High Rates of AIDS-Related Mortality Among Older Adults in Rural Kenya

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Background: Health challenges faced by older people in developing countries are often neglected amidst a wide range of competing priorities. This is evident in the HIV field where the upper age limit for reporting HIV prevalence remains 49 years. However, the long latency period for HIV infection, and the fact that older people continue to be sexually active, suggests that HIV and AIDS are likely to affect older people. To better understand this, we studied mortality due to AIDS in people aged 50 and older in an area of rural Kenya with high rates of HIV infection.

Methods: A community health worker–administered verbal autopsy system was introduced in Nyanza Province, encompassing 63,500 people. Algorithms were used to determine cause of death.

Results: A total of 1228 deaths were recorded during the study period; 368 deaths occurred in people aged 50 years and older. AIDS was the single most common cause of death, causing 27% of all deaths. AIDS continued to be the main cause of death up to age 70 years, causing 34% of deaths in people aged 50–59 years and 23% of deaths in people aged 60–69 years.

Conclusions: AIDS remains the principle cause of death among older people in Nyanza Province in western Kenya up until the age of 70 years. Greater efforts are needed to integrate older people into the HIV response and to better understand the specific vulnerabilities and challenges faced by this group.

Key Words: AIDS mortality, older adults, verbal autopsy

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INTRODUCTION

Beyond the immediate and acute impacts of HIV infection, it has been suggested that HIV represents a "long-wave event" whose full effects emerge gradually over a period of decades.[1] As HIV survival in sub-Saharan Africa increases with more individuals on antiretroviral therapy[2,3] and as populations age, the long-wave elements of the epidemic in Africa cannot be ignored. Despite this, the global HIV community has largely focused its attention on the 15–49 age bracket in surveillance and in prevention and treatment programming.

To date, very few studies on HIV have focused on people 50 and older, and these few studies have focused on developed countries.[4–10] With Joint United Nations Programme on HIV/AIDS and other prominent HIV data focusing on prevalence of those aged 15–49, the burden of disease among those older than 50 is often ignored and represents a significant blind spot in the response to the epidemic.

One component of understanding disease impact is through examining the patterns and determinants of mortality. However, in many developing countries, where high numbers of deaths take place outside of health facilities, vital events often go unregistered and unreported,[11] and the data that do exist are often of poor quality or derived from uncertain estimates.[12] Monitoring adult deaths, particularly among those older than 50 years, has received little attention despite the fact that the proportion of older people in developing countries is expected to rise dramatically over the coming decades.[13] A number of sources including Demographic and Health Surveys do not include mortality assessments among those aged 50 years or older and do not interview women older than 49 years of age.[14–16] Several other adult mortality studies also stop recording at either 49 or 59 years old.[17,18]

To contribute to a better understanding of HIV among older adults in Africa, this article examines patterns of mortality among older adults in rural western Kenya. We employed data from a novel real-time vital events and verbal autopsy (VA) monitoring platform to track numbers of deaths and their causes, with an emphasis on HIV and AIDS, and note the implications for more effective prevention, care, and support services.

SETTINGS AND METHODS

The project was conducted in a cluster of villages in rural Nyanza Province, Kenya—the site of a multisectoral health and development initiative launched in 2004. The Millennium Villages Project (MVP) aims to accelerate progress toward the Millennium Development Goals in rural Africa through the coordinated delivery of science-based interventions at the village scale in agriculture, health, education, and infrastructure.[19–21] The project operates in 14 sites in 10 sub-Saharan African countries with project sites drawn from a diversity of agro-ecological zones in "hunger hot-spots," where rates of child undernutrition exceed 20%.

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The villages in the Nyanza Province site encompass 63,500 people of whom 90% lived on less than $2 a day at project commencement in 2004. A baseline survey in 2004 revealed children younger than 5 mortality rate of 149 per 1000 live births and infant mortality rate of 95 per 1000 live births.[21] The area is holoendemic for malaria, and 63% of children younger than 5 tested positive for malaria. The majority of residents are engaged in subsistence agriculture and animal husbandry. Ethical approval for the MVP was provided by both Columbia University and Kenya Medical Research Institute ethics boards.

As of 2008, 12.1% of the study population were aged 50 years or older and 6.6% were 60 years or older.

In the MVP project site, mortality information was routinely collected through a community health worker (CHW)–administered vital events and VA system. VAs have evolved over the past several decades as tools to supplement deficiencies in vital information.[22–24] Operating at the juncture of demography and public health, VAs are structured interviews administered by nonhealth workers to the care givers of the deceased. They pose standardized questions about the main symptoms and signs experienced by the deceased in the time leading up to death and the circumstances preceding death. The information obtained from these field interviews are used to make a determination of the probable cause of death.[22] Numerous studies have documented the reliability of the VA technique and its validity (when compared with medical records), with reasonable sensitivity and specificity for selected causes of death among adults and children in Africa and Asia.[25–31]

The VA administered for this project included the following components:

1. CHW administration: CHWs have been introduced to maximize the delivery of health information and services to households in the project site. There are currently 83 CHWs in the project site—a ratio of 1 CHW to every 130–180 households, with household visits taking place every 1–2 months. Part of the portfolio of these CHWs is the tracking of vital events.
2. Verbal autopsy specialist: The VA specialist is a community health worker specially trained in the VA methodology. When a death is recorded, a VA is triggered immediately. In practice, VAs are conducted within 2–4 weeks after a death has taken place.
3. VA tools: A standardized VA tool has been developed with separate forms for adult/maternal deaths and for children. The cause of death form has been derived from previously validated VA tools that are tailored to assess signs and symptoms experienced by the deceased in the time preceding death.
4. Algorithmic assessment of cause of death diagnosis: To facilitate a rapid turn-around time for generating critical information for targeting interventions, "expert algorithms" have been employed. These are established valid techniques for determining the probable cause of death,[32–34] which have been expanded to facilitate an assessment of the social circumstances leading up to death. This innovation eliminates the need for standard dual physician-based assessments, which can be both expensive and create a long-time delay in generating "real-time" information for program managers that can contribute to operational adaptations to rapidly improve service delivery.

Mortality data were routinely collected as part of programatic interventions for the period January 2008 through May 2009 and were anonymized before analysis. Analysis was conducted in SPSS (SPSS Inc, Chicago, IL.) and Excel (Microsoft, Seattle, WA). The age and sex distribution of the population in the survey area was estimated from detailed population demographic information that was previously collected through a household survey of a subsample of the population. This methodology has been presented in detail elsewhere.[21] Deaths were categorized according to Global Burden of Disease designations with anemia and "old age" categories being added.[35]

RESULTS

Information on a total of 1228 deaths from January 2008 to May 2009 was collected. The annualized mortality rate was 13.65 per 1000. Males accounted for 56.2% of all deaths, with mortality rates of 15.44 per 1000 per year for males and 11.87 per 1000 per year for females. Figure 1 shows number of deaths and mortality rates per year by 5-year age band.

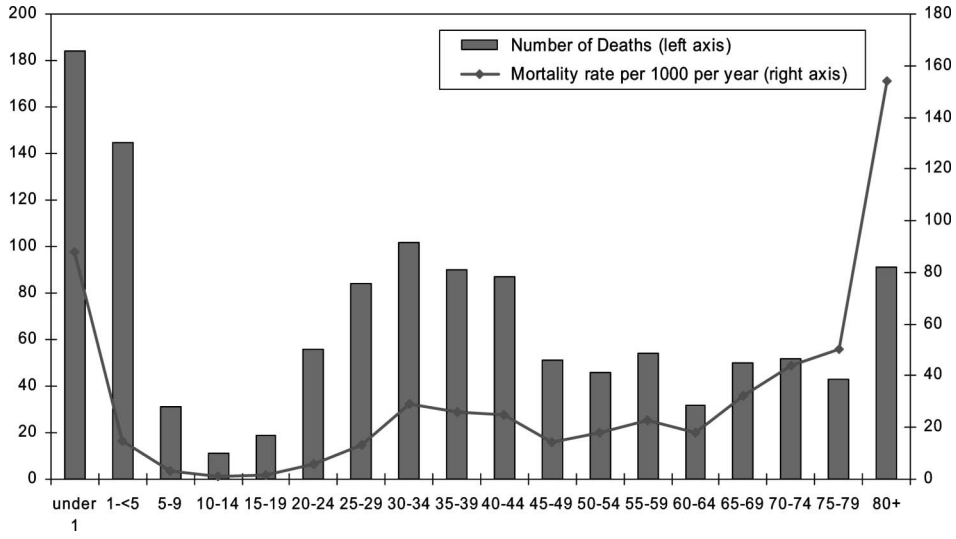

FIGURE 1. Number of deaths and mortality rate per 1000 per year by 5-year age groups.

Overall, communicable, maternal, perinatal, and nutritional conditions plus anemia accounted for 71.9% of deaths, with noncommunicable diseases accounting for 16.4% and injuries 7.8%. The 5 leading causes of death—AIDS, malaria, respiratory infections, diarrheal diseases, and cardiovascular diseases—accounted for two-thirds of total deaths (Table 1).

For 1.7% of deaths, no specific cause of death could be attributed, and these cases were classified as "other." The deaths attributed to old age were those for which no specific underlying cause of death could reliably be assigned based on the verbal autopsy tool. The average age of those whose death was characterized as old age was 85.7 years.

AIDS accounted for 39.2% of deaths among men aged 15–49 and 50.0% of deaths among women in the same age group. Together, intentional and unintentional injuries accounted for 15.8% of deaths among men aged 15–49.

Among people aged 50 and older, there were 368 deaths. AIDS was the most frequent cause of death, causing 18.3% of male deaths and 15.8% of female deaths (Table 2). Other communicable diseases such as respiratory infections and malaria were also common causes of death, whereas noncommunicable disease mortality rates were, as expected, higher than in those aged younger than 50. Analysis of mortality in 5-year age bands showed that AIDS remained the main cause of death among those aged in their 50s and 60s, with noncommunicable diseases such as cardiovascular disease and diabetes only overtaking AIDS as the major cause of death past the age of 70 years (Fig. 2).

TABLE 1. Total Deaths and Percentage by Cause and by Sex

Cause of Death	Male Deaths	Female Deaths	Total Deaths
HIV/AIDS	179 (25.9%)	154 (28.6%)	333 (27.1%)
Malaria	110 (15.9%)	67 (12.5%)	177 (14.4%)
Respiratory infections	67 (9.7%)	54 (10.0%)	121 (9.9%)
Diarrheal diseases	49 (7.1%)	39 (7.2%)	88 (7.2%)
Cardiovascular diseases	28 (4.1%)	24 (4.5%)	52 (4.2%)
Intentional injuries	40 (5.8%)	11 (2.0%)	51 (4.2%)
Malignant neoplasms	19 (2.8%)	28 (5.2%)	47 (3.8%)
Tuberculosis	30 (4.3%)	17 (3.2%)	47 (3.8%)
Unintentional injuries	28 (4.1%)	17 (3.2%)	45 (3.7%)
Perinatal conditions	14 (2.0%)	14 (2.6%)	28 (2.3%)
Diabetes mellitus	18 (2.6%)	9 (1.7%)	27 (2.2%)
Digestive diseases	17 (2.5%)	10 (1.9%)	27 (2.2%)
Old age	9 (1.3%)	17 (3.2%)	26 (2.1%)
Respiratory diseases	11 (1.6%)	13 (2.4%)	24 (2.0%)
Meningitis	15 (2.2%)	6 (1.1%)	21 (1.7%)
Other	10 (1.4%)	11 (2.0%)	21 (1.7%)
Infectious diseases other	8 (1.2%)	12 (2.2%)	20 (1.6%)
Anemia	10 (1.4%)	9 (1.7%)	19 (1.5%)
Genitourinary diseases	14 (2.0%)	3 (0.6%)	17 (1.4%)
Nutritional deficiencies	6 (0.9%)	7 (1.3%)	13 (1.1%)
Maternal conditions	0 (0.0%)	10 (1.9%)	10 (0.8%)
Childhood cluster diseases	2 (0.3%)	4 (0.7%)	6 (0.5%)
Neuropsychiatric conditions	5 (0.7%)	0 (0.0%)	5 (0.4%)
Congenital anomalies	1 (0.1%)	1 (0.2%)	2 (0.2%)
Endocrine disorders	0 (0.0%)	1 (0.2%)	1 (0.1%)
Total	690	538	1228

TABLE 2. Total Deaths and Percentage by Cause and by Sex Among Those 50 and Older

Cause of Death	Male Deaths	Female Deaths	Total Deaths
HIV/AIDS	36 (18.3%)	27 (15.8%)	63 (17.1%)
Respiratory infections	27 (13.7%)	17 (9.9%)	44 (12.0%)
Cardiovascular diseases	23 (11.7%)	20 (11.7%)	43 (11.7%)
Malignant neoplasms	12 (6.1%)	22 (12.9%)	34 (9.2%)
Malaria	19 (9.6%)	10 (5.8%)	29 (7.9%)
Old age	9 (4.6%)	17 (9.9%)	26 (7.1%)
Diabetes mellitus	16 (8.1%)	6 (3.5%)	22 (6.0%)
Diarrheal diseases	7 (3.6%)	14 (8.2%)	21 (5.7%)
Digestive diseases	5 (2.5%)	7 (4.1%)	12 (3.3%)
Genitourinary diseases	9 (4.6%)	2 (1.2%)	11 (3.0%)
Tuberculosis	7 (3.6%)	4 (2.3%)	11 (3.0%)
Unintentional injuries	6 (3.0%)	5 (2.9%)	11 (3.0%)
Infectious diseases other	6 (3.0%)	4 (2.3%)	10 (2.7%)
Intentional injuries	4 (2.0%)	4 (2.3%)	8 (2.2%)
Respiratory diseases	3 (1.5%)	5 (2.9%)	8 (2.2%)
Other	8 (4.1%)	7 (4.1%)	15 (4.1%)
Total	197	171	368

DISCUSSION

This study employed a vital events and verbal autopsy system to examine patterns of mortality in rural western Kenya, with a particular focus on older adults. Communicable diseases were the most frequent cause of death with AIDS, malaria, respiratory infections, and diarrheal diseases causing the largest number of deaths. Among those aged 50 and older, AIDS remained the most significant cause of death up to the age of 70. It was only among those aged older than 70 that noncommunicable diseases surpassed AIDS as the most common cause of death.

Total annual mortality rates in this study were slightly lower than that seen across demographic surveillance systems sites in Tanzania, Ethiopia, Ghana, Burkina Faso, and Mozambique.[36] In a study conducted in another area in Western Kenya in 2003, rates of cardiovascular disease, diarrheal disease, and respiratory infections rates were relatively similar to the rates found in our study, but rates of AIDS and tuberculosis mortality were higher and number of deaths through injuries was lower.[37] Other studies have confirmed high rates of malaria mortality among older adults even in highly endemic areas where acquired immunity has been assumed.[38–40]

The high level of mortality found in this study suggests that AIDS is a very important cause of death among people older than 50 in rural Kenya. The HIV epidemic in Kenya is generalized and mature. Women are generally infected younger than men[41] perhaps contributing to the higher rates of AIDS-related mortality among males older than 50 given the median 10-year period between infection and death.[42] Recent studies in Kenya have estimated that, nationally, 5% of those infected with HIV are aged 50 years and older and that HIV prevalence is 7.8% among 50-year to 54-year olds, 3.6% among 55–59, and 2.7% among 60-year to 64-year olds.[43] A home-based voluntary counseling and testing program in the project site revealed HIV prevalence of 6.8% among those

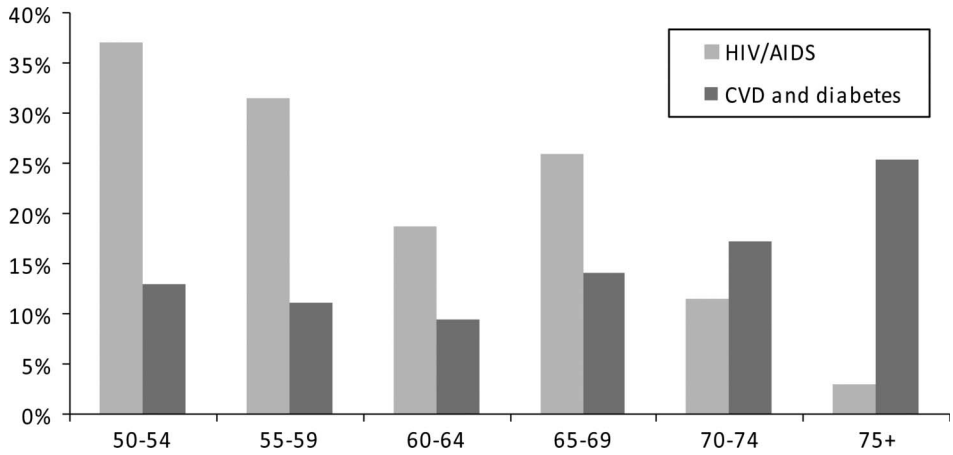

FIGURE 2. HIV/AIDS and major noncommunicable disease as percentage of total deaths by age.

aged 50 and older (8.5% in males, 5.8% in females).[44] Prevalence among 50-year to 59-year olds was 10.0% (11.1% in males, 9.5% in females) and for those 60 and older, it was 4.8% (7.2% in males, 3.1% in females).

In one of the few sub-Saharan African studies to look carefully at causes of death in people 50 years and older, Adjuik et al[38] found that, in Southern Africa, the AIDS mortality rate was higher in 45-year to 59-year olds than among 15-year to 44-year olds. Zaba et al,[45] using cohort study data from 6 African sites, also show that mortality of HIV-infected persons increases steadily with age though their data stops at age 55 for some sites and 65 for others. This suggests that the results of this study are generalizable to locations beyond rural Kenya that share similar HIV prevalence rates.

Most studies on HIV and older adults in developing countries focus on the impact of HIV on economic and social roles—and in particular on the role of grandparents in caring for HIV orphans—with little regard to the prevalence of HIV in older people or the direct impact of HIV infection on their health.[9,46,47] Misconceptions remain common regarding older people and HIV. The authors of a study in Nigeria assert that "older people are no longer sexually active, and it is believed that HIV/AIDS is not a major problem in that segment of the population."[48] This low sense of risk can potentially lead to older people not being tested as part of routine testing and low uptake of HIV counseling, testing, and other services. Kyobutungi et al[10] lament the lack of HIV programs targeting older people in sub-Saharan Africa.

Reasons have been posited for the high rates of AIDS mortality among older people. The Collaborative Group on AIDS Incubation and HIV Survival has noted that the older the individual, the faster the progression from HIV infection to AIDS with life expectancy of only 4 years for those infected at age 65 or older.[49] The high levels of HIV prevalence among older people might be related to remarriage after widowhood or divorce and the risk of forming HIV discordant partnerships.[50] In general, however, the sexual activity of older individuals in the developing world is barely researched.[9]

Older populations also experience high rates of mortality due to noncommunicable diseases such as cardiovascular disease and diabetes. As has been reported elsewhere, such diseases are common even in rural areas of developing countries.[51,52] However, the mortality rates from cardiovascular disease and diabetes in rural Kenya appear to be much lower than in rural India.[53]

CHW-administered VAs could potentially overlook a proportion of deaths, thus underrepresenting mortality. To assess this systematically, a 3-month retrospective review of all households was conducted. It revealed only one missing death during the assessment period suggesting information on the vast majority of deaths in the cluster are routinely captured using the CHW-based approach.

Over the past several decades, VAs have been increasingly accepted as a tool to assess mortality, and have undergone substantial methodological refinement. Although VAs have been validated in numerous studies,[25–31] limitations include recall bias, alongside errors in classification, and verification.[54,55] Additionally, many deaths are multifactorial with significant overlap between causes of death such as AIDS and tuberculosis. Multiple studies have, however, demonstrated a high correlation between VA cause of death and HIV status[56,57] though the validity of VA in identifying child HIV deaths[58] and older adult HIV death[59] has been questioned. Another potential limitation is that, in rural populations in resource-poor countries, age reporting may be inaccurate especially among older age groups.[18]

IMPLICATIONS

With HIV and noncommunicable diseases together contributing to more than half of the deaths among older people in western Kenya, greater efforts are needed to address premature deaths arising from these conditions. Although responses have traditionally been implemented separately, there is increasing realization that there are significant synergies available. In particular, the shared "chronicity" of therapies for HIV, diabetes, and cardiovascular disease suggest that a unified response might be appropriate.[60] HIV, cardiovascular disease, and diabetes are largely asymptomatic and require long-term treatments to prolong life, and therefore require similar systems of protocol-based decentralized delivery, with well-coordinated care and support to optimize adherence. Furthermore, the

diseases themselves are biologically linked, as antiretroviral therapy has been associated with increased risk of diabetes[61,62] and heart disease.[63,64]

The HIV treatment systems that have been developed in many African countries—adherence support, ongoing treatment delivery mechanisms, drug procurement procedures—could be leveraged to deliver noncommunicable disease programs. Already systems that had been developed for other diseases are shifting to respond to noncommunicable diseases; in Cambodia, for example, those trained to provide leprosy care are being retrained to support diabetes patients with foot care (Sally Duke, MBBS, MIPH, personal communication, August 2009).

The high rate of AIDS mortality among older adults highlights the need for targeted prevention and treatment efforts and research to develop a better understanding of the specific vulnerabilities facing this age group. As more individuals with HIV survive and as population aging continues, the challenge of HIV and older adults will only become more pressing.

REFERENCES

1. Barnett T. A long-wave event: HIV/AIDS, politics, governance and 'security': sundering the intergenerational bond? *Int Aff*. 2006;82:297–313.
2. Mermin J, Were W, Ekwaru JP, et al. Mortality in HIV-infected Ugandan adults receiving antiretroviral treatment and survival of their HIV-uninfected children: a prospective cohort study. *Lancet*. 2008;371:752–759.
3. Stover J, Fidzani B, Molomo BC, et al. Estimated HIV trends and program effects in Botswana. *PLoS ONE*. 2008;3:e3729.
4. Nguyen N, Holodniy M. HIV infection in the elderly. *Clin Interv Aging*. 2008;3:453–472.
5. Bhavan KP, Kampalath VN, Overton ET. The aging of the HIV epidemic. *Curr HIV/AIDS Rep*. 2008;5:150–158.
6. Navarro G, Nogueras MM, Segura F, et al. HIV-1 infected patients older than 50 years. PISCIS cohort study. *J Infect*. 2008;57:64–71.
7. Elford J, Ibrahim F, Bukutu C, et al. Over fifty and living with HIV in London. *Sex Transm Infect*. 2008;84:468–472.
8. Bodley-Tickell AT, Olowokure B, Bhaduri S, et al. Trends in sexually transmitted infections (other than HIV) in older people: analysis of data from an enhanced surveillance system. *Sex Transm Infect*. 2008;84:312–317.
9. Schmid GP, Williams BG, Garcia-Calleja JM, et al. The unexplored story of HIV and ageing. *Bull World Health Organ*. 2009;87:162–162A.
10. Kyobutungi C, Ezeh AC, Zulu E, et al. HIV/AIDS and the health of older people in the slums of Nairobi, Kenya: results from a cross sectional survey. *BMC Public Health*. 2009;9:153.
11. Setel PW, Macfarlane S, Szreter S, et al. A scandal of invisibility: making everyone count by counting everyone. *Lancet*. 2007;370:1569–1577.
12. Mathers CD, Fat DM, Inoue M, et al. Counting the dead and what they died from: an assessment of the global status of cause of death data. *Bull World Health Organ*. 2005;83:171–177.
13. United Nations Department of Economic and Social Affairs. *World Population Ageing 2007*. New York, NY: United Nations; 2007.
14. Central Bureau of Statistics (CBS) [Kenya], Ministry of Health (MOH) [Kenya], and ORC Macro. *Kenya Demographic and Health Survey 2003*. Calverton, MD: CBS, MOH, and ORC Macro; 2004.
15. Institut National de la Statistique (INS) et Ministère de la Lutte contre le Sida [Côte d'Ivoire] et ORC Macro. *Enquête sur les Indicateurs du Sida, Côte d'Ivoire 2005*. Calverton, MD: INS et ORC Macro; 2006.
16. Central Statistical Agency [Ethiopia] and ORC Macro. *Ethiopia Demographic and Health Survey 2005*. Addis Ababa, Ethiopia and Calverton, MD: Central Statistical Agency and ORC Macro; 2006.
17. Boerma JT, Ngalula J, Isingo R, et al. Levels and causes of adult mortality in rural Tanzania with special reference to HIV/AIDS. *Health Transit Rev*. 1997;7:63–74.
18. Setel PW, Unwin N, Alberti KGMM, et al. Cause-specific adult mortality: evidence from community-based surveillance – selected sites, Tanzania 1992–1998. *MMWR*. 2000;49:416–419.
19. Earth Institute. *Annual Report, Sauri Millennium Research Village: July 2004 to June 2005*. New York, NY: Earth Institute at Columbia University; 2005.
20. Sanchez P, Palm C, Sachs JD, et al. The African Millennium Villages. *Proc Natl Acad Sci U S A*. 2007;104:16775–16780.
21. Mutuo P, Palm C, Konecky B, et al. *Baseline Report Sauri, Millennium Research Village*. New York, NY: Earth Institute, Columbia University; 2006.
22. Garenne M, Fontaine O. Assessing probable causes of death using a standardized questionnaire: a study in rural Senegal. In: Vallin J, D'Souza S, Palloni A, eds. *Measurement and Analysis of Mortality*. Clarendon Press: Oxford, United Kingdom; 1990.
23. Faveau V. The study of causes of death in developing countries. In: Wunsch G, Caselli G, Vallin J, eds. *Demography: Analysis and Synthesis*. Vol 2. New York, NY: Elsevier; 2005.
24. Biraud Y. *Methodes pour l'enregistrement par des non medecines des causes elementaires de deces dans les zones sous-developpees*. Geneva, Switzerland: World Health Organization; 1956.
25. Soleman N, Chandramohan D, Shibuya K. Verbal autopsy: current practices and challenges. *Bull World Health Organ*. 2006;84:239–245.
26. Bhandari N, Bahl R, Taneja S, et al. Pathways to infant mortality in urban slums of Delhi, India: implications for improving the quality of community- and hospital-based programmes. *J Health Popul Nutr*. 2002;20:148–155.
27. Kahn L, Tollman SM, Garenne M, et al. Validation and application of verbal autopsies in a rural area of South Africa. *Trop Med Int Health*. 2000;5:824–831.
28. Setel PW, Whiting DR, Hemed Y, et al. Validity of verbal autopsy procedures for determining cause of death in Tanzania. *Trop Med Int Health*. 2006;11:681–696.
29. Kumar R, Thakur JS, Rao BT, et al. Validity of verbal autopsy in determining causes of adult deaths. *Indian J Public Health*. 2006;50:90–94.
30. Yang G, Rao C, Ma J, et al. Validation of verbal autopsy procedures for adult deaths in China. *Int J Epidemiol*. 2006;35:741–748.
31. Marsh DR, Sadruddin S, Fikree FF, et al. Validation of verbal autopsy to determine the cause of 137 neonatal deaths in Karachi, Pakistan. *Paediatr Perinat Epidemiol*. 2003;17:132–142.
32. Lulu K, Berhane Y. The use of simplified verbal autopsy in identifying causes of adult death in a predominantly rural population in Ethiopia. *BMC Public Health*. 2005;5:58.
33. Quigley MA, Chandramohan D, Rodrigues L. Diagnostic accuracy of physician review, expert algorithms and data derived algorithms in adult verbal autopsies. *Int J Epidemiol*. 1999;28:1081–1087.
34. Murray CJL, Lopez AD, Feehan DM, et al. Validation of the symptom pattern method for analyzing verbal autopsy data. *PLoS Med*. 2007;4:e327.
35. World Health Organization. *The Global Burden of Disease: 2004 Update*. Geneva, Switzerland: World Health Organization; 2008.
36. INDEPTH Network. *Population and Health in Developing Countries: Population, Health, and Survival at INDEPTH Sites*. Ottawa, Canada: International Development Research Centre; 2002.
37. Van Eijk AM, Adazu K, Ofware P, et al. Causes of deaths using verbal autopsy among adolescents and adults in rural western Kenya. *Trop Med Int Health*. 2008;13:1314–1324.
38. Adjuik M, Smith T, Clark S, et al. Cause-specific mortality rates in sub-Saharan Africa and Bangladesh. *Bull World Health Organ*. 2006;84:181–188.
39. Eholie SP, Ehui E, Adou-Bryn K, et al. Paludisme grave de l'adulte autochtone à Abidjan (Côte d'Ivoire). *Bulletin de la Société de pathologie*. 2004;97:340–344.
40. Becher H, Kynast-Wolf G, Sié A, et al. Patterns of malaria: cause-specific and all-cause mortality in a malaria-endemic area of west Africa. *Am J Trop Med Hyg*. 2008;78:106–113.
41. National AIDS and STD Control Program. *AIDS in Kenya*. 7th ed. Nairobi, Kenya: NASCOP; 2005.
42. Morgan D, Mahe C, Mavanja B, et al. HIV-1 infection in rural Africa: is there a difference in median time to AIDS and survival compared with that in industrialized countries? *AIDS*. 2002;16:597–603.
43. National AIDS and STD Control Program. *Kenya AIDS Indicator Survey 2007 Final Report*. Nairobi, Kenya: Ministry of Health; 2009.
44. Negin J, Wariero J, Jan S, et al. The feasibility, acceptability and cost of home-based HIV testing in rural Kenya. *Trop Med Int Health*. 2009;14:849–855.

45. Zaba B, Marston M, Crampin AC, et al. Age-specific mortality patterns in HIV-infected individuals: a comparative analysis of African community study data. *AIDS*. 2007;21(Suppl 6):S87–S96.
46. Schatz E, Ogunmefun C. Caring and contributing: the role of older women in rural South African multi-generational households in the HIV/AIDS Era. *World Dev.* 2007;35:1390–1403.
47. Williams N, Knodel J, Kiry Kim S, et al. Overlooked potential: older-age parents in the era of ART. *AIDS Care*. 2008;20:1169–1176.
48. Akanji BO, Ogunniyi A, Baiyewu O. Healthcare for older persons, a country profile: Nigeria. *J Am Geriatr Soc*. 2002;50:1289–1292.
49. Collaborative Group on AIDS Incubation and HIV Survival. Time from HIV-1 seroconversion to AIDS and death before widespread use of highly-active anti-retroviral therapy. A collaborative analysis. *Lancet*. 2000;355: 1131–1137.
50. Bärnighausen T, Biraro S, Bwanika JB, et al. Diverse age patterns of HIV incidence rates in Africa. Presented at: XVII International AIDS Conference; August 5, 2008; Mexico City, Mexico.
51. Gill GV, Mbanya JC, Ramaiya KL, et al. A sub-Saharan African perspective of diabetes. *Diabetologia*. 2009;52:8–16.
52. Leeder S, Raymond S, Greenberg H, et al. *A Race Against Time: The Challenge of Cardiovascular Disease in Developing Economies*. New York, NY: The Center for Global Health and Economic Development, Columbia University; 2004.
53. Joshi R, Cardona M, Iyengar S, et al. Chronic diseases now a leading cause of death in rural India—mortality data from the Andhra Pradesh Rural Health Initiative. *Int J Epidemiol*. 2006;35:1522–1529.
54. Chandramohan D, Maude GH, Rodrigues LC, et al. Verbal autopsies for adult deaths: issues in their development and validation. *Int J Epidemiol*. 1994;23:213–222.
55. Anker M. The effect of misclassification error on reported cause-specific mortality fractions from verbal autopsy. *Int J Epidemiol*. 1997;26: 1090–1096.
56. Kamali A, Wagner HU, Nakiyingi J, et al. Verbal autopsy as a tool for diagnosing HIV-related adult deaths in rural Uganda. *Int J Epidemiol*. 1996;25:679–684.
57. Doctor HV, Weinreb AA. Estimation of AIDS in adult mortality by verbal autopsy in rural Malawi. *AIDS*. 2003;17:2509–2513.
58. Dowell SF, Davis HL, Holt EA, et al. The utility of verbal autopsies for identifying HIV-1-related deaths in Haitian children. *AIDS*. 1993;7: 1255–1259.
59. Lopman B, Cook A, Smith J, et al. Verbal autopsy can consistently measure AIDS mortality: a validation study in Tanzania and Zimbabwe. *J Epidemiol Community Health*. 2010;64:330–334.
60. Bischoff A, Ekoe T, Perone N, et al. Chronic disease management in sub-Saharan Africa: whose business is it? *Int J Environ Res Public Health*. 2009;6:2258–2270.
61. Brown TT, Cole SR, Li X, et al. Antiretroviral therapy and the prevalence and incidence of diabetes mellitus in the Multicenter AIDS Cohort Study. *Arch Intern Med*. 2005;165:1179–1184.
62. Wand H, Calmy A, Carey DL, et al. Metabolic syndrome, cardiovascular disease and type 2 diabetes mellitus after initiation of antiretroviral therapy in HIV infection. *AIDS*. 2007;21:2445–2453.
63. Friis-Møller N, Weber R, Reiss P, et al. Cardiovascular disease risk factors in HIV patients—association with antiretroviral therapy. Results from the DAD study. *AIDS*. 2003;17:1179–1193.
64. Vittecoq D, Escaut L, Chironi G, et al. Coronary heart disease in HIV-infected patients in the highly active antiretroviral treatment era. *AIDS*. 2003;17:S70–S76.