The prevalence of rheumatic heart disease among Grade 10 - 12 learners in the Free State and Northern Cape – Preliminary results of the Wheels-of-Hope Outreach Programme

F.E. Smit*, L. Botes†, S. Rossouw* and S.C. Brown#

*Department of Cardiothoracic Surgery, University of the Free State, Bloemfontein, South Africa
#Department of Paediatric Cardiology, University of the Free State, Bloemfontein, South Africa
†Department of Health Sciences, Central University of Technology, Bloemfontein, South Africa

Address for correspondence:
Professor F.E. Smit
Department of Cardiothoracic Surgery
University of the Free State
Internal Box G 32
PO Box 339
Bloemfontein
9301
South Africa

Email:
SmitFE@ufs.ac.za

ABSTRACT

An outreach programme was initiated to echocardiographically screen Grade 10 - 12 learners, in Central South Africa, for rheumatic heart disease (RHD). Preliminary results, after the screening of 1 015 learners, identified 102 abnormal echocardiograms. The abnormal echocardiograms were reviewed by an echocardiographer and paediatric cardiologist team and 14 pathological conditions were confirmed in 13 patients. The abnormalities included RHD (n=5), pericardial effusion (n=2), left ventricular hypertrophy (n=2), mitral valve prolapse (n=3), ventricle septal defect (VSD) (n=1) and sub-aorta stenosis (n=1).

The benchmark study by McClaren, et al. conducted in Soweto in 1972 (n=12 050, age 2 - 18 years) showed an overall RHD prevalence of 6.9 per 1 000 and 12.2 per 1 000 in the 15 - 18 year old bracket. The highest incidence (19.2/100) was found in Grade 7 learners (age not defined). The preliminary result of this study is 4.9 RHD cases per 1 000 in Grade 10 - 12 learners. This finding may indicate an actual decline in the prevalence of RHD in Central South Africa. SAHeart 2015;12:146-151

INTRODUCTION

Rheumatic fever (RF) follows a throat infection by a group A-streptococcus. More than one third of affected children develop carditis, followed by progressive and permanent valvular lesions.[1]

Industrialised countries have reported a virtual disappearance of RHD.[2] The burden of RHD in developed countries declined drastically at the end of the 20th century, largely due to reduced overcrowding and improved sanitation and living conditions.[3] In contrast, acute RF and RHD remain a public health issue in developing countries.[4] Currently, RHD is the principal cause of acquired heart disease in children and young adults in developing countries and it is estimated that there are over 15 million cases of RHD worldwide, with 282 000 new cases and 233 000 deaths annually.[5,6]

The burden of RHD, in developing nations, is both social and economic in nature. Repeated hospitalisation, premature death and disability affect the emerging workforce.[7,8] Screening programmes provide authorities with epidemiological data to assist in alleviating the burden of RHD through regional health care planning and programmes.

The prevalence of rheumatic heart disease in the paediatric or adolescent population of Central South Africa has never been studied. Consequently, there is no data to support the conduct, or public funding, of mass screening programmes in this region.

The study aims to determine the prevalence rate of RHD in Grade 10 - 12 learners in Central South Africa and to compare the prevalence rate to South African prevalence rates published in the 1970s.[9]

MATERIALS AND METHODS

"Wheels-of-Hope", a non-profit organisation, was established by the Department of Cardiothoracic Surgery in collaboration with the Department of Paediatric Cardiology, both of the University of the Free State, the Central University of Technology, Life Rosepark Hospital and John Williams Motors Bloemfontein, to provide diagnostic, treatment, training and education services to patients with cardiovascular disease in Central South Africa.

Wheels-of-Hope initiated a prospective echocardiographic study in Central South Africa in January 2011, after gaining

approval from the Ethics Committee of the University of the Free State and permission from the Department of Education. Volunteer asymptomatic Grade 10 - 12 learners who gave informed consent (at 18 years), or for whom written informed consent could be obtained from a parent or guardian (learners under the age of 18 years), were included in the study.

The programme was initiated in Bloemfontein, and then moved on to screening learners in Kimberley and Welkom. At the time of this report, the programme had started to screen learners in Brandfort, a rural town in Central South Africa. The study focuses on schools drawing learners from lower socio-economic areas. Schools were selected, initially in urban areas (Bloemfontein, Kimberley, Welkom) and then in rural communities (Brandfort) (Figure 1).

Demographic information consisting of age, gender and blood pressure was obtained from all learners. This was followed by a routine cardiac echocardiographic examination performed according to the guidelines of the American Society of Echocardiography by 2 experienced echocardiographers.[10] Images were obtained in the left lateral decubitus position using either a Philips CX50 Diagnostic Ultrasound System, equipped with a S5-1 ultrasound transducer, or GE Vingmed Ultrasound Vivid q fitted with a V3 transducer. Minimum views obtained consisted of standard long axial, short axial and 4 chamber segments. M-mode, pulsed wave, and colour Doppler flows were obtained in all views. Care was taken with 2-dimensional and gain settings in order to ensure accurate and concise measurements. Leaflet thickness was only measured when tissue appeared thickened in either the 2-dimensional or M-mode views and in all cases where regurgitatant jets (even minor) were observed. Image data was captured and stored in a dedicated software system for transcription to CD for review. Raw data was recorded on a study specific datasheet and then entered in Excel spreadsheets for analysis. RHD was diagnosed according to the WHF criteria published in 2012.[11]

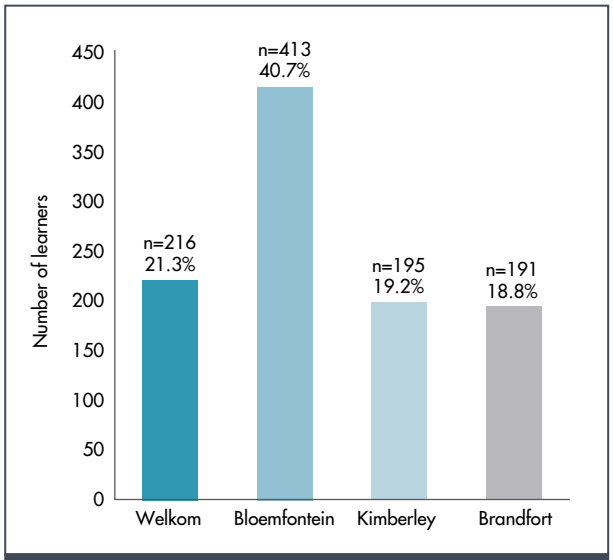

FIGURE 1: Number and percentage of learners screened for RHD per area (n=1 015).

All echocardiograms with any minor regurgitation or other abnormality were afterwards re-evaluated by an expert panel consisting of at least 2 experienced echocardiographers and/or a paediatric cardiologist. Cases where unanimity regarding diagnosis could not be obtained, or where rheumatic fever/pathology was suspected, were independently reviewed by a senior paediatric cardiologist. Findings were recorded in frequency tables.

Fifty (50) cases reported as normal were randomly selected as a quality control measure. These echocardiograms were reviewed and aortic and mitral valve leaflet thickness was measured: all of these were consistent with the original echocardiographers' assessment.

All learners with pathological lesions were booked at the Universitas Academic Hospital's paediatric cardiology clinic for further management, follow-up and institution of appropriate prophylactic regimens.

Statistical Analysis

The sample size calculation required the screening of a minimum of 1 500 learners. The programme had screened 1 015 learners at the time of this report; therefore these are preliminary results and are statistically under-powered.

Descriptive data are presented as the number and proportion of learners. Prevalence rates are presented per 1 000 learners.

It is important to note that this is an outreach initiative based on a prospective cross-sectional study design, but is not robust in its sampling of schools or learners and is biased towards low socio-economic areas.

RESULTS

A total of 1 015 learners, between the ages of 14 - 22 years were screened. Normal echocardiograms were observed in 913 learners and 102 echocardiographic studies, with suspected abnormalities, were referred to the echocardiographic team for review (Figure 2). A total of 132 abnormal findings were recorded in the 102 suspected abnormal echocardiograms (Table I). The majority of abnormal findings could be attributed to physiological incompetence of the aorta (n=7), mitral (n=33), pulmonary (n=18) and tricuspid (n=54) valves. The physiological incompetance findings formed 84.8% (112/132) of all abnormal findings.

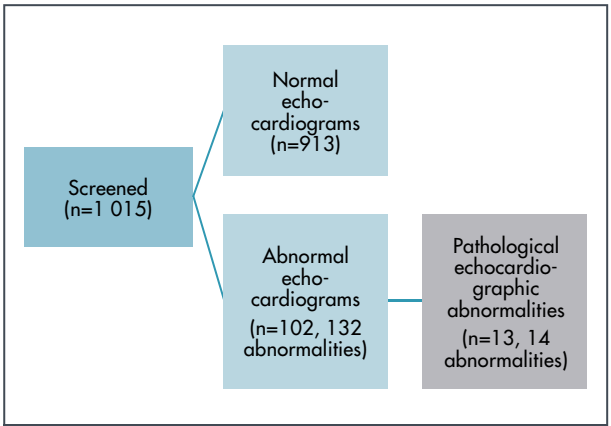

FIGURE 2: Number of learners screened for RHD (n=1 015).

TABLE 1: Echocardiograms referred for evaluation (n=102).

Diagnosis	Number of learners (n = 102)	Final diagnosis
Aortic incompetence	7	Physiological AI
Sub aortic stenosis	2	1 Pathological
1 Not pathological		
Mitral incompetence (physiological)	33	Physiological
Pulmonary incompetence	18	Physiological
Tricuspid incompetence	54	Physiological TI
Left ventricle hypertrophy	2	2
Suspected rheumatic heart disease	**8**	**2 Confirmed RHD** **3 Probable RHD** **3 Did not fulfill RHD criteria**
ASD/PFO	1	Normal
VSD 1	1	
Dilated ascending aorta	1	1
Mitral valve prolapse	3	3
Pericardial effusion	2	2

Note: A learner could have more than one diagnosis

The echocardiographic team identified 14 pathological conditions in 13 learners (Table 2). In these 13 learners, 5 had (3 definite and 2 borderline) RHD according to WHF criteria, 1 had sub aorta stenosis, 3 had mitral valve prolapse, one had a restrictive peri-membranous VSD, 2 had left ventricular hypertrophy and 2 asymptomatic pericardial effusions were found.

The 5 RHD cases that were detected in the 1 015 screened learners translates to a RHD prevalence rate of 4.9 per 1 000 learners.

DISCUSSION

The interim results of this study may be indicative of an overall decrease in the prevalence of RHD in Central South Africa. This is particularly notable since the lower RHD prevalence rate was obtained using echocardiographic screening procedures, which generally result in higher prevalence rates compared to results observed using auscultation. Also, note that none of the RHD patients diagnosed to date have required surgical intervention. To our knowledge this is the first prevalence study of its kind in Central South Africa.

RHD prevalence rates reported for sub-Saharan Africa are difficult to compare since the rates are gathered in different age groups, using different detection methods and according to criteria that have evolved over time.

In their discussion of global research priorities for RHD, Carapetis and Zühlke highlight the importance of identifying people with RHD while they are asymptomatic, before they develope severe valvular damage.[12] Such asymptomatic individuals are most likely to benefit from secondary prophylactic treatment. Active echocardiographic screening allows for the identification of asymptomatic patients.

However, echocardiographic screening also leads to higher prevalence estimates than have been observed through screening programmes that use auscultation and passive screening such as hospital disease registers.[1] Prevalence rates have been found to be up to 10 times higher when using echocardiograms compared to clinical examination alone.[13]

In February 2012, the World Heart Federation published the first evidence-based criteria for echocardiographic detection of RHD.[11] These guidelines were developed to resolve many of the current concerns with respect to the implementation of echocardiographic screening methods for RHD. In our study, the WHF echocardiographic criteria were applied to all subjects. All echocardiograms performed before publication of the 2012 WHF criteria, were re-evaluated according to the updated criteria.

Prevalence rates in Sub-Saharan Africa

Sub-Saharan Africa is considered to be the region in the world with the greatest burden of RHD, but unfortunately epidemiological data for RHD in this region is limited.[14] An extensive screening study using auscultation, was conducted in Soweto, South Africa, over 40 years ago, in 1972. A prevalence rate of 6.9/1 000 was reported in the 2 - 18 year age

group. More specifically, a rate of 12.2/1 000 was observed in the 15 - 18 year age sub-group (which included approximately 15% of the study population).[9] The highest prevalence rate of 19.2/1 000 was reported for Grade 7 pupils, but their age group was not specified.[9,15]

In 1984 a survey was conducted in Inanda in KwaZulu-Natal.[16] The pupils who were screened using auscultation came from an area with both rural and urban characteristics that was serviced by a primary health care programme. The vast majority of the 4 408 pupils who were screened were younger than 15 years old (99% of pupils). Four cases of RHD were detected resulting in a prevalence rate of 1.0/1 000. However, it is speculated that the rate is underestimated due to selection bias resulting from affected children possibly not attending school.

Recently, Engel, et al. published their findings in a well-designed, prospective echocardiographic study on the prevalence of RHD in 4 720 asymptomatic scholars from Cape Town, South Africa (n=2 720) and Jimma, Ethiopia.[17] The study found a prevalence rate of 30.5/1 000 in Jimma and 20.2/1 000 in Cape Town. Two populations were studied in Cape Town. In Bonteheuwel (n=1 279) an overall rate of 12.5/1 000 was demonstrated with 2.3/1 000 definitive cases and 10.2/1 000 borderline cases. In the Langa population (n=1 441), the total RHD prevalence was 27/1 000, with 6.9/1 000 definitive cases and 20.1/1 000 borderline cases.

In the age group sub analyses, the Cape Town study populations had a prevalence of RHD of 8.1/1 000 (Bonteheuwel) and 32/1 000 (Langa) in the 15 - 19 year group and 0/1 000 (Bonteheuwel) and 50.5/1 000 (Langa) in the >19 year old group. The age-group differences in RHD prevalence are surprising since both areas are in close proximity to Cape Town. The authors speculate that the differences may be linked to income differences between the communities.

The Cape Town groups reported a high percentage of borderline RHD findings. If only definite RHD diagnoses are considered, the RHD prevalence was 2.3/1 000 in Bonteheuwel and 6.9/1 000 in Langa. These findings are in line with our interim finding of a total prevalence of RHD of 4.9/1 000 and 3/1 000 definitive RHD cases. The authors also discuss the inter-reader difference between South African and Ethiopian echocardiographers in identifying borderline cases; a counter-intuitive finding that was confirmed in a re-evaluation of the Ethiopian cases by the South African team. This highlights the importance of uniform interpretation of echocardiographic data and might explain the continuing challenge to explain inter-study differences.

In the Republic of the Congo an echocardiographic study involving 4 848 school children aged 5 - 16 years from Kinshasa was conducted in 1996. The overall prevalence of rheumatic heart disease was 14/1 000. The prevalence was greater in slums schools (22.2/1 000) than in urban schools (4/1 000).[18]

Marijon, et al. conducted a study in 2001 and 2002, in Mozambique, in 2 170 otherwise healthy school children between the ages of 6 - 17.[19] They found a RHD prevalence rate of 2.3/1 000 detected through clinical examination. In contrast, echocardiographic screening in the same group of children detected a prevalence rate of 30.4 cases per 1 000.

A study, in Uganda in 2010, involved the clinical examination and echocardiographic screening of almost 5 000 school children.[13] A prevalence rate of 14.8/1 000 children was observed in the 5 - 16 year age group when using the 2006 WHO/NIH echocardiographic screening guideline. On clinical evaluation alone, a prevalence of 4.9 cases per 1 000 children was observed.

A school-based echocardiography survey of 2 004 pupils was conducted in Dakar, Senegal, in 2010. Pupils were enrolled in 2 groups, those aged 5 - 15 years old (Group 1, n=1 116), and others aged 16 - 18 years old (Group 2, n=888). Prevalence rates of 5.4 and 10.1 per 1 000 were observed in Group 1 and Group 2, respectively.[20] Kane, et al. recommended extending RHD screening to adolescents in their late teens in the light of the higher prevalence of the disease and since subclinical

TABLE 2: Pathological echocardiographic findings by area .

Town	Learners	RHD	Sub AS	MV prolapse	VSD	LVH	Effusion	% Abnormal findings
Welkom	n=216	0	0	1	0	1	1	1.4%
Bloemfontein	n=413	3	1	0	1	1	1	1.7%
Kimberley	n=195	0	0	1	0	0	0	0.5%
Brandfort	n=191	2	0	1	0	0	0	1.6%
TOTAL	**n=1 015**	**5**	**1**	**3**	**1**	**2**	**2**	**1.4%**

cardiac lesions are more pronounced in this age category and could thus be more easily detected in the field by means of portable echocardiography.

The preliminary RHD prevalence rate of 4.9/1 000 that we observed in Central South Africa is comparable to the definite RHD rates of the Engel study (2.3/1 000 in Bonteheuwel and 6.6/1 000 in Langa). It should be noted that the current studies utilise echocardiography screening as opposed to the auscultation project conducted by McLaren, making comparison with this historical rate problematic.

Despite the use of echocardiography with its expected higher prevalence rates, the Central South African rate is lower than the peak prevalence rate of 12.2/1 000 cases reported for the 15 - 18 year old age group; an age group that is most comparable to our own grade 10 - 12 learners.

Since 2004, only 7 children had RHD-related valvular surgery in Bloemfontein, the only referral centre for paediatric cardiac surgery in Central South Africa. The mean age at surgery for RHD in Bloemfontein is now 46 years and it correlates with the age of presentation with RHD of 43 years reported in the Hearts of Soweto study.[21,22] The mean age at surgery for RHD reported by Antunes in 1987 was 21.5 years.[23] The change in mean age of operation/presentation supports the anecdotal impression that there is a decline of RHD in South Africa, and specifically in Central South Africa.

Limitations

The project does not use randomised sampling. There is considerable sampling bias in this project owing to its design with a declared bias to detect the incidence of RHD in the most vulnerable population of South Africa. No attempt was made to include schools in affluent areas. The results might therefore exhibit inflated prevalence rates of RHD for the general population in Central South Africa, however the researchers feel that this is justified as RHD is a disease often associated with poverty.[1]

CONCLUSION

Since 1994 there has been a substantial investment in rural development in South Africa. Socio-economic development has an undeniable impact on the prevalence of RHD in a population. It is postulated that the developments in South Africa have had an impact on RHD prevalence in Central South Africa.

This is a preliminary report of a study that is not statistically robust as regards sampling. However, the echocardiography based RHD prevalence rate of 4.9/1 000 learners in the Grade 10 - 12 learner group in Central South Africa, is notably lower than the 12.2/1 000 clinical prevalence rate reported by McLaren in 1975.[9] Combining the results with the lack of acute RF admissions, the average age of presentation with RHD as reflected in the Hearts of Soweto study, and the doubling of the age of patients presenting for RHD valvular surgery, indicates that there may be a real reduction in the prevalence of RHD in Central South Africa.

The recent Cape Town study demonstrated an overall RHD prevalence of 20.2/1 000.[17] Our results (4.9/1 000), in an older age group cohort, however corresponds with the definitive RHD rate mentioned in the Engel study (2.3/1 000 in Bonteheuwel and 6.9/1 000 in Langa). As previously mentioned, the highly variable findings in the older age groups of the Engel study makes inter-study age group comparisons difficult. The inter-reader interpretation of echocardiographic data, mentioned by Engel, continues to be a challenge for all researchers in this field.

This data is unique for Central South Africa and may be useful for the planning of cardiovascular disease management in this region and may stimulate Health Departments in South Africa to support and invest in robust population screening studies.

ACKNOWLEDGEMENTS

The authors would like to thank the collaborators and sponsors of the "Wheels-of-Hope" initiative. The Department of Cardiothoracic Surgery and Department of Paediatric Cardiology, both of the University of the Free State, and the Central University of Technology provide personnel to main-tain the programme. Life Rosepark Hospital and John Williams Motors provide equipment, transport and public relations to support the programme.

The authors acknowledge the contributions of the field echocardiographers, S. Jacobs, O. Volschenk and M. Mitrovich, for the performance of the echocardiograms and data capturing.

We wish to thank Jean Diedericks for assistance with data capturing and computation.

Conflict of interest: none declared.

REFERENCES

1. Marijon E, Mirabel M, Celermajer DS, et al. Rheumatic heart disease. Lancet 2012;379:953-64.
2. Gordis L. The virtual disappearance of rheumatic fever in the United States: Lessons in the rise and fall of disease. T. Duckett Jones memorial lecture. Circulation 1985;72:1155-1162.
3. Essop MR, Nkomo VT. Rheumatic and nonrheumatic valvular heart disease: Epidemiology, management, and prevention in Africa. Circulation 2005: 112:3584-91.
4. Zühlke LJ, Steer AC. Estimates of the Global Burden of Rheumatic Heart Disease. Global Heart, 2013;8:189-195.
5. Zühlke L, Mirabel M, Marijon E. Congenital heart disease and rheumatic heart disease in Africa: Recent advances and current priorities. Heart (British Cardiac Society) 2013;99:1554-61.
6. Seckeler MD, Hoke TR. The worldwide epidemiology of acute rheumatic fever and rheumatic heart disease. Clinical Epidemiology 2011;3:67-84.
7. Eisenberg MJ. Rheumatic heart disease in the developing world: Prevalence, prevention, and control. European Heart Journal 1993;14:122-128.
8. WHO programme for the prevention of rheumatic fever/rheumatic heart disease in 16 developing countries: Report from Phase I (1986-90). WHO Cardiovascular Diseases Unit and principal investigators. Bulletin of the World Health Organisation 1992;70:213-218.
9. McLaren MJ, Hawkins DM, Koornhof HJ, et al. Epidemiology of rheumatic heart disease in black shcoolchildren of Soweto, Johannesburg. British Medical Journal 1975;3:474-478.
10. Sahn DJ, DeMaria A, Kisslo J, et al. Recommendations regarding quantification in M-Mode echocardiography: Results of a survey of echocardiography measurements. Circulation 1987;1:72-1081.
11. Reményi B, Wilson N, Steer A, et al. World Heart Federation criteria for echocardiographic diagnosis of rheumatic heart disease: An evidence-based guideline. Nature Reviews. Cardiology 2012;9:297-309.
12. Carapetis JR, Zühlke LJ. Global research priorities in rheumatic fever and rheumatic heart disease. Annals of Pediatric Cardiology 2011:4:4-12.
13. Beaton A, Okello E, Lwabi P, et al. Echocardiography screening for rheumatic heart disease in Ugandan schoolchildren. Circulation 2012;125:3127-32.
14. Zühlke L, Watkins D, Engel ME. Incidence, prevalence and outcomes of rheumatic heart disease in South Africa: A systematic review protocol. BMJ Open 2014;4:e004844.
15. Nkomo VT. Epidemiology and prevention of valvular heart diseases and infective endocarditis in Africa. Heart (British Cardiac Society) 2007;93: 1510-1519.
16. Maharaj B, Dyer R, Leary WP, et al. Screening for rheumatic heart disease amongst black schoolchildren in Inanda, South Africa. J Trop Pediatr 1987;33:60-61.
17. Engel ME, Haileamlak A, Zühlke L, et al. Prevalence of rheumatic heart disease in 4 720 asymptomatic scholars from South Africa and Ethiopia. Heart 2015;0:1-6.
18. Longo-Mbenza B, Bayekula M, Ngiyulu R, et al. Survey of rheumatic heart disease in school children of Kinshasa town. International Journal of Cardiology 1998;63:287-294.
19. Marijon E, Ou P, Celermajer DS, et al. Prevalence of rheumatic heart disease detected by echocardiographic screening. The New England Journal of Medicine 2007;357:470-6.
20. Kane A, Mirabel M, Touré K, et al. (2013). Echocardiographic screening for rheumatic heart disease: Age matters. International Journal of Cardiology 2013;168:888-891.
21. Smit, FE. 21st World Congress World Society of Cardio-Thoracic Surgeons. Abstracts. Heart Surg Forum 2011;14:S2-136.
22. Sliwa K, Carrington M, Mayosi BM, et al. Incidence and characteristics of newly diagnosed rheumatic heart disease in urban African adults: Insights from the Heart of Soweto study. European Heart Journal 2010;31:719-27.
23. Antunes MJ, Magalhães MP, Colsen PR, et al. Valvuloplasty for rheumatic mitral valve disease. A surgical challenge. J Thorac Cardiovasc Surg 1987; 94:44-56.