Prevalence of Hypertension and Diabetes Mellitus in Adults from a Rural Community in Ghana

Mariana Cook-Huynh, MD, MPH;[*] Daniel Ansong, MBChB;[*] Rachel Christine Steckelberg, MD, MPH; Isaac Boakye, BSc; Katherine Seligman, MD; Lambert Appiah, MBChB; Neha Kumar, MD; John H. Amuasi, MBChB

Objectives: The aim of this study was to determine the prevalence of hypertension and diabetes mellitus (DM) in the Adankwame community of Ghana.

Design: This was a cross-sectional, observational study.

Setting: This study took place in the rural Adankwame community of Ghana, approximately 12 km from Kumasi, Ghana.

Participants: Study subjects were adults (older than aged 18 years). A two-tier random sampling approach was taken to recruit study participants to achieve a sample size of 326 adults, 94 males and 232 females.

Main Outcome Measures: The subjects' height, weight, abdominal circumference, demographic and risk factor information, blood pressure measurements, and blood glucose levels were measured and recorded.

Results: The mean systolic and diastolic blood pressures in the population were 131 (SD 26.61) and 78 mmHg (SD 15.24), respectively. The prevalence of hypertension was 0.35 (95% CI 0.30-0.40). The prevalence of pre-hypertension, Stage 1 hypertension, and Stage 2 hypertension were approximately 0.248, 0.19, and 0.16, respectively. Mean fasting blood sugar and random blood sugar in the study population were 108 mg/dL (SD 35.33) and 131 mg/dL (SD 41.35), respectively. The overall prevalence of DM in this sample population was 0.077 (95% CI 0.05–0.11).

Conclusions: Hypertension and diabetes mellitus are rising as diseases of public health importance in the Adankwame community. Research to provide substantial data on the prevalence of these two diseases in Ghana is needed to inform national non-communicable disease policy. (*Ethn Dis.* 2012;22[3]:347–352)

Key Words: Africa, Diabetes, Ghana, Hypertension, Prevalence, Rural

From the Komfo Anokye Teaching Hospital, Research and Development Unit, Kumasi, Ghana (DA, IB, LA, JA); the Mayo Clinic, College of Medicine, Rochester, Minnesota, (MC-H., RCS, KS, NK); and the University of Minnesota School of Public Health, Division of Health Policy and Management, Minneapolis, Minnesota (JA).

Introduction

Hypertension, defined as blood pressure in excess of 140/90 mm Hg, is one of the most common diseases afflicting humans.[1] Because of its associated morbidity, mortality and cost to society, hypertension is an important public health challenge.[2,3] An estimated 20% of the world's adults have hypertension and its prevalence dramatically increases in patients older than aged 60 years.[4] Research from several countries has shown a high prevalence of poorly controlled hypertension. Prevalence of hypertension is 22% in Canada, of which 6% is controlled; 26.3% in Egypt, of which 8% is controlled; and 13.6% in China, of which 3% is controlled. [4]

Until fairly recently however, hypertension was thought to be rare in rural Africa. Hypertension is now being widely reported in Africa and is the most common cause of cardiovascular disease on the continent.[5] A study conducted in 1950 in a village in Ghana measured a 5.5% prevalence of cardiovascular disease among its 255 inhabitants.[6] Studies conducted in 2003 and 2004 in Accra and Kumasi (the two largest cities in Ghana) respectively, revealed hypertension prevalence rates of 28.3% and 28.7% respectively.[7,8] In Accra, the capital city of Ghana, in 2007, hypertension became only second to malaria as the leading cause of outpatient morbidity, although in most regions of Ghana, hypertension ranks as the fifth highest cause of outpatient morbidity.[9] Hypertension has generally been shown to become more common with increasing urbanization.[10] Hypertension in sub-Saharan Africa is now a widespread problem of immense health and economic importance due to its high prevalence in urban areas, and it is further complicated by inadequate diagnosis and the severity of its complications.[5,10]

Diabetes mellitus (DM) is one of the most common chronic diseases in both Western and developing countries.[11,12] The disease has a prevalence of approximately 8% in much of Europe and the United States, and is associated with high morbidity and mortality.[13,14] This metabolic disorder is characterized by hyperglycemia and disturbances of carbohydrate, protein and fat metabolism secondary to an absolute or relative lack of the hormone insulin. Pre-diabetes mellitus is characterized by elevated blood glucose levels with fasting plasma glucose between 100 and 125 mg/dL or an oral glucose tolerance test between 140 and 200 mg/dL.[15,16] Glucose levels greater than these values characterize DM. The prevalence of DM in adults worldwide was estimated to be 4% in 1995 and is expected to rise to 5.4% by the year 2025 [11] and 7.0% by the year 2050 due in large part to the global obesity epidemic and other factors.[17] The majority of this projected numerical increase in cases of DM worldwide is expected to occur in developing countries. With the urban population in developing countries projected to

[*] Drs. Cook-Huynh and Ansong serve as co-first authors of this article.

Address correspondence to: Daniel Ansong, MBChB; College of Health Sciences, Medical School; Kwame Nkrumah University of Science & Technology; Private Mail Bag; Kumasi, Ghana; +233-3221-94995; +233-3220-60137(f); ansongd@gmail.com

It is important to possess baseline information on non-communicable diseases, such as hypertension and DM, that can be prevented by the application of specific informed public health interventions.

double between 2000 and 2030, an estimated 82 million individuals aged >64 years in developing countries and more than 48 million in developed will have diabetes.[18] The burden of diabetes in sub-Saharan Africa is not well established[19] and reported prevalence varies widely (Benin 3%; Mauritania 6%; Cameroon 6.1%; Congo 7.1%; Zimbabwe 10.2%; Democratic Republic of Congo 14.5%).[20] With increasing prevalence in Africa,[21,22] type 2 diabetes mellitus is the most common form of diabetes (90–95%).[23] Reliable data on the prevalence of diabetes in Ghana are largely unavailable. The only major study on the subject was carried out in 1998 and published in 2002, involving a random cluster sample of 4,733 Ghanaian study participants aged 25 years and older from two urban communities in the Accra metropolis and 20 small villages from one rural part of Accra. The crude prevalence of diabetes was 6.3% and the age-adjusted prevalence of diabetes, impaired fasting glycaemia (IFG) and impaired glucose tolerance (IGT) were 6.1% and 10.7%, respectively.[24]

The increasing adoption of Western lifestyles by people in developing countries has led to a sharp rise in the incidence of hypertension and DM.[25] While much research has been conducted into the cost of hypertension and DM in various global societies, there is still a paucity of information available using validated methods to estimate the true prevalence of these two diseases, particularly in rural Africa.[18] The rising incidence of non-communicable diseases in developing countries is of major concern because of increasing morbidity and mortality, and their impact on the socioeconomic development of individuals and societies.[26-28] In poor rural communities, where knowledge and practice of primary health care and basic disease prevention are often lacking,[29] it is important to possess baseline information on non-communicable diseases, such as hypertension and DM, that can be prevented by the application of specific informed public health interventions.

This study was therefore designed to determine and discuss the prevalence of hypertension and DM in the adult population living in the Adankwame community of Ghana as an extension of the Barekuma Community Collaborative Development Programme being hosted by the Komfo Anokye Teaching Hospital (KATH) in Kumasi, Ghana.

METHODS

Study subjects were adult members (aged >18 years) of the Adankwame community of Ghana, which is part of the Barekuma Community Collaborative Development Programme (BCC DP). Based on an unpublished census conducted by the Komfo Anokye Teaching Hospital (KATH) as part of the BCCDP in 2006–2007, the village has more than 400 households and more than 5,000 inhabitants. The village is about 12 km from Kumasi, the second largest city in Ghana.

Inclusion criteria included adult members of the Adankwame community older than aged 18 years who consented to participate in the study. Guided by the existing unpublished BCCDP 2006–2007 household data, a two-tier sampling approach was employed by randomly selecting households and then randomly selecting two consenting adults from each household to achieve the desired sample size. Location of each household had already been identified by global position system during the census programme of the BCCDP.

The team of fieldworkers consisted of students from Mayo Clinic College of Medicine, researchers from KATH, and community volunteers. Study procedures were approved and conducted in compliance with the KATH and School of Medical Sciences, Kwame Nkrumah University of Science and Technology joint Committee on Human Research Publication and ethics (CHRPE). Informed consent was completed either at the household level or at the field site. Fieldwork was conducted during four consecutive days from 08:00 to 12:00 at the community meeting place in the centre of the Adankwame community. At the site, four stations were set up, each with a medical student or researcher and a volunteer translator where needed. The clinicians were accessible to all subjects.

The subjects were seen in order of arrival. Initially their height, weight and abdominal circumference were measured and recorded. Once the subject was seated at a station, the following steps were completed: 1) first blood pressure measurement; 2) demographic information questionnaire; 3) second blood pressure measurement; 4) administration of risk factors questionnaire; 5) third blood pressure measurement; and 6) blood glucose measurement. All data were recorded on the Case Report Form (CRF), which included the following variables: demographic information (age, sex, occupation, religion, highest educational level, and number of dependents), anthropometric indices (weight, height, BMI, and abdominal girth), medical indices (systolic blood pressure [BP], diastolic BP, pulse rate, and random/fasting blood glucose), and risk factors (family history of either diabetes or hypertension, subject history of chronic kidney disease, current

pregnancy, oral contraceptive use, alcoholism, steroid/skin bleach use, drugs/medications use, and salt intake).

Blood pressure measurement was obtained using the Omron® HEM-711DLX blood pressure monitor with ComFit® Cuff. Blood pressure was measured from the subject's left brachial artery. The subject was seated for at least 10 minutes before the first measurement was taken. Each subject completed 10 fist pumps and the cuff sensor was placed over the brachial pulse at least one inch above the cubital fossa. Three blood pressure measurements were taken in total with at least three-minute time lapse between each measurement.

Screening for hypertension was based on the following National Heart, Lung and Blood Institute criteria. Blood pressure below 120/80 mm Hg was considered *normal*. Systolic pressure ranging from 120 to 139 mm Hg or a diastolic pressure ranging from 80 to 89 mm Hg was considered *pre-hypertension*. Systolic pressure ranging from 140 to 159 mm Hg or a diastolic pressure ranging from 90 to 99 mm Hg was considered *stage one hypertension*. Systolic pressure greater than or equal to 160 mm Hg or diastolic pressure greater than or equal to 100 mm Hg was considered *stage two hypertension*. All subjects who met the criteria for stage one or two hypertension were referred to onsite clinicians.

Subjects were requested to fast for 12 hours prior to arrival at the data collection site. Their compliance with this was checked at the site, where they were asked about the timing of their last meal and their blood glucose measurement was categorized as either fasting blood sugar (FBS) or random blood sugar (RBS) based on compliance.

Screening for DM was conducted using capillary blood glucose (CBG) measurement and ACCU-CHEK® strips that were analyzed by an ACCU-CHEK® Aviva commercial reflectance meter, which was standardized daily. Blood samples were obtained using individual retractable lancing devices. The first blood drop was discarded and the second drop was collected on the test strips and analyzed.

Screening for DM was based on the following World Health Organization (WHO) criteria: A fasting blood glucose level >110 mg/dL but <126 mg/dL was considered *pre-diabetic*. A fasting blood sugar level 126 mg/dL or above was considered *diabetic*. A random blood sugar level >140mg/dL but <200mg/dL was considered *pre-diabetic*. A random blood sugar level of ≥200mg/dL was considered *diabetic*. All subjects who met the criteria for being diabetic were referred to the onsite clinician. Transportation to the nearest health facility was made available for those who required immediate medical intervention.

Table 1. Anthropometric and medical indices (*N=326*)

Characteristics			
Anthropometric	**Mean**	**SD**	**Range**
Weight in kilograms	59	12.54	34–105
Waist circumference (cm)	81	8.96	64–100
Height (cm)	160	8.03	141–184
Body mass index (BMI)	22	4.28	15–38
Medical Indices	**Mean**	**SD**	**Range**
Systolic blood pressure (mmHg)	131	26.61	78–223
Diastolic blood pressure(mmHg)	78	15.24	50–151
Random blood sugar (mg/dL)	131	41.35	73–398
Fasting blood sugar (mg/dL)	108	35.33	65–413
Hypertension (*n*=326)[a]	***N***	**%**	
None	131	40.2	
Pre-hypertension	81	24.8	
Stage 1 hypertension	62	19.0	
Stage 2 hypertension	52	16.0	
Random blood glucose level predicting diabetes (*n*=101)	***N***	**%**	
Normal	69	68.3	
Pre-diabetes mellitus	29	28.7	
Diabetic	3	2.9	
Fasting blood glucose level predicting diabetes mellitus (*n*=226)	***N***	**%**	
Normal	204	90%	
Diabetic	22	9.7%	
Prevalence	**%**	**95% CI**	
Diabetes mellitus	8%	0.05–0.11	
Hypertension	35%	0.30–0.40	

[a] data on hypertension missing for one participant.

Data were collected and entered on a daily basis into an epi-info designed database. Basic summary description of the sample's socio-demographics, systolic BP, diastolic BP, random blood sugar levels as well as fasting blood sugar levels were provided as means and medians. Standard deviation, range and 95% confidence interval were used to describe the variability of the data. Multivariate analyses using student *t*-tests were conducted. Odds ratios were calculated and Chi-square analysis conducted where appropriate.

RESULTS

A total of 327 adults were examined in this study (94 male and 233 female).

Table 2. Risk factors and hypertension

Risk Factor		Hypertension present		OR (95% CI)	*P*
		No *n* (%)	Yes *n* (%)		
Family history	No	170(81)	90(78.9)	0.13 (0.61–2.06)	.665
	Yes	40(19)	24(21.1)		
Chronic kidney disease	No	210(100)	113(99.0)	Inf[a] (0.05- Inf)	.352
	Yes	0(0)	1(0.9)		
Pregnancy	No	134(95.0)	90(100)	0 (0–0.8)	.030
	Yes	7(5.0)	0(0)		
Oral contraceptive use	No	129(93.0)	87(94.4)	0.49 (0.11–1.70)	0.170
	Yes	12(7.0)	4(4.6)		
Alcoholism	No	199(93.9)	107(93.9)	1 (0.33–2.8)	.998
	Yes	13(6.1)	7(6.1)		
Steroid use/ bleaching	No	176(83)	94(82.5)	1.04 (0.54–1.97)	.898
	Yes	36(17)	20(17.5)		
Other medications used	No	167(78.8)	72(64.3)	2.04 (1.2–3.5)	.005
	Yes	45(21.2)	40 (35.7)		
Salt in-take	No	129(61.4)	80(70.2)	0.68 (0.4–1.13)	.116
	Yes	81(38.6)	34(28.9)		

[a] Inf=infinity.

The prevalence of hypertension (35%) found in this sample is greater than the estimated average prevalence found in these earlier studies in Ghana, as well as greater than the prevalence in countries such as Canada (22%), Egypt (23.6%) and China (13.6%).[4]

Participants were 18 to 94 years of age; mean age was 52 years with a standard deviation of 19.21 years. Body mass index (BMI) ranged from 15 to 38, with a mean of 22 and standard deviation of 4.28. Mean waist circumference was 81 cm (range 64–100 with standard deviation of 8.96) (Table 1).

Mean systolic blood pressure in the population ranged from 78 to 233 mm Hg with a mean of 131 mm Hg (SD 26.61). Mean diastolic blood pressure ranged from 50 to 151 mm Hg with a mean of 78 mm Hg (SD 15.24). Using the criteria outlined in our protocol, we found 114 hypertensive individuals, resulting in a prevalence of 0.35 (95% CI 0.30–0.40). Prevalence of pre-hypertension was approximately 0.248, stage 1 hypertension prevalence was 0.19, and prevalence of stage 2 hypertension was 0.16 (Table 1).

Fasting blood sugar in the study population ranged from 65 to 413 mg/dL with a mean of 108 mg/dL (SD 35.33). Of those individuals who had their fasting glucose level measured, 9.7% (n=22) met the criteria for DM. Random blood sugar levels in the study population ranged from 73 to 398 mg/dL with a mean of 131 mg/dL (SD 41.35). Of those individuals whose random glucose levels were checked, 28.7% (n=29) met the criteria for pre-diabetes mellitus, and 2.9% (n=3) met criteria for DM. The overall prevalence of DM in this sample population was found to be 0.08 (95% CI 0.05–0.11) (Table 1).

Other medication use was found to be a risk factor significantly associated with the presence of both hypertension and DM (not necessarily co-existing). Family history was also a significant risk factor associated with diabetes in this study population. (P<.05; Tables 2 and 3).

DISCUSSION

Our study found that both hypertension and DM were significantly prevalent, 35% and 7.7%, respectively, in the Adankwame community of Ghana. In various studies of adult populations in Ghana, the prevalence of hypertension (BP ≥140/90 mmHg) ranged from 25.4 to 29.4%[7,8,30,31] and that of DM was 6.3%.[24] Both our study and these cited studies are not nationally representative, and as yet, no nationwide study has been conducted to determine the prevalence of hypertension and DM in Ghana. However, because these chronic diseases require early diagnosis and consistent follow-up to control, they are important to recognize in any population.

The prevalence of hypertension (35%) found in this sample is greater than the estimated average prevalence found in these earlier studies in Ghana, as well as greater than the prevalence in countries such as Canada (22%), Egypt (23.6%) and China (13.6%).[4] Previous studies in Ghana have found high blood pressure to be associated with urban dwelling,[31,32] greater age[7,31,33] and greater BMI.[31,33] In one study conducted in rural communities surrounding the capital city of Accra, the prevalence of hypertension was 25.4%; hypertension was considered a rare disease in this area only 30 years ago.[30] In another study of civil servants who had adopted Western lifestyles in Accra, the prevalence of hypertension was 30.3%.[34] The higher prevalence rate of hypertension found in a rural population in this study suggests that hypertension may be a greater public health concern than previously considered in Ghana.

This study also found the prevalence of DM in the study population (7.7%) to be only slightly higher than the average prevalence of DM in previous

Table 3. Risk factors and diabetes mellitus

Risk Factor		Diabetes Mellitus present		OR (95% CI)	*P*
		No *n* (%)	Yes *n* (%)		
Family history	No	246(82.0)	15(60)	3.03 (1.15–7.65)	.015
	Yes	54(18.0)	10(40)		
Chronic kidney disease	No	299(99.7)	25(100)	0 (0–464.61)	1.0
	Yes	1(0.3)	0(0)		
Pregnancy	No	208(97.2)	17(94.4)	2.0 (0.04–18.06)	0.440
	Yes	6 (2.8)	1(5.6)		
Oral contraceptive use	No	199(93.0)	17(94.4)	0.78 (0.02–5.72)	0.600
	Yes	15(7.0)	1(5.6)		
Alcoholism	No	283(93.7)	24(96)	0.62 (0.01–4.27)	1.0
	Yes	19(6.3)	1(4)		
Steroid use/ bleaching	No	253(84.1)	17(68)	2.47 (0.87–6.46)	.053
	Yes	48(15.9)	8(32)		
Other medication use	No	225(75)	14(56)	2.35 (0.92–5.85)	.039
	Yes	75(25)	11(44)		
Salt in-take	No	189(63)	20(80)	0.43 (0.12–1.22)	.088
	Yes	111(37)	5(20)		

studies conducted in Ghana (6.3%).[24] However, this is greater than the estimated worldwide prevalence of DM (4%).[11]

While the percentage of the study participants that met the criteria for DM is similar to that found in an earlier study conducted in Ghana, an additional 8.9% of this study's population met the criteria for the diagnosis of pre-diabetes. The presence of this group in the study population indicates an important role for early detection and intervention at this stage of the disease. Through these measures, we may offer a way to decrease the prevalence of pre-diabetes, prevent progression to DM, and avoid the resulting negative medical and economic consequences in this population.

Many of the risk factors known to contribute to hypertension and DM were not found to be significantly correlated with blood pressure readings and glucose levels in our study population. The risk factors in this study's survey included family history, chronic kidney disease, pregnancy, oral contraceptive use, alcoholism, bleaching cream use, other medication use, and regular high salt intake. Further studies may be necessary to adequately identify these and other risk factors in our study population. We discovered that smoking is a low risk factor for hypertension and DM in this society, especially among women, because it is generally unpopular. This is markedly different from other populations, especially in Western countries where high smoking rates have been shown to significantly increase the risk of acquiring these diseases.[31,35,36]

There are a number of limitations to this study. Subjects were randomly selected using household number, sex, and age controls. Subjects were self-selected to participate by characteristics such as capability to travel to field site and availability. As such, not all selected subjects consented to, or were able to participate. In addition, the study population may have been more or less interested in checking their blood pressure and sugar status than others in the community due to a number of reasons including pre-existing health problems or concerns. This may have resulted in an over- or under-estimation of the prevalence of hypertension and DM. Furthermore, there was a female predominance in the subject population, most likely due to the fact that male members of the community were occupied with income-generating activities during the time of data collection. Some of the translators enlisted to aid in data collection and subject interactions lived in the study area. This may have resulted in subjects being less honest about the answers to personal questions about their health, home life, religion, and medication profiles. Finally some subjects were too large for the largest blood pressure cuff available at the data collection site, and this may have led to inconsistent blood pressure measurements and calculations.

CONCLUSION

In conclusions, there is a high prevalence of hypertension and the presence of DM (undiagnosed and/or uncontrolled) in Adankwame, a rural community in the Ashanti region of Ghana. Although this study is small, it adds significant information to the relatively scanty information available on hypertension and DM in Ghana and rural West Africa. While significant benefit would be derived from a national epidemiologic study on these two chronic diseases, this study supports the growing need for increased education on lifestyle changes (especially diet and exercise), as well as national health policy considerations for preventive tools against hypertension and diabetes in rural Africa.

ACKNOWLEDGMENTS

The authors thank the Mayo Clinic in Rochester, Minnesota for the donation of medical testing supplies and other materials. The authors also thank the Komfo Anokye Teaching Hospital's Research and Development Department for their assistance in data collection and analysis.

REFERENCES

1. Kearney PM, Whelton M, Reynolds K, Whelton PK, He J. Worldwide prevalence of hypertension: a systematic review. *J Hypertens*. 2004;22(1):11–19.
2. Gaziano TA, Bitton A, Anand S, Weinstein MC. The global cost of nonoptimal blood pressure. *J Hypertens*. 2009;27(7):1472–1477.
3. Kearney PM, Whelton M, Reynolds K, et al. Global burden of hypertension: analysis of worldwide data. *The Lancet*. 2005;365 (9455):217–223.
4. Sat Sharma, Claude Kortas. Hypertension: eMedicine Nephrology. http://emedicine.

medscape.com/article/241381-overview. Accessed January 6, 2010.
5. Mensah GA. Epidemiology of stroke and high blood pressure in Africa. *Heart*. 2008; 94(6):697–705.
6. Colbourne MJ, Edginton GM, Hughes MH, Ward-Brew A. A medical survey in a Gold Coast village. *Trans R Soc Trop Med Hyg*. 1950;44(3):271–290.
7. Amoah AGB. Hypertension in Ghana: a cross-sectional community prevalence study in greater Accra. *Ethn Dis*. 2003;13(3):310–315.
8. Cappuccio FP, Micah FB, Emmett L, et al. Prevalence, Detection, Management, and Control of Hypertension in Ashanti, West Africa. *Hypertension*. 2004;43(5):1017–1022.
9. Anon. *Greater Accra Regional Health Directorate: Annual Report 2007*. Accra, Ghana: Ghana Health Service; 2008.
10. Addo J, Smeeth L, Leon DA. Hypertension in Sub-Saharan Africa: a systematic review. *Hypertension*. 2007;50(6):1012–1018.
11. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995–2025: prevalence, numerical estimates, and projections. *Diabetes Care*. 1998;21(9):1414–1431.
12. King H, Rewers M. Global estimates for prevalence of diabetes mellitus and impaired glucose tolerance in adults. WHO Ad Hoc Diabetes Reporting Group. *Diabetes Care*. 1993;16(1):157–177.
13. Passa P. Diabetes trends in Europe. *Diabetes Metab Res Rev*. 2002;18(S3):S3–S8.
14. Skyler JS, Oddo C. Diabetes trends in the USA. *Diabetes Metab Res Rev*. 2002; 18(S3):S21–S26.
15. Votey SR. Diabetes Mellitus, Type 1 - A Review: eMedicine Emergency Medicine. 2009. http://emedicine.medscape.com/article/766036-overview. Accessed March 27, 2011.
16. Votey SR. Diabetes Mellitus, Type 2 - A Review: eMedicine Emergency Medicine. 2010. http://emedicine.medscape.com/article/766143-overview. Accessed March 27, 2011.
17. Boyle JP, Honeycutt AA, Narayan KMV, et al. Projection of diabetes burden through 2050. *Diabetes Care*. 2001;24(11):1936–1940.
18. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care*. 2004;27(5):1047–1053.
19. Beran D, Yudkin JS. Diabetes care in sub-Saharan Africa. *The Lancet*. 2006;368(9548): 1689–1695.
20. Mbanya JCN, Motala AA, Sobngwi E, Assah FK, Enoru ST. Diabetes in sub-Saharan Africa. *The Lancet*. 2010;375(9733):2254–2266.
21. Gill GV, Mbanya J-C, Ramaiya KL, Tesfaye S. A sub-Saharan African perspective of diabetes. *Diabetologia*. 2008;52(1):8–16.
22. Levitt NS. Diabetes in Africa: epidemiology, management and healthcare challenges. *Heart*. 2008;94(11):1376–1382.
23. Tuei VC, Maiyoh GK, Ha C-E. Type 2 diabetes mellitus and obesity in sub-Saharan Africa. *Diabetes Metab Res Rev*. 2010; 26(6):433–445.
24. Amoah AGB, Owusu SK, Adjei S. Diabetes in Ghana: a community based prevalence study in Greater Accra. *Diabetes Res Clin Pract*. 2002;56(3):197–205.
25. Nathan DM, Herman WH. Screening for diabetes: can we afford not to screen? *Ann Intern Med*. 2004;140(9):756–758.
26. Maher D, Smeeth L, Sekajugo J. Health transition in Africa: practical policy proposals for primary care. *Bull World Health Organ*. 2010;88(12):943–948.
27. Mufunda J, Chatora R, Ndambakuwa Y, et al. Emerging non-communicable disease epidemic in Africa: preventive measures from the WHO Regional Office for Africa. *Ethn Dis*. 2006;16(2):521–526.
28. Anon. *Non Communicable Diseases: An Overview of Africa's New Silent Killers* - OMS | Escritório Regional Africano. http://www.afro.who.int/pt/uganda/uganda-publicacoes/1236-non-communicable-diseases-an-overview-of-africas-new-silent-killers.html. Accessed March 27, 2011.
29. Mendis S, Lindholm LH, Mancia G, et al. World Health Organization (WHO) and International Society of Hypertension (ISH) risk prediction charts: assessment of cardiovascular risk for prevention and control of cardiovascular disease in low and middle-income countries. *J Hypertens*. 2007;25(8): 1578–1582.
30. Addo J, Amoah AGB, Koram KA. The changing patterns of hypertension in Ghana: a study of four rural communities in the Ga District. *Ethn Dis*. 2006;16(4):894–899.
31. Agyemang C. Rural and urban differences in blood pressure and hypertension in Ghana, West Africa. *Public Health*. 2006;120(6): 525–533.
32. Bosu W. Epidemic of hypertension in Ghana: a systematic review. *BMC Public Health*. 2010;10(1):418.
33. Agyemang C, Redekop W, Owusu-Dabo E, Bruijnzeels M. Blood pressure patterns in rural, semi-urban and urban children in the Ashanti region of Ghana, West Africa. *BMC Public Health*. 2005;5(1):114.
34. Addo J, Smeeth L, Leon DA. Prevalence, detection, management, and control of hypertension in Ghanaian civil servants. *Ethn Dis*. 2008;18(4):505–511.
35. Halperin RO, Michael Gaziano J, Sesso HD. Smoking and the Risk of Incident Hypertension in Middle-aged and Older Men. *Am J Hypertens*, 2008;21(2):148–152.
36. Wannamethee SG, Shaper AG, Perry IJ. Smoking as a modifiable risk factor for type 2 diabetes in middle-aged men. *Diabetes Care*. 2001;24(9):1590–1595.

AUTHOR CONTRIBUTIONS

Design and concept of study: Ansong, Boakye, Appiah, Amuasi

Acquisition of data: Cook-Huynh, Ansong, Steckelberg, Boakye, Seligman, Appiah, Kumar, Amuasi

Data analysis and interpretation: Cook-Huynh, Ansong, Steckelberg, Boakye, Seligman, Appiah, Kumar, Amuasi

Manuscript draft: Cook-Huynh, Ansong, Steckelberg, Boakye, Seligman, Appiah, Kumar, Amuasi

Statistical expertise: Ansong, Boakye, Appiah, Amuasi

Administrative: Cook-Huynh, Ansong, Steckelberg, Boakye, Seligman, Appiah, Kumar, Amuasi

Supervision: Ansong, Boakye, Appiah, Amuasi