[58]

Disparity in cardiovascular outcomes persists in sub-Saharan Africa compared to other countries in the world because of the inadequacies of the current health-care system and the failure to focus adequate efforts on population most in need. Furthermore, public and private health care in sub-Saharan Africa differ in terms of lower quality of service, lower quality of diagnoses and poor quality of medicine provided. There is a need for health ministries to improve the public health sector so as to reduce the gap between the rich and the poor.

Health-care professionals should identify high-risk patients and set a strict target and offer the potential to exert maximal impact on cardiovascular outcome. Although personal and parental responsibility remain crucial, it also falls on the government to help control powerful environmental factors that are leading our children to premature ill-health and mortality. Equally, health professionals are increasingly recognized for the significant role they played in delivering medical treatment of hypertension in children. Successful treatment requires great understanding of hypertension causes, consequences and the particular style of approach that is required for children and their families.

An unhealthy lifestyle in the population has led to the escalating increase in CVD mortality. Before deciding on any intervention for CVD prevention and control in a population, a few practical issues have to be taken into account. Firstly, the community health workers employed by the government should be available, particularly in rural areas, to educate the illiterate and ignorant people about the dangers posed by these diseases. Secondly, in urban areas, there should be safe walking or cycling trails to encourage physical activity, as most people could read and learn behaviour by imitation. Thirdly, a multifaced health promotion programme directed at the whole population and a well coordinated primary health service for early diagnoses and the management of persons at high risk of developing the CVD could be helpful. Finally, the success of the policy depends on equity, unified and decentralization of a healthy service for the population. Community participation is central to the success of the programme.

There are some limitations to this review. The period from 1 January 2000 to 30 September 2007 could yield a selection bias, as in some studies subjects were studied before the date and were reported only in 2000, as the review process and publication period differ from one journal to another. Although we have gained insight into the epidemiology of hypertension by investigators of different geographical regions, caution must be exercised in using these data as there was heterogeneity in access to care even within the region.[57] Furthermore, population genetic studies indicate tremendous heterogeneity, even within a particular geographic region, as such non-modifiable and management strategies of hypertension and CVD may be unequally distributed within the region, leading to population stratification and confounding even within a seemingly homogeneous group.[42]

We do have a powerful strength; however, as this review included prospective cohort studies[24,33,55] and some national studies,[12,23,25] the data were subject to less bias from recall and old measurements and may thus elucidate a true cause-and-effect association. In addition, BP was measured during early childhood, demonstrating that proper monitoring should be started from a child's early days from a viewpoint of screening for vulnerable individuals.

What is known about the topic

- Cardiovascular risk factors start in early childhood, track throughout adolescence and manifest at middle age in most societies.
- Cardiovascular diseases occur earlier among the sub-Saharan African population as compared to other population groups and the age period where risk factors escalate is not known.

What this study adds

- Risk factors for high blood pressure develop at age below 25 years and effective management strategies for cardiovascular diseases could start any time from birth to adulthood.
- The cost of medicine is escalating and hence prevention efforts should target the whole population in the sub-Saharan African continent.

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