East African Medical Journal Vol. 95 No. 8 August 2018
A PROFILE OF DEMOGRAPHIC, GEOGRAPHIC, AND SOCIOECONOMIC RISK FACTORS AMONG CHILDREN WITH CONGENITAL AND RHEUMATIC HEART DISEASE IN WESTERN KENYA

Myra Koech, Moi Teaching and Referral Hospital, Eldoret, Kenya, P.O Box 4606-30100 Eldoret, Kenya. Gedion T. K. Ngeno, Moi Teaching and Referral Hospital, Eldoret, Kenya, Duke University School of Medicine, Durham, NC, USA, Duke Global Health Institute, Duke University, Durham, NC, USA, Box 2301 Erwin Road, Durham, NC 27705 USA. Brandon A. Knettel, Duke Global Health Institute, Duke University, Durham, NC, USA, Box, 310 Trent Drive, Box 90519, Durham, NC 27710 USA. Elizabeth Jung, Duke University School of Medicine, Durham, NC, USA, Haas School of Business, University of California, Berkeley, CA, USA, Box 48 Diamond Drive, Danville, CA 94526 USA. Gerald S. Bloomfield, Duke University School of Medicine, Durham, NC, USA, Duke Global Health Institute, Duke University, Durham, NC, USA, Duke Clinical Research Institute, Duke University, Durham, NC, USA, Box 200 Morris Street, Durham, NC 27701 USA.

Corresponding Author: Gerald S. Bloomfield, MD, MPH, Duke University School of Medicine, 200 Morris Street, Durham, NC 27701. Email: Gerald.Bloomfield@duke.edu.

# A PROFILE OF DEMOGRAPHIC, GEOGRAPHIC, AND SOCIOECONOMIC RISK FACTORS AMONG CHILDREN WITH CONGENITAL AND RHEUMATIC HEART DISEASE IN WESTERN KENYA

M. Koech, G. T. K. Ngeno, B. A. Knettel, E. Jung and G. S. Bloomfield

## ABSTRACT

*Objectives:* **Congenital heart disease (CHD) and rheumatic heart disease (RHD) are major health concerns among children in sub-Saharan Africa. Poverty is a key predictor of both conditions, but the mechanisms of that association are not well understood.**

*Design:* **We conducted a retrospective review of medical records of children diagnosed with CHD or RHD to identify associations between demographic, geographic, and socioeconomic variables and the two diseases.**

*Setting:* **Medical records were obtained for care received at the Moi Teaching and Referral Hospital (MTRH), a public hospital in Eldoret, western Kenya.**

*Participants:* **Our sample included 180 children with a mean age of 9 years.**

*Main Outcome Measures:* **We examined multiple potential predictors associated with a diagnosis of CHD or RHD, including the child's household size, family socioeconomic status, age, gender, geographical distribution, and racial/ethnic identity.**

*Results:* **Siblings per household was greater amongst children with RHD (4.6) than among those with CHD (3.7). Patients were of low socio-economic status in both groups. The gender, geographical, and ethnic composition were similar between the CHD and RHD groups. Age and family size were significantly higher among children with RHD as compared to CHD.**

*Conclusion:* **Future exploration of the environmental factors associated with childhood CHD and RHD will complement studies of genetic and biological risk factors and can advance understanding of the determinants of cardiac diseases in western Kenya. These data may inform early intervention, prevention, and screening efforts for children at risk of both conditions.**

## INTRODUCTION

Congenital heart disease (CHD) and rheumatic heart disease (RHD) are major health concerns in sub-Saharan Africa (SSA) (1). The region is known to suffer from the highest burden of RHD worldwide, with estimates of 21.5 cases per 1,000 people in the population (2). Although the measured prevalence of CHD is much lower at 2.3 cases per 1,000 people, it may be underestimated due to inadequate screening (2,3). Rheumatic heart disease is progressive and tends to impact health in later childhood, while CHD is more likely to create challenges from birth. Given their early onset, both conditions have far reaching, negative social and economic implications (4,5). In Kenya, in 2016, RHD was responsible for 6,012 disability adjusted life years (DALYS) amongst people 5-14 years old, whilst the CHD burden for children aged 0-5 years of age was estimated at 153,796 DALYs (6).

Regional incidence and prevalence of both CHD and RHD varies according to geographical region, ethnicity, socioeconomic status and access to healthcare (1,7). In Australia, for example, Aboriginal and Torres Strait Islander people account for 94% of all RHD cases in the country (8). In New Zealand, the Maori and Pacific Islander groups have similarly high prevalence when compared to other ethnic groups (3). A global meta-analysis observed similar prevalence differences in global CHD epidemiology, which was postulated to arise from disparities in access to health care, as well as the influence of the genetic environmental and socioeconomic determinants on the disease (7). Regional CHD disparities have been observed in areas such as the Sichuan Basin in China, where watershed and ammonia–nitrogen pollution were associated with the high prevalence of CHD in the area (9).

Although regional disparities in RHD and CHD are clear in some regions of the world, and among some population sub-groups, specific risk factors are not always well-understood. We sought to examine demographic, geographic, and ethnic associations of RHD and CHD in patients receiving care at a large referral hospital in western Kenya, which may shed light on potential disparities in disease prevalence in the local population.

## METHODS

We conducted a retrospective review of patient medical records for care received at the Moi Teaching and Referral Hospital (MTRH) in western Kenya. MTRH is a tertiary public hospital in Uasin Gishu County, with a predominantly rural catchment population, estimated at 894,179 as of the 2009 census (10). The pediatric cardiology clinic at MTRH is the only public subspecialty clinic in the region. The predominant ethnic groups in the surrounding counties are Kalenjin, Luhya and Kikuyu.

Standard case report forms were used to abstract data from records of pediatric cardiology clinic patients identified to have CHD or RHD based on echocardiographic findings. CHD was defined as structural defects of the heart and related vessels present at birth. RHD was defined as an acquired inflammatory valvular heart disease affecting one or more heart valves. Other heart diseases, including pulmonary hypertension not caused by CHD or RHD, were excluded. A research assistant (EJ) reviewed each chart manually to collect information on age, diagnosis, location of residence, location of birth, ethnic identity (tribal affiliation), size of the household, socio-economic status (SES) and whether they had undergone surgical repair. SES was measured by a summary variable accounting for ownership of five items/services in one's household (i.e., automobile, flushing toilet, television, electricity and refrigerator). In the event information was not available in the medical record, patients and/or their guardians were interviewed in person to ascertain missing data.

Our primary analysis identified the distribution of demographics, ethnic affiliation, and geographic location of residence for RHD and CHD separately. For each group, data were expressed as number (percent), means (standard deviation [SD]) or medians (interquartile range [IQR]). For comparisons, we used Wilcoxon rank-sum and Fisher's exact tests used for continuous and binary variables, respectively. Multivariate logistic regression models were generated to evaluate associations between disease type (RHD or CHD) and family size, location, and ethnicity. Data were analyzed using Stata version 11 software.

## RESULTS

We reviewed 262 patient records representing patients on active follow-up in the pediatric cardiology clinic. Of those records, 180 reported on all the variables of interest. Characteristics of the sample are summarized in Table 1.

**Table 1**

*Demographic characteristics*

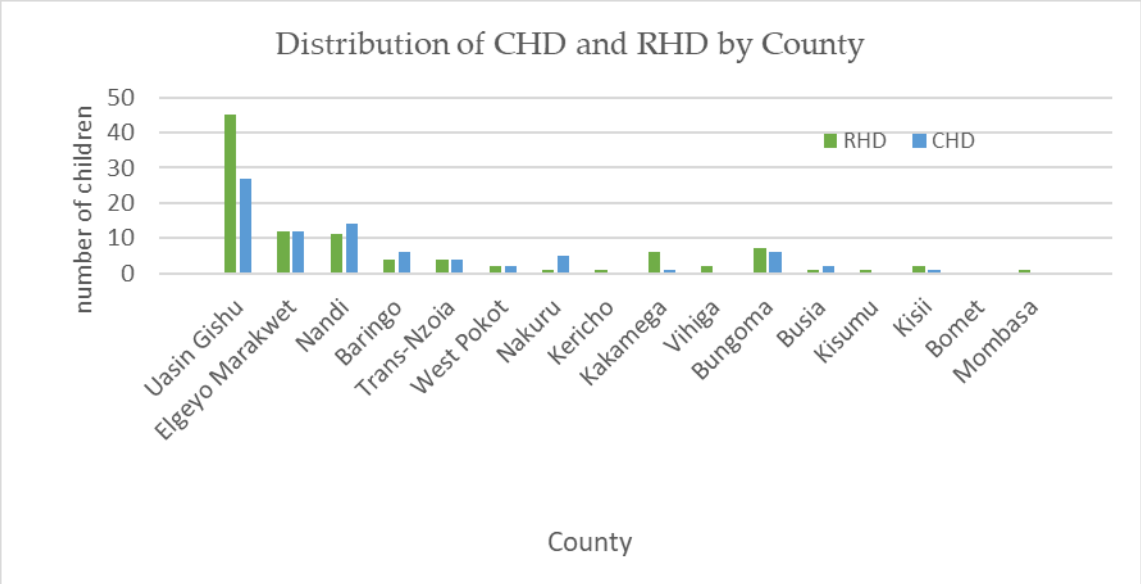
| Characteristic | Total (n=180) | RHD (n=100) | CHD (n=80) |
|---|---|---|---|
| Age, years, mean ± SD | 8.6 ± 5.2 | 11.9 ± 3.1 | 4.4 ± 4.2† |
| Female, n (%) | 91 (51%) | 55 (55%) | 35 (44%) |
| No. of children in Family, mean ± SD | 4.3 ± 2.2 | 4.6 ± 2.2 | 3.7 ± 2.2* |
| Socioeconomic Status, n (%) | | | |
| 0/5 Very Low | 101 (57%) | 58 (59%) | 43 (54%) |
| 1/5 Low | 33 (19%) | 16 (16%) | 17 (22%) |
| 2/5 Lower-Middle | 25 (14%) | 12 (12%) | 13 (16%) |
| 3/5 Upper-Middle | 12 (7%) | 7 (7%) | 5 (6%) |
| 4/5 High | 7 (4%) | 6 (6%) | 1 (1%) |
| 5/5 Very High | 0 (0%) | 0 (0%) | 0 (0%) |

| | | | |
|---|---|---|---|
| Surgically Repaired, n (%) | 2 (1%) | 0 | 2 (3%) |
| HIV seropositive, n (%) | 7 (4%) | 1 (1%) | 6 (8%) * |

**p<0.05; †p<0.001*

The main county of residence for both RHD and CHD patients was Uasin Gishu (72%) as shown in Figure 1. There were more patients with CHD than RHD from Nandi, Nakuru and Baringo counties.

**Figure 1: Distribution of CHD and RHD by county of residence**




Nine ethnic communities were identified: Kalenjin, Luhya, Kikuyu, Pokot, Kisii, Luo, Teso and Maasai and Kamba. Of these, 132 (73%) patients were Kalenjin and 24 were Luhya (13%). There was no statistically significant difference observed between patients with CHD versus those with RHD, when analyzed by ethnicity or broader language groups, as shown in Table 2 below.

**Table 2**

*Child's self-reported ethnicity and language group according to disease type*

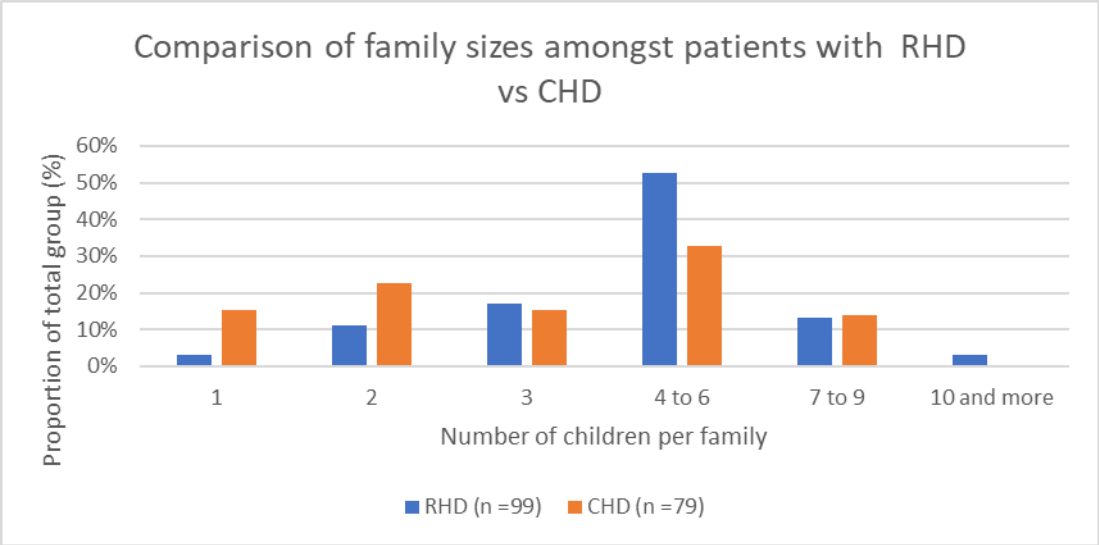
| **Language group (Ethnic communities in study)** | **Children with CHD (%)** | **Children with RHD (%)** | **Z Statistic** | **P value** |
|---|---|---|---|---|
| Highland Nilotes (Nandi, Kipsigis, Pokot, Keiyo, Tugen, Sabaot, Marakwet) | 77 | 60 | 0.31 | 0.76 |
| Plain Nilotes (Maasai, Iteso) | 1 | 1 | -0.16 | 0.87 |
| Riverine - Lake Nilotes (Luo) | 2 | 4 | -1.11 | 0.27 |
| Bantu (Kamba, Kisii, Luhya and Kikuyu) | 20 | 15 | 0.20 | 0.83 |

We found no significant differences in sex, SES, ethnic group or county of residence between RHD and CHD cases. Patients with CHD were significantly younger than patients with RHD by a mean difference of 7.5 (95% CI 8.6, 6.4) years. Higher age was more strongly associated with RHD than CHD (OR 1.6, 95%CI 1.4, 1.8). A larger

family size was also more strongly associated with having RHD when compared to CHD. (OR 1.2, 95%CI 1.0, 1.4). A family size of 4-6 children was the most common for patients with RHD (52% of patients) and CHD (32%) as shown in figure 2.

**Figure 2**

*Comparison of family sizes amongst patients with RHD vs CHD*




## DISCUSSION

This study found that geographical and ethnic distribution of patients with CHD and RHD is similar amongst patients attending the MTRH pediatric cardiology clinic. Early childhood presentation of CHD and a later presentation of RHD may be due to the pathophysiology of the two diseases (7,8). Notably, we found no children in this sample who were co-afflicted by the two diseases. Co-affliction is a rare occurrence even though patients with congenital heart disease are reported to be at greater risk for rheumatic heart disease as described by Bokhandi *et al* (11). It is plausible that factors such as heightened awareness around health and treatment of infections, and early mortality amongst patients with CHD may be the reason for a this difference (1,4).

Family sizes of children afflicted with RHD were significantly higher when compared to those afflicted with CHD. Smaller family size may be attributable to fetal losses arising from genetic abnormalities, while larger family sizes contribute to overcrowding and reduced resources for healthcare, which are thought to perpetuate RHD (1,2). The specific mechanism of increased risk may be the transmission of streptococcus in shared spaces, an area of inquiry requiring further exploration (8).

A larger proportion of patients with CHD (8%) were observed to have HIV when compared to patients who have RHD and HIV (1%). Birth defects have been reported to have a greater prevalence amongst children born to mothers with HIV as a result of direct viral effects as well as antiviral therapeutic agents (12). Though there exist variations HIV prevalence by geographic location amongst counties in the region, larger community-based prevalence

studies are needed to further characterize risk and disease impact.

Most of our study population was in the lowest socioeconomic tier (56%), as is reflective of the catchment population attending public hospitals in the region. However, our ability to detect a differential effect of poverty on disease status was limited by the small study sample size. Furthermore, because most of the participants surveyed were from Uasin Gishu County, the findings may not be representative of the wider regional population, whose ability to attend the clinic may have been precluded by high travel costs and other barriers. In addition, entry into the study relied on availability of complete data. The findings may not be representative of all participants, including those who did not have echo studies or receive comprehensive care at this facility.

## CONCLUSION

We did not find major differences in ethnic and geographic associations between subjects with RHD or CHD. This favors a postulate that predisposing genetic factors and environmental influences are shared across regional groups and may be outweighed by environmental and socioeconomic factors, such as poverty, family size, and close living arrangements. These results may be further explored through a larger study focused on genetic profiles, but we suggest that further studies continue to include sociodemographic as a key influencer of heart disease risk. Such studies should incorporate methods to compare the characteristics of RHD and CHD patients with the general population, improve discrimination of SES, and delineate other environmental influences related to health, nutrition, infection control, and living conditions.

## REFERENCES

1. Zühlke L, Mirabel M, Marijon E. Congenital heart disease and rheumatic heart disease in Africa: recent advances and current priorities. Heart Br Card Soc. 2013 Nov;99(21):1554–61.
2. Marijon E, Ou P, Celermajer DS, Ferreira B, Mocumbi AO, Jani D, et al. Prevalence of Rheumatic Heart Disease Detected by Echocardiographic Screening. N Engl J Med. 2007 Aug 2;357(5):470–6.
3. Jaine R, Baker M, Venugopal K. Epidemiology of acute rheumatic fever in New Zealand 1996-2005. J Paediatr Child Health. 2008;44(10):564–71.
4. Koech MM, Ngeno TK. Perceptions of Parents with Children with Congenital Heart Disease at the Moi Teaching and Referral Hospital, Kenya. Open Sci Repos Med. 2013 Jul 29; Online(open-access): e70081994.
5. Koech MM, Ngeno TK. Economic impact on families with children with rheumatic heart disease at a referral hospital, Kenya. :6.
6. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet Lond Engl. 2016 Oct 8;388(10053):1459–544.
7. van der Linde D, Konings EEM, Slager MA, Witsenburg M, Helbing WA, Takkenberg JJM, et al. Birth prevalence of congenital heart disease worldwide: a systematic review and meta-analysis. J Am Coll Cardiol. 2011 Nov 15;58(21):2241–7.
8. Guilherme L, Ramasawmy R, Kalil J. Rheumatic fever and rheumatic heart disease: genetics and pathogenesis. Scand J Immunol. 2007 Sep;66(2–3):199–207.
9. Ma L-G, Zhao J, Ren Z-P, Wang Y-Y, Peng Z-Q, Wang J-F, et al. Spatial patterns of the congenital heart disease prevalence among 0- to 14-year-old children in Sichuan Basin, P. R

China, from 2004 to 2009. BMC Public Health. 2014 Dec;14(1):595.

10. Population and housing census of Kenya, 2009 - Kenya Data Portal [Internet]. Knoema. [cited 2019 Feb 13]. Available from: http://kenya.opendataforafrica.org//KEPOPHUS2015/population-and-housing-census-of-kenya-2009?tsId=1107500

11. Bokhandi SS, Tullu MS, Shaharao VB, Bavdekar SB, Kamat JR. Congenital heart disease with rheumatic fever and rheumatic heart disease: a coincidence or an association? J Postgrad Med. 2002 Jul 1;48(3):238.

12. Brogly SB, Abzug MJ, Watts DH, Cunningham CK, Williams PL, Oleske J, et al. Birth defects among children born to HIV-infected women: Pediatric AIDS Clinical Trials Protocols 219 and 219C. Pediatr Infect Dis J. 2010 Aug;29(8):721–7.