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Prevalence of rheumatic heart disease among school children in Ethiopia: A multisite echocardiography-based screening

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ABSTRACT

Background: Auscultation-based surveys in Ethiopia conducted in the late 1990's reported a rural prevalence of 4.6/1000 and an urban prevalence of 6.4/1000 of rheumatic heart disease (RHD). With echo-based screening, we aimed to estimate the national prevalence of RHD in school children by taking school-based samples from six regions across the country using the 2012 World Heart Federation echocardiographic criteria.

Patients and methods: We conducted a cross-sectional echocardiographic screening of RHD in school children aged 6–18 years from 28 randomly selected primary and secondary schools found in six different geographic regions of Ethiopia. We used the standardized WHF echocardiographic criteria.

Results: A total of 3238 children (48.5% females) were screened. The mean age was 13.2 ± 3.2 years. Of these, 44 patients (1.4%) met the WHF criteria for definite RHD, while 15 (0.5%) met the criteria for borderline disease, yielding a prevalence of 19 [13.9–23.4, 95% CI] cases per 1000 school children between the ages of 6–18 years. The majority of those who tested positive were girls (26/44). The prevalence was lowest in children aged 6–9 years and otherwise uniformly distributed across ages 10–18 years. Definite RHD involved the mitral valve in 42 subjects, 39 of whom had mitral regurgitation and 3 with mitral stenosis. The aortic valve was affected in 6 children. The ratio of definite to borderline cases was 2.9.

Conclusion: This study demonstrated a consistent pattern of high prevalence of asymptomatic RHD with definite disease predominating over borderline involvement across six regions of Ethiopia.

1. Introduction

Rheumatic heart disease (RHD) continues to be a major public health problem in developing countries where it causes most of the cardiovascular morbidity and mortality in young people [1]. Recent studies and estimates suggest that 62 to 78 million individuals worldwide may have RHD which may potentially be responsible for 1.4 million premature deaths per year [2]. RHD is also responsible for the highest cardiovascular-related loss of disability adjusted life years among 10–14 years old worldwide and the second highest among children aged 5–9 years [3]. Most of the studies in Africa reported a prevalence 2.4–10.2/1000 based on clinical detection of murmur with confirmation by echocardiography [2,4,5]. Echocardiographic surveys in Uganda and Mozambique reported a higher prevalence of rheumatic

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heart disease than previously thought (14 and 30 per 1000 respectively) [4,6]. Auscultation-based surveys in Ethiopia conducted in the late 1990's reported a rural prevalence of 4.6/1000 and an urban prevalence of 6.4/1000 [7,8]. One recent collaborative echocardiographic screening project from Jimma, ET and Cape Town, SA using World Heart Federation (WHF) criteria reported a definite RHD prevalence of 16 per 1000 [9]. The variation in echocardiographic definitions of rheumatic heart disease necessitated the development of standardized criteria for consistent identification of individuals with RHD. In 2012 the WHF developed a guideline to define the minimum echocardiographic criteria for diagnosing definite and borderline RHD [10]. This study was designed to determine the prevalence of RHD among 6–18 year old school children using echocardiography as a screening technique across different regions of Ethiopia.

2. Methods

A national cross-sectional echocardiography survey was conducted from April 01, 2013 to December 10, 2014. Ethiopia is the second most populous country in Africa with estimated population size of 87,858,703 in 2013 [11]. The majority of the population lives in rural areas (82.6%). There were 20,137,755 school children (6–18 years) at school in 2013 with overall school enrollment ratio of 77.7%. Our study involved 3238 school children from 28 primary and secondary schools located in six major administrative regions. We calculated a total sample size of 3300 school children based on: 1) previous clinical surveys showing urban prevalence of RHD in Ethiopia 6.4/1000 and rural prevalence of 4.6/1000 giving an average prevalence of 5.5/1000 [7,8]; 2) previous echocardiography based screening from other countries showing 5–10 fold increase in prevalence compared to auscultation-based screening; (upper border = 10%) taken to increase the sample size); 3) a margin of error (α) of 5%; 4) a cluster design effect of 1.5 and incomplete echocardiography data of 10%. Fig. 1 shows the 6 regions where the study was conducted and the number of school children sampled from each region.

The total sample size was divided to the six study sites proportionally to predefined population size under each study site. At each site the allocated sample size was divided to 1/3rd urban and 2/3rd rural school children. At each study site, Districts having both rural and urban school children were identified and one district was selected by simple random sampling. Simple random sampling was used to select one primary and one secondary school for both rural and urban residence from the list of schools in the district. At the selected school the total sample size was divided to the grades of the school equally. Then systematic random sampling was used to select a given school child by using their roster numbers. Informed consent was obtained from each patient and the study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human research committee. At the study sites, after getting permission from the local educational bureau and principals of the schools, written consent forms were sent to parents and caretakers. Echocardiographic and selected socio demographic data were obtained from those who returned signed consent forms. Additional verbal assent was taken from students.

Children found to have RHD based on the screening were linked to the nearest hospital or to the respective University Hospitals for initiation of secondary Benzathine penicillin prophylaxis and for further follow up. Children found to have non-Rheumatic cardiac lesions were referred to the university hospitals for further investigation, follow up and subsequent management.

We used two dimensional and Doppler echocardiography to diagnose RHD according to the WHF criteria [12]. Except at Mekele Site, where Vivid e (GE company) was used, we used a Sonosite Turbo (P21 probe) machine for the screening purpose. To keep uniformity in the definitions of RHD cases, training (both theoretical and practical) on the current WHF echocardiography criteria of RHD was conducted for all participants before the actual data collection was begun. The echocardiograms were recorded by echocardiography trained pediatricians and internists working in the referral hospitals of the study regions under supervision of adult and pediatric cardiologists who were responsible for the quality and confirmation of the findings. Central independent reviewer again reviewed the echocardiograms and third independent cardiologist resolved any disagreement with field cardiologists. Children were classified "normal" or as having 'definite' or 'borderline' RHD according to the WHF criteria [10]. Additional data such as age, gender, family size and residential area were collected during the screening.

Data were analyzed using IBM SPSS Statistics 21 (IBM, New York, USA) and Excel 2013. Descriptive data were summarized using standard univariate techniques and reported as percentages with odds ratios (OR) with 95% confidence intervals (95% CI), means with standard deviation (SD), or medians with interquartile range (IQR) depending on the data format and distribution. Categorical data were analyzed univariately by Chi-square tests or Fisher's exact test. A P value less than 0.05 was taken to indicate statistical significance and all tests were two-sided. Logistic regression models were developed to identify independent factors associated with the presence of RHD.

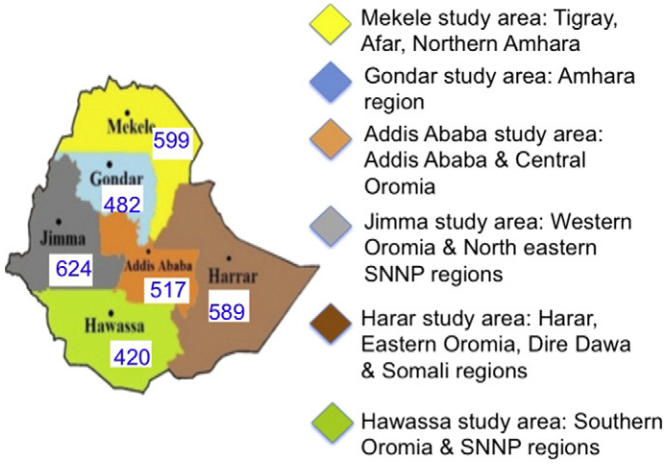

Fig. 1. Study areas included in the rheumatic heart disease survey and corresponding number of children screened from each study site.

3. Results

A total of 3238 schoolchildren were screened with response rate of 98.1%. Two thirds (66.9%) of the children were from schools in rural areas. Female students contributed to almost half (48.5%) of those screened. Overall age range for both males and females was 6 to 18 years with a median age of 14 years. These data are presented in Table 1.

As shown in Table 2, from the 3238 school children screened, 44 (1.4%) of them were diagnosed to have definite RHD making the prevalence 14/1000. The majority were girls (26/44, 59%). RHD involved the mitral valve in 42 subjects; and the aortic valve in 6 of the subjects. Fifteen (0.5%) of the school children had borderline RHD, making the prevalence 5/1000, with mitral regurgitation constituting the majority. Definite RHD is about three fold higher than borderline RHD. We found mitral stenosis in 3 of the students, whose mean age was 12.7 years.

Table 3 describes the distribution of RHD within the various characteristics. The prevalence of definite RHD was seen slightly more often in females, students of age group 10–12 years, those from urban area, family size of 7 and above, and from the Gondar study site, but there were no statistically significant differences when logistic regression analysis was performed. The prevalence of RHD was lowest in children aged 6–9 years and is uniformly distributed in those aged 10–18 years.

Table 1
Sociodemographic characteristics of the school children screened for rheumatic heart disease.

Variables	Frequency	Percent
Sex		
Male	1666	51.6
Female	1565	48.4
Age		
6–9	474	14.7
10–12	830	25.7
13–15	1034	32.0
16–18	890	27.5
Missing	3	0.1
Mean age (in years) (SD)	13.22 (3.18)	
Median age (in years)	14 IQR [11–16]	
Urban vs rural		
Urban	1069	33.1
Rural	2162	66.9
Study site		
Jimma	624	19.3
Mekele	599	18.5
Harar	589	18.2
Addis Ababa	517	16.0
Gondar	482	14.9
Hawasa	420	13.0

Table 2
Prevalence of definite and borderline rheumatic heart disease.

Variable	Frequency (n = 3238)	Percent
Definite RHD	**44**	**1.4**
Mitral regurgitation with two mitral morphological features of RHD	39	1.2
Aortic regurgitation: with two aortic morphological features of RHD	6	0.2
Mitral stenosis with mean gradient >4 mm HG	3	0.1
Borderline RHD	**15**	**0.5**
Pathologic Mitral regurgitation	8	0.3
Pathologic Aortic regurgitation	3	0.1
Two morphologic Features of RHD	4	0.1

Abbreviations: RHD = rheumatic heart disease.

4. Discussion

This survey is the first multicenter study involving six sites across Ethiopia, representing regions in Central, Southern, North, Northwest, Southwest, and East Ethiopia. We demonstrate three key findings: First, the prevalence of asymptomatic RHD (definite and borderline) in school children aged 6 to 18 years is almost 3-fold higher compared to Oli K et al. auscultation-based report: 17/1000 versus 6.4 per 1000 for urban and 12/1000 versus 4.6/1000 for rural [7,8]. Second, we have confirmed the findings of Engel et al. in a previous single-site study done in rural Ethiopia that definite disease is the predominant lesion in asymptomatic RHD in Ethiopia. Third, our sampling across regions and settings shows a consistent pattern of asymptomatic RHD across districts and rural–urban settings.

The higher prevalence in echocardiographic screening is in agreement with other studies done in Uganda, Mozambique, Nicaragua, and Cambodia [2,6,13]. The recent study done in rural Jimma, Ethiopia and South Africa using WHF criteria reported a higher prevalence of RHD in Jimma (16/1000) than Cape Town, South Africa [9]. The Jimma–Cape Town study also showed variation in the prevalence of RHD in different countries and variation in different communities of the same country [9]. In our study there were only subtle variations in the regional prevalence, suggesting less of a socio-economic gradient difference between the regions compared to the larger difference between rural Jimma and peri-urban Cape Town.

Table 3
Descriptive characteristics of the school children stratified by the presence or absence of definite rheumatic heart disease.

	Definite RHD			
	Yes (%)	No (%)	P-value	Crude OR
Sex				
Female	26 (0.8)	1543 (47.7)	0.16	1.5
Male (ref)	18 (0.6)	1651 (51)		1.00
Age				
6–9 (ref)	4 (0.1)	472 (14.6)		1.00
10–12	13 (0.4)	819 (25.3)	0.28	1.9
13–15	14 (0.4)	1022 (31.6)	0.4	1.6
16–18	13 (0.4)	878 (27.1)	0.33	1.7
Residence				
Urban (ref)	18 (0.6)	1057 (32.6)		1.00
Rural	26 (0.8)	2137 (66)	0.28	0.7
Family size				
Less than 7	26 (0.8)	2066 (66.0)	0.72	0.89
7 and above	18 (0.6)	1024 (32.7)		1.00
Study site				
Jimma	8 (0.2)	616 (19.0)	0.6	1.4
Mekele	5 (0.2)	594 (18.3)	0.86	0.89
Harar	6 (0.2)	583 (18.0)	0.9	1.1
Addis Ababa	9 (0.3)	508 (15.7)	0.3	1.9
Gondar	12 (0.4)	470 (14.5)	0.09	2.7
Hawassa (ref)	4 (0.1)	423 (13.1)		1.00

The prevalence of borderline RHD in this study is 5 per 1000. This gives a ratio of definite to borderline cases of 3 confirming the findings from Jimma, Ethiopia previously published. This implies a higher severity of disease, which is also supported by the findings of three cases of mitral stenosis. The vast majority of previous echocardiographic findings has been of mild mitral regurgitation, and mitral stenosis has only previously been reported in screening studies combined with auscultation [14]. A recent report has shown a high prevalence of juvenile mitral stenosis in our country [15]. This finding suggests a more aggressive course of RHD and deserves further investigation.

Analysis of RHD prevalence in relation to different socio demographic parameters suggested slightly more cases of definite RHD in females, older age groups, urban areas and children with larger family size, but none of these socio-demographic factors reached statistical significance. A recent systematic review and meta-analysis by Rothenbuhler et al. also concluded that there were no documented sex-related differences in prevalence of rheumatic heart disease in school children-based studies [16]. The prevalence of RHD was lowest in children aged 6–9 years and is uniformly distributed in those aged 10–18 years. This is similar to other studies from Uganda, Senegal and Australia [6,13,17]. There was a tendency of higher prevalence in the urban areas, as was also observed by Oli et al. in Ethiopia and Pakistan. In contrast to the finding in our study, the prevalence of RHD from Nicaragua was reported to be higher in rural settings when compared with urban areas [2,13].

When we looked in to the pattern of affected valves, the majority, 42/44 (95.5%), of the affected children had mitral valve involvement. Mitral regurgitation was present in 88.7% of these children and mitral stenosis in 6.8%. The aortic valve was involved in 13.6% of the definite RHD cases, and all were aortic regurgitation. This is similar to previous study done in Jimma where majority had mitral regurgitation (84.2%) [9]. The majority of the definite RHD cases were mild (32, 73%); there were only 5 severe cases. Only 2 (4.5%) of those knew that they had rheumatic heart disease and were on secondary prophylaxis. This finding is in line with the usual clinical scenario of RHD patients who present with complications like heart failure and stroke. It also correlates well with several echocardiographic surveys which showed higher prevalence of clinically silent rheumatic heart disease: 7–8-fold higher than that of clinically manifest disease [16].

This study has several strengths. It represents the first multisite survey done using standardized echocardiographic criteria from potentially representative regions in the country. It also sampled rural and urban sites, thus allowing for a more representative better national figure. The study however, had inadequate power to detect significant predictors for RHD.

5. Conclusion

The national prevalence of RHD as determined by echocardiography screening is almost three-fold higher than previously predicted in Ethiopia by auscultation-based screening. Definite disease is higher than borderline disease in all areas of Ethiopia, thus suggesting that a directed screening program targeted at both urban and rural areas should be considered. All aspects of prevention for RHD should be prioritized, including timely treatment of sore throat, secondary prophylaxis for those detected to have the disease and multi-level engagement to address mortality and morbidity from RHD in Ethiopia.

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Conflict of interest

None.

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