EMERGING NON-COMMUNICABLE DISEASE EPIDEMIC IN AFRICA: PREVENTIVE MEASURES FROM THE WHO REGIONAL OFFICE FOR AFRICA

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The World Health Organization Regional Office for Africa (WHO AFRO) commissioned a study to compile and analyze published reports on non-communicable diseases (NCDs) in Africa to build evidence on the burden of NCDs in the region. Anecdotally, little information or literature was available on this subject. The objective of the study was to establish the status of NCDs in Africa by using published sources of information. A literature search was done through MEDLINE/PubMed and Google to identify studies that reported on prevalence rates of NCD risk factors. The study confirmed that information on NCDs in Africa was lacking. The prevalence of hypertension was found to be rapidly increasing, from 3% in rural areas to >30% in some urban settings. In some populations, hypertension prevalence rates were higher in women than in men while the opposite was true in others. Most people with hypertension were not aware of their condition, and of those who were on treatment, <20% had optimal control. The prevalence of diabetes mirrored that of hypertension, from <1% in some rural areas to >20% in some selected populations and racial groupings in urban settings. The predominant type was type 2 diabetes, which accounted for >80% of all cases in some reports and tended to present later in life. The prevalence of tobacco smoking also varied across the continent, from <1% in rural women to 50% in some urban men. Recent studies based on analysis of hospital-based information have documented NCD trends that were similar to prevalence data generated from national risk factor surveys. NCD risk factors such as hypertension and diabetes are increasing in Africa. (*Ethn Dis*. 2006;16:521–526)

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INTRODUCTION

The rapid rise of non-communicable diseases (NCDs) represents one of the major health challenges to global development.[1] The priority diseases included in the NCD cluster are cardiovascular diseases and their risk factors such as hypertension, coronary heart disease, and cerebrovascular accidents in addition to diabetes, cancers, injuries, chronic respiratory diseases, and mental health. These diseases share common risk factors: unhealthy diet, smoking, excessive alcohol use, and physical inactivity. These diseases are manifested initially as obesity, high blood pressure, and high blood lipids. The focus of this report is on cardiovascular diseases, particularly hypertension and diabetes mellitus. The global burden of NCDs is projected to approach epidemic levels, especially in developing countries.[2] In 1999, NCDs were responsible for 60% of deaths in the world and 43% of the global burden of disease.[3] By the year 2020, the global impact of NCDs has been projected to cause up to 73% of deaths and 60% of the disease burden. NCDs are already of major importance in developed countries and are rapidly becoming a major public health threat in the developing world. According to a WHO NCD Surveillance Strategy report, over a period of 30 years, the burden of disease from NCDs for developing and newly industrialized countries is expected to rise by >60% by 2020, compared to a rise of <10% in developed countries.[4]

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Developing countries, especially those in Africa, are among the poorest in the world, with per capita gross domestic product (GDP) less than US $200 in some countries.[5] Expenditure on health is low; most countries spend <2% on healthcare services.[6] The available limited resources are committed to communicable diseases such as HIV/AIDS, tuberculosis, and malaria, whose prevalence data and impact on economic development are much more noticeable, leaving the increase in the disease burden from NCDs unchecked.[7]

The conclusions and estimates of NCD burden in developing countries are based on limited literature and extrapolation from studies done in Western societies because the studies done on NCDs in Africa have used different study designs and different case definitions, which complicates

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Table 1. The prevalence of hypertension by environment and sex with case definition of blood pressure ≥160/95 mm Hg

		Rural			Urban			National*		
Country	Author	RM	RF	All	UM	UF	All	M	F	All
Cameroon	Mbanya et al 1998[9]	5.4	5.9	5.6	16.4	12.1	14.3			10
Ethiopia	Pauletto et al 1994[10]			.4			3.2			1.8
Lesotho	Nair et al 1995[11]			14.9			12.4			13.6
Nigeria	Kadiri et al 1999[12]				10.4	7.1	9.3			
Senegal	Astagneau et al 1992[13]						10.4			
Senegal	Lang et al 1988[14]				7.4	10.2				
Seychelles	Aubert et al 1998[15]							36	25	30.5
Seychelles	Bovet et al 1991[16]							25	20	22.5
Sierra Leone	Lisk et al 1999[17]			14.7		23.4				19
South Africa	Steyn et al 1986[18]							35.6	24.7	30
South Africa	Seedat et al 1982[19]	8.8	7.4							
South Africa	Seedat et al 1980[20]				25.6	20				
Tunisia	Ghannem et al 1997[21]						15.6			
Zaire	Mbuyamba-Kabangu 1987[22]			14.2			9.9			12
Zaire	Mbuyamba-Kabangu 1986[23]							13.6	6.8	10.2

* National=males and females rural and urban combined.
RM=rural males; RF=rural females; All=males and females combined; UM=urban males; UF=urban females; M=males; F=females.

comparing the results with findings from other countries.[8] Therefore, we need to take stock of published literature on the prevalence of NCDs in Africa, focusing on cardiovascular diseases and some of their risk factors.

METHODS

Literature on NCDs was accessed by using MEDLINE/PubMed and Google searches with the words noncommunicable diseases, prevalence rates, incidence rates, Africa, hypertension, diabetes, strokes, obesity, tobacco. Fifty-seven studies from 27 African countries were reviewed. However, not all reports were used in the generation of this review.

Selection criteria for the studies included:

- Use of random selection of sample
- Standard definition of NCD risk factors
- Inclusion of demographics of sample such as age and sex
- Clear definition of environment

Exclusion criteria included:

- Unclear study design
- No clear case definition of NCD risk factors
- Use of convenience samples or selection process not described

Limitations of the method:

- Not all reports are published.
- Some reports do not appear in the search engines used.
- Some reports are disseminated locally.
- Some national surveys have been conducted but not externally disseminated.
- Most dissertations from universities are not published.

RESULTS

The hypertension prevalence with case definition of blood pressure ≥160/95 mm Hg was higher in urban settings compared with rural settings in most countries, with a few exceptions (Table 1). Blood pressure levels were higher in men than in women in some studies, whereas the opposite was true in other populations.

Most studies used the case definition for hypertension of blood pressure ≥160/95 mm Hg or taking medications. Some used diastolic pressures ≥95 or ≥90 mm Hg and were excluded from the analysis.

Using the current WHO case definition of hypertension of blood pressure ≥140/90 mm Hg, we found a greater rural-urban difference; the urban population faired worse than their rural counterparts (Table 2). No difference

Table 2. Prevalence of hypertension at country level with case definition of blood pressure ≥140/90 mm Hg

Country	Author	Urban Males	Urban Females	Rural Males	Rural Females	Males Combined	Females Combined
Mauritius	Chitson et al 1999[24]					10.5	8.8
Morocco	Tazi et al 2003[25]					30.2	37
Tanzania	Edwards et al 2000[26]	37.3	39.1	26.3	27.4		
Zimbabwe	Mufunda et al 2000[27]	24	35				

Table 3. The prevalence of hypertension by socioeconomic status and geoeconomic stratification with definition of blood pressure 160/95 mm Hg

Country	Author	Rural 1 F	Rural 2 F	Rural 3 F	Rural 1 M	Rural 2 M	Rural 3 M
Zimbabwe	Sparks et al 1996[28]	3.5	5.4	15.1			
Tanzania	Swai et al 1993[29]	3.4	4.7	7.5	2.6	3.3	6.6

Rural 1–3 are geoeconomic groupings based on socioeconomic status, with 1 most rural and 3 least rural.
F=females; M=males.

Table 4. The prevalence of diabetes by country and sex

Country	Author	All Rural	Urban Males	Urban Females	Combined Males and Females, Rural and Urban Settings
Ethiopia	Peters 1983[30]				.3
Ghana	Dodo et al 1964[31]				.2
Mali	Fisch et al 1987[32]				1
Mauritius	Chitson et al 1999[24]		18.4	20.6	
Morocco	Tazi et al 2003[25]				6.6
Nigeria	Owoaje et al 1997[33]				2.8
Nigeria	Osuntokun et al 1971[34]				.43
Seychelles	Tappy et al 1991[35]		3.4	4.6	
South Africa	Michael et al 1971[36]		6	8.7	
South Africa	Omar et al 1988[37]		7	10.5	
South Africa	Levitt et al 1993[38]				8
Tunisia	Ghannem et al 1997[21]				10.2
Tanzania	Ahren et al 1984[39]	.7			
Tanzania	McLarty et al 1989[40]		1.1	.68	.87

was seen between the trends with the two definitions.

The prevalence of hypertension appeared to differ depending on socioeconomic status and geoecologic stratification (Table 3). The prevalence was lowest in the rural areas and increased with socioeconomic status. Some differences were also noted with different geographic areas (Table 3).

The prevalence of hypertension increased from rural to urban areas almost consistently across all reports reviewed, and rates were higher in the urban setting. The prevalence was higher in some population groupings (Table 4).

The prevalence of glucose intolerance was also higher in the urban areas. The coexistence of hypertension and diabetes varied from population to population (Table 5).

The prevalence of tobacco smoking differed between regions and sex. It was highest in urban male smokers and lowest in rural female smokers. Isolated population groupings were found in which the incidence of tobacco smoking was fairly high (Table 6).

A recent analysis of hospital management information system data demonstrated doubling of hypertension incidence rate in a space of just six years.[49] Diabetes increased by ≈40% in that report (Figure 1). The other NCDs, such as cardiac failure, myocardial infarction (MI), and cerebrovascular accident (CVA), did not change as much.

The NCD risk factor survey confirmed this emerging epidemic of NCDs. The prevalence of hypertension was 16%, with no sex or environment difference.[50]

Table 5. The coexistence of hypertension and diabetes

Country	Authors and Year	Percentage
Cameroon	Kingue et al 1998[42]	82
Cameroon	Durcops et al 1996[41]	66
Sudan	Bani et al 1994	38
Ouagadougou	Drabo et al 1996[45]	29

DISCUSSION

The objective of the study was to review literature on the prevalence of NCDs in Africa. The available data have demonstrated that NCDs are increasing in the region, but some shortcomings pertain to the quality of the reports.

Some of the studies were performed on convenience samples and others on special categories of hospital patients, which made generalizing findings to the whole population difficult. These limitations, especially in terms of standard-

Table 6. The prevalence of tobacco smoking by country and sex

Country	Authors and Year	Setting and Sample	All	Males	Females
Chad	Leonard 1996[44]	Urban men	24		
Cote d'voire	Roudaut et al 1992[45]	Secondary school pupils	14.5		
Ethiopia	Betre et al 1997[46]	Men and women		11.8	1.1
Ethiopia	Kebede et al 1993[47]	Adolescents	13.8		
Mauritius	Chitson et al 1999[24]	Population survey		42	3.3
Morocco	Tazi et al 2003[25]	National survey	37		
Senegal	Kane et al 1998[48]	Rural areas	32		
Seychelles	Bovet et al 1991[16]			54	

ization, compromise the strength and quality and therefore the reliability of the data in making plausible generalizations on the prevailing status of NCDs in Africa.

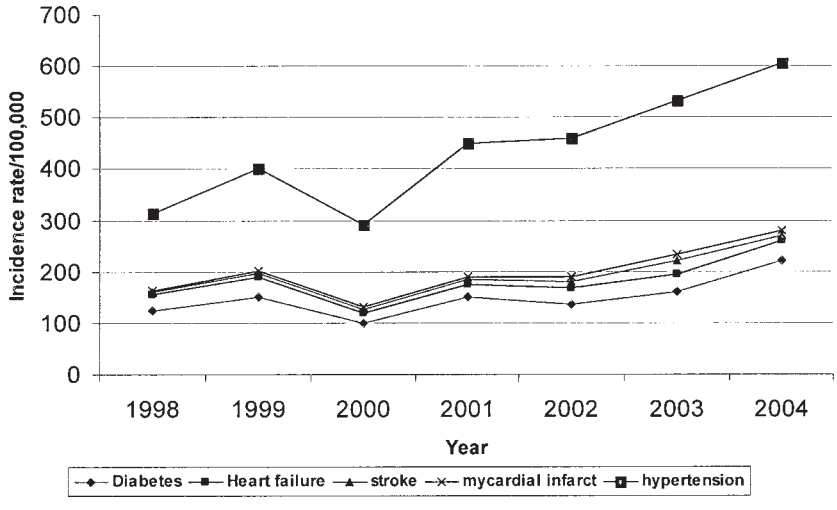
The report using hospital-based data generated according to current WHO guidelines used across the continent has shown the same message of an emerging NCD epidemic, which makes that information a good proxy of the national prevalence of NCDs. In the absence of national surveys, we can rely on this parameter for policy decisions on resource mobilization and allocation.

The NCDs whose prevalence rates were increasing were hypertension and diabetes mellitus. Hypertension had a number of features, some of which have been reported before[8], eg, rural urban dichotomy and gender dichotomy.[27,52] In spite of use of different case definitions for hypertension among the different studies, the qualitative message is consistent. Some studies used a definition of ≥160/95 mm Hg, while others used ≥140/90 mm Hg and yet a few used ≥90 mm Hg or ≥95 mm Hg. Some reports have observed higher prevalence rates in the urban setting compared with a few exceptions where the opposite was true.

The NCDs whose prevalence rates were noted to be increasing were hypertension and diabetes mellitus.

Hypertension has been reported to be closely associated with obesity in a causal relationship, but hypertension was prevalent in some lean populations.[3] The relationship between blood pressure and body mass index (BMI) requires further evaluation in Africa. A recent report highlighted a high prevalence of hypertension among a lean population in Africa. The population had a culture and tradition of high consumption of coffee, and >30% had a BMI that was less than normal.[51] Whether the high level of coffee consumption played a role in the development of hypertension has not yet been studied in this setting. The level of salt intake and stress were not assessed in that report, although ample evidence suggests these factors should be decreased.

The analysis of reports demonstrating sex difference in blood pressure and the prevalence of hypertension produced a mixed picture.[18,25] Most observations recorded higher prevalence rates in men than women, whereas a few reports found higher rates in women.[27] Contributory factors to higher blood pressures in women than in men were hyperinsulinemia and higher BMI.[53–55] While obesity has an association with hypertension, the relationship was by no means simple. Although BMI and blood pressure relationship is stronger in lean populations,[56] this observation is no longer consistent. There was a report of a need for a threshold, below which no relationship exists. Instead, in the normal range of BMI, the relationship was



strong, and the relationship appeared to become weaker as BMI increased.[51] We need to further analyze the relationship between hypertension and BMI in the light of these recent observations, especially looking at the neurohormonal involvement.

The prevalence of diabetes mellitus was confounded by using different case definitions ranging from fasting hyperglycemia and glucosuria to responses to intravenous glucose tolerance tests.[56] The features of diabetes mellitus resembled those of hypertension in terms of rural-urban dichotomy and sex differences. A mixed picture was seen; rates tended to be higher, with a few exceptions, in women than in men and in urban than in rural areas.[40] Prevalence was lowest in rural areas, where it was <2% on average, while it was >20% in some urban areas. The prevalence of type 2 diabetes was higher than type 1 and accounted for >80% of cases. Diabetes presented later in life has been reported from studies of Caucasians.[57]

The prevalence of diabetes needs to be closely monitored because of the devastating consequences when it coexists with hypertension. This association was very high, from as low as 30% in some settings to 80% in other settings.[56,57] The close relationship among diabetes, hypertension, and atherosclerotic target organ damage was worth noting, and the role of smoking was pivotal. The prevalence of smoking was high among high school pupils and adolescents.[46,48] We must, therefore, introduce interventions and measures targeting youths in order to slow increasing rates of NCDs.

The target organ damage was skewed toward CVA and away from MI. Some studies that used health management information systems (HMIS) have reported steady incidence rates of MI.[50] In the absence of NCD surveys, analyzing, interpreting, and publishing HMIS-based data was used as a surveillance tool for guiding policy on management and resource mobilization and allocation. In this regard, the WHO regional office for Africa division of NCDs commissioned the instrument for this analysis. The HMIS or data in the central registry compiled from all healthcare centers in the country was analyzed and reported. The prevalence data of most NCDs corroborated with those generated from a national NCD risk factor survey.[50]

Most African countries have not conducted NCD risk factor surveys to establish the baseline prevalence rates and to accurately quantify the magnitude of the problem. In the meantime, HMIS data have been shown to be a proxy of national prevalence status, provided standard guidelines for case definitions are used to enable comparisons over time and across countries.

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REFERENCES

1. Murray CJL, Lopez AD. The global burden of disease. In: Murray CJL, Lopez AD, eds. *The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Disease, Injuries, and Rusk in 1990 and Projections to 2020*. Cambridge, Mass: Harvard School of Public Health; 1996:1–5.
2. Unwin N, Mugusi F, Asparay T, et al. Tackling the emerging pandemic of noncommunicable diseases in sub-Saharan Africa: the essential NCD health intervention study. *Public Health*. 1999;113:141–146.
3. Cooper RS, Rotimi CN, Kaufman JS, Muna WF, Mensah GA. Hypertension treatment and control in sub-Saharan Africa. *BMJ*. 1998;316:614–617.
4. Murray C, Lopez A. Mortality by cause for eight regions of the world: global burden of diseases study. *Lancet*. 1997:1269–1276.
5. Gwatkin D, Guillo TM, Heuveline P. The burden of disease among the global poor. *Lancet*. 1999;354:586–589.
6. Jha P, Bangoura O, Ranson K. The cost effectiveness of forty health interventions in Guinea. *Health Policy Plann*. 1998;13:249–262.
7. Joint United Nations Program on HIV/AIDS. *AIDS Epidemic Update: December 2000*. Geneva: UNAIDS/WHO; 2000.
8. Unwin N, Setel P, Rashid S, et al. Noncommunicable diseases in sub-Saharan Africa: where do they feature in the health research agenda? *Bull World Health Organ*. 2001;79:1–13.
9. Mbanya JC, Minkoulou EM, Salah JN, Balkau B. The prevalence of hypertension in rural and urban Cameroon. *Int J Epidemiol*. 1998;27(2):181–185.
10. Pauletto P, Caroli M, Pessina AC, Dal Palu C. Hypertension prevalence and age-related changes of blood pressure in semi-nomadic and urban Oromos of Ethiopia. *Eur J Epidemiol*. 1994;10(2):159–164.
11. Nair P, Nyamphisi M, Yarnell JW. Lack of difference in blood pressure between the urban and rural population in Lesotho, Africa. *Cent Afr J Med*. 1994;40(10):278–281.
12. Kadiri S, Walker O, Salako BL, Akinkugbe O. Blood pressure, hypertension, and correlates in urbanized workers in Ibadan, Nigeria: a revisit. *J Hum Hypertens*. 1999;13(1):23–27.
13. Astagneau P, Lang T, Delarocque E, Jeannee E, Salem G. Arterial hypertension in urban Africa: an epidemiological study on a representative sample of Dakar inhabitants in Senegal. *J Hypertens*. 1992;10(9):1095–1101.
14. Lang T, Pariente P, Salem G, Tap D. Social, professional conditions, and arterial hypertension: an epidemiological study in Dakar, Senegal. *J Hypertens*. 1988;6(4):271–276.
15. Aubert L, Bovet P, Gervasoni JP, Rwebogora A, Waeber B, Paccaud F. Knowledge, attitudes, and practices on hypertension in a country in epidemiological transition. *Hypertension*. 1998;31(5):136–145.
16. Bovet P, Shamlaye C, Kitua A, Riesen WF, Paccaud F, Darioli R. High prevalence of cardiovascular risk factors in the Seychelles (Indian Ocean). *Arterioscler Thromb*. 1991;11(6):1730–1736.
17. Lisk DR, Williams DE, Slattery J. Blood pressure and hypertension in rural and urban Sierra Leoneans. *Ethn Dis*. 1999;9(2):254–263.
18. Steyn K, Jooste PL, Fourie JM, Parry CD, Rossouw JE. Hypertension in the Colored population of the Cape Peninsula. *S Afr Med J*. 1986;69(3):165–169.
19. Seedat YK, Mayet FG, Latiff GH, Joubert G. Risk factors and coronary heart disease in Durban Blacks—the missing links. *S Afr J*. 1992;82(4):251–256.
20. Seedat YK, Seedat DB. The prevalence of hypertension in the urban and rural Zulus. *Trans R Soc Trop Med Hyg*. 1980;57:1025–1030.
21. Ghannem H, Hadj Fredj A. Prevalence of cardiovascular risk factors in the urban population of Soussa in Tunisia. *J Public Health Med*. 1997;19(4):392–396.

22. M'Buyamba-Kabangu JR, Fagard R, Staessen J, Lijnen P, Amery A. Correlates of blood pressure in rural and urban Zaire. *J Hypertens*. 1987;5(3):371–375.
23. M'Buyamba-Kabangu JR, Fagard R, Lijnen P, et al. Epidemiological study of blood pressure and hypertension in a sample of urban Bantu of Zaire. *J Hypertens*. 1986;4(4):485–491.
24. Chitson P, Hemraj F, Radhakeesoon R. *Mauritius Non-Communicable Disease Survey*. Preliminary report to minister of health and quality of life. 1998.
25. Tazi MA, Abir-Khalil S, Chaouki N, et al. Prevalence of the main cardiovascular risk factors in Morocco: results of a National Survey. *J Hypertens*. 2003;21:897–903.
26. Edwards R, Unwin N, Mugusi F, et al. Hypertension prevalence and care in an urban and rural area of Tanzania. *J Hypertens*. 2000;18:145–152.
27. Mufunda J, Scott L, Chifamba J, et al. Correlates of blood pressure in an urban Zimbabwean population. *J Hum Hypertens*. 2000;14:65–73.
28. Sparks BT, Mufunda J, Musabayane CT, Sparks HV, Mahomed K, Hunter JM. Prevalence of hypertension among women in rural Zimbabwe: a comparison of pregnant and non-pregnant women. *Cent Afr J Med*. 1996;42(4):93–97.
29. Swai AB, McLarty DG, Kitange HM, et al. Low prevalence of risk factors for coronary heart disease in rural Tanzania. *Int J Epidemiol*. 1993;22(4):651–659.
30. Peters WH. A study on the prevalence of diabetes mellitus in Northern Ethiopia (Gondar Survey). *Gesundheitswesen*. 1983;38:1283–1289.
31. Dodo SRA, de Heer N. A diabetes case finding survey in Ho, Ghana. *Ghana Med J*. 1964; 3:75–80.
32. Fisch A, Pichard E, Prazuck T, Leblanc H, Sidibe Y, Brucker G. Prevalence and risk factors of diabetes mellitus in the rural region of Mali (West Africa): a practical approach. *Diabetologia*. 1987;30(11):859–862.
33. Owoaje EE, Rotimi CN, Kaufman JS, Tracy J, Cooper RS. Prevalence of adult diabetes in Ibadan, Nigeria. *East Afr Med J*. 1997; 74(5):299–302.
34. Osuntokun BO, Akinkugbe FM, Francis TI, Reddy S, Osuntokun O, Taylor GO. Diabetes mellitus in Nigerians: a study of 832 patients. *West Afr Med J Niger Pract*. 1971;5:295–312.
35. Tappy L, Bovet P, Shamlaye C. Prevalence of diabetes and obesity in the adult population of the Seychelles. *Diabet Med*. 1991;8(5): 448–452.
36. Michael C, Edelstein I, Whisson A, et al. Prevalence of diabetes, glycosuria, and related variables among a Cape Colored population. *S Afr Med J*. 1971;45(29):795–801.
37. Omar MA, Seedat MA, Dyer RB, Motala AA. Diabetes and hypertension in South African Indians. A community study. *S Afr Med J*. 1988;73(11):635–637.
38. Levitt NS, Katzenellenbogen JM, Bradshaw D, Hoffman MN, Bonnici F. The prevalence and identification of risk factors for NIDDM in urban Africans in Cape Town, South Africa. *Diabetes Care*. 1993;16(4):601–607.
39. Ahren B, Corrigan CB. Prevalence of diabetes mellitus in northwestern Tanzania. *Diabetologia*. 1984;26(5):333–336.
40. McLarty DG, Swai AB, Kitange HM, et al. Prevalence of diabetes and impaired glucose tolerance in rural Tanzania. *Lancet*. 1989; 1(8643):871–875.
41. Ducorps M, Bauduceau B, Mayaudon H, Sonnet E, Groussin L, Castagne C. Prevalence of hypertension in a Black African diabetic population. *Arch Mal Coeur Vaiss*. 1996; 89(8):1069–1073.
42. Kingue S, Kuaban C, Dongmol L, Nguefack C, Muna WF. Ultrasonic demonstration of carotid arteriosclerosis in Black Cameroonian adults with cardiovascular risk. *Ann Cardiol Angeiol (Paris)*. 1998;47(10):722–727.
43. Drabo PY, Guira O, Ouandaogo BJ, Kabore J. Arterial hypertension and diabetes in Ouagadougou. *Bull Soc Pathol Exot*. 1996;89(1): 33–34.
44. Leornard L. Cigarette smoking and perceptions about smoking and health in Chad. *East Afr Med J*. 1996;73(8):509–512.
45. Roudaut M, Meda AH, Seka A, Fadiga D, Pigearias B, Akoto A. Prevalence of asthma and respiratory disease in schools in Bouake (Ivory Coast): preliminary results. *Med Trop (Mars)*. 1992;52(3):279–283.
46. Betre M, Kebede D, Kassaye M. Modifiable risk factors for coronary heart disease among young people in Addis Ababa. *East Afr J*. 1997;74(6):376–381.
47. Kebede D, Ketsela T. Precursors of atherosclerotic and hypertensive disease among adolescents in Addis Ababa, Ethiopia. *Bull World Health Organ*. 1993;71(6):787–794.
48. Kane A, Ly M, Sarr M, et al. Arterial pressure and body mass index of children and adolescents in a rural area of Thiadiaye, Senegal. *Dakar Med*. 1998;43(1):83–89.
49. Mufunda J, Nyarango P, Kosia A, et al. Noncommunicable diseases in Africa: a silent hypertension epidemic in Eritrea. *J Hum Hypertens*. 2005;19:255–256.
50. Mufunda J, Mebrahtu G, Usman A, et al. The prevalence of hypertension and its relationship with obesity: results from a national blood pressure survey in Eritrea. *J Hum Hypertens*.- September 2005. Advance on line publication.
51. Mufunda J, Gregory DF, Harvey S. Blood pressure responses to dietary salt in rural and urban African men. *Ethn Dis*. 1993;3: S46–S58.
52. Simmons D, Barbour G, Congleton J, et al. Blood pressure and salt intake in Malawi: an urban rural study. *J Epidemiol Community Health*. 1986;40(2):188–192.
53. Preston RA, et al. Age-race subgroup compared with rennin profile as predictors of blood pressure response to antihypertensive therapy. *JAMA*. 1998;798:168–172.
54. Mufunda J, Sigola LB, Chifamba J, Vengesa PM. Hyperinsulinemia: possible cause of high blood pressure in unemployed urban Black women. *High Blood Press*. 1995;4: 137–140.
55. Sobngwi E, Mauvais-Jarvis F, Vexiau P, Mbanya JC, Gautier JF. Diabetes in Africans: epidemiology and clinical specificities. *Diabetes Metab*. 2001;27:628–634.
56. Mbanya JC, Sobngwi E. Diabetes in Africa. Diabetes microvascular and macrovascular disease in Africa. *J Cardiovasc Risk*. 2003;10: 97–102.
57. Motala AA. Diabetes trends in Africa. *Diabetes Metab Rev*. 2002;18:s41–s20.

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