

# Electrocardiographic Assessment of Coronary Artery Disease and Stroke Risk Factors in Rural and Urban Tanzania: A Case-control Study

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*Background:* Although the association between cerebrovascular and coronary artery disease (CAD) is well known in high-income countries, this association is not well documented in black Africans. *Aims:* The aim of this study was to document electrocardiographic (ECG) evidence of CAD in stroke cases and controls and to identify other common ECG abnormalities related to known stroke risk factors in a community-based population of incident stroke cases in Tanzania, East Africa. *Methods:* This was a case-control study. Incident stroke cases were identified by the Tanzanian Stroke Incidence Project. Age- and sex-matched controls were randomly selected from the background population. Electrocardiograms were manually analyzed using the Minnesota Coding System, looking for evidence of previous myocardial infarction (MI), atrial fibrillation (AF) or atrial flutter (AFI), and left ventricular hypertrophy (LVH). *Results:* In Hai, there were 93 cases and 241 controls with codable electrocardiograms, and in Dar-es-Salaam, there were 39 cases and 72 controls with codable electrocardiograms. Comparing cases and controls, there was a higher prevalence of MI and AF or AFI (but not LVH) in cases compared with controls. *Conclusions:* This is the first published study of ECG assessment of CAD and other stroke risk factors in an incident population of stroke cases in sub-Saharan Africa. It suggests that concomitant CAD in black African stroke cases is more common than previously suggested. **Key Words:** Electrocardiography—stroke—Tanzania—coronary artery disease—sub-Saharan Africa.

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## Introduction

Coronary artery disease (CAD) is commonly found in conjunction with cerebrovascular disease in high-income countries.<sup>1</sup> A person may be asymptomatic of their CAD

but several studies have shown a relationship between computed tomography evidence of cerebrovascular disease and abnormal myocardial perfusion defects indicative of CAD.<sup>1-3</sup> However, the association between CAD

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and cerebrovascular disease is more tenuous in the black population in sub-Saharan Africa (SSA), with the frequency of myocardial infarction (MI) in the general black population in South Africa less than 1/10th that in whites,<sup>4</sup> and a similarly low prevalence of CAD recorded in black African stroke cases.<sup>5</sup>

The INTERSTROKE study of stroke risk factors across 22 countries worldwide reported that hypertension and cardiac causes (such as ischemic heart disease [IHD], atrial fibrillation [AF] and atrial flutter [AFL]) were the 2 strongest independent predictors of stroke risk.<sup>6</sup> However, few of those countries studied were from SSA. The aim of this study was to use electrocardiographic (ECG) findings to evaluate the prevalence of CAD and arrhythmias in an urban and a rural population of incident black stroke cases in Tanzania.

## Participants and Methods

Favorable ethical opinions were obtained from the National Institute of Medical Research in Tanzania and from the Newcastle and Northumberland Joint Ethics Committee, UK.

### *Setting and Recruitment*

#### **Cases**

The study described here was part of the Tanzanian Stroke Incidence Project (TSIP).<sup>7</sup> The study prospectively identified people who had survived the initial stroke event and aimed to assess them as soon after stroke onset as possible. Details of the study have been published and they are described briefly here.<sup>7</sup> Cases were recruited from June 15, 2003, until June 15, 2006, in 2 demographic surveillance sites (DSSs): 52 villages in the Hai district of northern Tanzania and 8 geographical divisions of the city of Dar-es-Salaam. Both the urban and rural site chosen for the study were set up in the 1990s as DSSs for use in the Adult Morbidity and Mortality Project (AMMP), the key results of which have been published.<sup>8</sup> The Hai district, in northern Tanzania, is a rural area, with an economy based on cash crops, mainly coffee. Dar-es-Salaam is Tanzania's largest city and its commercial capital; the DSS within Dar-es-Salaam was selected to cover a range of socioeconomic conditions. The DSS in Hai had a population of 159,814 and the DSS in Dar-es-Salaam a population of 56,517, at the midpoint of the study, on December 15, 2004.<sup>7</sup> Both sites have previously been described as part of the AMMP.<sup>8</sup>

#### **Controls**

Controls were recruited from the background census population of the DSSs in Hai and Dar-es-Salaam. They were identified from the census list, and were frequency matched to cases for age ( $\pm 3$  years) and sex. A list of possible controls was produced using a random number gen-

erator. The controls were randomly assigned a preference and visited in order. If a control was unavailable or refused to participate, the next person on the list was visited, and so forth, until sufficient controls had been recruited.

### *Assessment*

Blood pressure (BP) was recorded at least 7 days post-stroke to allow for the fact that BP rises during the first few days after stroke. BP was recorded while sitting using an A&D UA-767 (A&D Instruments Ltd, Abingdon, Oxfordshire, United Kingdom) BP monitor.<sup>9</sup> Three measurements were taken 1 minute apart after 5 minutes resting quietly. An average of the last 2 readings was taken.<sup>10</sup> Nonfasting blood samples were taken from those who consented. The collected blood samples were frozen on dry ice and subsequently transported back to the United Kingdom before being analyzed at North Tyneside General Hospital.

During assessment, resting 12-lead ECGs for cases and controls were recorded using a GE MAC 1200 machine (GE Healthcare, Chalfont St Giles, Buckinghamshire, United Kingdom) and interpreted by the study cardiologist (M.D.).<sup>11</sup> Every 10th ECG was then reviewed by a second independent cardiologist (P.C.A.). The Minnesota Coding System (MCS) was developed for population-based studies to analyze ECGs for the prevalence of prognostically significant abnormalities.<sup>12</sup> In order that the evaluation was standardized, we used the MCS as a guideline to analyze the ECGs manually. Manual evaluation has previously been shown to be reliable when reporting ECG abnormalities by the MCS.<sup>13</sup> We paid particular attention to pathological Q waves (Q waves in 2 contiguous leads, Q/R ratio  $>1/3$  and Q duration  $>30$  ms) and ST-T wave changes, in particular ST elevation in presence of reciprocal ST depression/T-wave inversion (TWI) when looking for potential MI or ischemia. We defined subjects as having evidence of previous MI, using the MCS, if their ECG revealed pathological Q waves. In addition, according to MCS classification, we looked for evidence of arrhythmias, particularly AF and AFL, and left ventricular hypertrophy (LVH).

### *Statistics*

Frequency matching for age and sex was employed, and data were analyzed as for an unmatched case-control study. The data were quantitative in nature and collected at a nominal, ordinal, and interval/ratio level. Data were analyzed using standard statistical software, PASW (version 18; PASW, Chicago, IL) and SAS (version 9.2; SAS Institute, Cary, NC). Confidence intervals (CIs) were calculated for odds ratios (ORs; categorical data), with a 95% CI not containing 1.0 signifying significance. For differences between means (continuous, normally distributed data), 95% CI not crossing zero signifies significance.

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