Prevalence of Rheumatic Valvular Heart Disease Among Egyptian School Children: An Echocardiographic Screening

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Abstract

Introduction: Rheumatic valvular heart disease remains a major cause of morbidity and premature death in developing countries. Exact prevalence data are still lacking and are also highly desirable to facilitate health care planning.

Methodology: An indicative sample of school children in Egyptian Governorates was examined clinically and by echocardiographic Doppler examination for the presence of rheumatic valvular heart disease, in the period between Sept 2009 to May 2011. Definite rheumatic valvular affection as defined by the presence of any definite evidence of mitral and/or aortic valve regurgitation seen in two planes by Doppler echocardiography, accompanied by at least two of the following three morphologic abnormalities of the regurgitant valve: Restricted leaflet mobility, focal or generalized valvular thickening.

Results: A total of 48930 school children, age ranged between 6 and 18 years, 49.1% males, were included. An abnormal cardiac examination or history suggestive of rheumatic affection was reported in 2712 students, only 1603 had an adequately imaged transthoracic echocardiography fulfilling the protocol. Definite rheumatic valvular disease was documented in only 35 (2.2%), and probable affection in 107 (6.6%) of the total examined sample who underwent echocardiographic examination (n=1603). The prevalence rate of rheumatic valvular heart disease is 0.07% (7 in 10,000 of examined Egyptian students), abnormal combination of mitral valve affection was the dominant feature in 174 (65.9%, n=264); 34 had thickening of leaflets, 21 had subvalvular thickening, 16 had mitral stenosis, 86 had variable degree of mitral valve prolapse. Regurgitant jet area of more than 1cm² in two planes was reported in 125 students, and 17 had grade I mitral regurge of undertermined etiology. Aortic valve was reported abnormal in 43 students (16.3%), bicuspid in 6 (0.2%), and regurgitant of grade II severity in 8 students (0.3%), out of 1603 echo performed.

Conclusion: Because rheumatic heart disease remains a major cause of morbidity and mortality in developing nations, these data have potentially important implications for case finding and early detection, delivery of effective primary and secondary prevention, and adequate planning of health services.

Key Words: Rheumatic valvular heart disease — Echocardiographic screening.

Introduction

RHEUMATIC valvular heart disease remains a major cause of morbidity and premature death in developing countries [1,2]. Exact prevalence data are still lacking and are also highly desirable to facilitate health care planning.

Almost all population-based epidemiologic surveys have relied on careful clinical examination of school-age children, with confirmation of clinically suspected cases by echocardiography. Such surveys show current prevalence rates of rheumatic heart disease of approximately 1 to 5 cases per 1000 among school-age children in developing countries, with the highest rates in sub-Saharan Africa [2,3].

Echocardiography is known to be more sensitive than auscultation for the detection of pathologic valve disease, [4] and the recent availability of high-quality portable ultrasound equipment makes it possible to screen large numbers of children at schools in developing nations. Furthermore, the 2004 World Health Organization Expert Consultation Report states that echocardiographically diagnosed, clinically silent rheumatic valve involvement should be managed as rheumatic heart disease until proved otherwise [4].

Hypothesis:

We therefore hypothesized that comprehensive clinical screening, endorsed by conventional as well as Echo Doppler in school children, may yield
or reveal a higher prevalence of cases than clinical examination alone.

Project team performed multi-phasic stratified random samples on two governorates, population-based studies of school-age children, one in Northern Coastal Governorate, Alexandria (Lower Egypt), and one in Southern Upper Egypt (Upper Egypt), Minia, in order to assess the feasibility of echocardiographic screening and to ascertain whether this method would yield a more realistic estimate of the prevalence of rheumatic valvular heart disease than that obtained by screening with the use of predominantly clinical criteria alone.

Material and Methods

The study was conducted in Alexandria and Minia Governorates, because these two areas are representative of two important and different geographic regions of Egypt, where previous surveys on the prevalence of rheumatic valvular heart disease in school-age children were not known or documented, and because local authorities and investigators were willing and able to participate in the studies.

Setting and Survey Methods:

School visits were done by a team of cardiologists with at least three years experience in a University Hospital or in National Heart Institute in Cairo. The steering group of project’s team, or the central group of investigators, reviewed the established protocol for prospectively defined clinical and echocardiographic criteria for the diagnosis of rheumatic valvular abnormalities.

After approval of both the Ministry of Health and of the Ministry of Education, the investigators in both Alexandria and Minia, approached the directors of randomly selected both private and national schools, who agreed to participate. All children in each school were invited to participate after an oral informed consent obtained from their parents or legal guardians.

The children underwent comprehensive clinical and echocardiographic examination (with a hand carried, battery operated Vivid E, General Electric echocardiographic machine, equipped with a 1.5-4 MHz transducer [351], for signs of rheumatic heart disease.

Images were recorded on external drive for later review by an independent cardiologist who was experienced in diagnosing rheumatic heart disease, and was not aware of the clinical findings. The following data were obtained: Parasternal long and short axis views at the levels of great vessels, mitral valve and papillary muscles, apical four, two, long axis, five chamber and subcostal views. Attention was directed to the cardiac valve morphology, and the extent of functional affection as assessed by two dimensional and color echo-Doppler techniques. Transvalvular flow gradients were assessed for peak and mean values. The study was performed by the researcher and in 15% by a blind expert cardiologist for interobserver variability, and 20% of the echocardiographic reexamination were reviewed for quality control.

For each child, a full questionnaire was obtained including history data suggesting acute rheumatic fever, and a detailed clinical examination. Those students who elicited any abnormality in either history taking or in cardiac examination, namely a cardiac murmur, underwent the detailed echocardiographic and Doppler examination at their schools. Absentees were noted and revisits were made to examine all of them, whenever possible.

Clinical and echocardiographic definitions:

Clinical examination was directed to the diagnosis of rheumatic heart disease. Careful cardiac auscultation was performed with the patient in the supine and left lateral decubitus positions if needed. Children in whom an organic murmur was detected clinically, and/or a history suggestive of acute rheumatic fever [4], or history of taking long acting penicillin, echo Doppler examination was performed to confirm the presence of rheumatic valvular or any other structure or congenital heart disease.

Two sets of criteria were used for the diagnosis of rheumatic heart disease; the first are those set by WHO referring to a set of consensus recommendations for the subclinical rheumatic heart disease based on echoDoppler findings of the association of a regurgitant jet of more than one centimeter in length, seen in at least two planes, a mosaic color jet with a peak velocity >2.5m/sec, persisting throughout systole or diastole [5,6], or the presence of at least two of the three morphological rheumatic valvular features; leaflet restriction, valvular or subvalvular thickening, associated with any Doppler detected valvular regurgitation seen in at least two planes [6,7].

Only left-sided valves were examined for features of rheumatic heart disease; mild tricuspid regurgitation and pulmonary regurgitation were frequently noted but were not regarded as indicating rheumatic heart disease. Rheumatic heart disease was defined by the presence of any definite evi-
dence of mitral and/or aortic valve regurgitation seen in two planes by Doppler echocardiography, accompanied by at least two of the following three morphologic abnormalities of the regurgitant valve: Restricted leaflet mobility, focal or generalized valvular thickening, and abnormal subvalvular thickening. For a definite diagnosis of rheumatic heart disease, these features had to be identified concordantly by each of the echocardiographers, all of whom were experienced in the diagnosis and treatment of rheumatic heart disease. A possible rheumatic valvular heart disease is considered if there was an isolated valvular thickening or leaflet restriction of isolated mitral regurgitation of more than mild severity.

Isolated aortic regurgitation, mitral stenosis and thickening or fusion of subvalvular apparatus and/or commissures were regarded as definite rheumatic valvular affection. The severity of valvular affection was determined according to the American Society of Echocardiography recommendation for valvular disease [7].

**Statistical analysis** [8]:

1. **Sample size:**
   
The sample was based on using Epi Info program, EpiInfo, 2010. It is based on using the available number of students in each education district, prevalence of rheumatic heart diseases known in the region, and the acceptance accuracy rate for the investigator. These numbers are applied to program to produce the samples needed for each district.

2. **Analysis:**
   
   Data were analyzed on a personal computer using SPSS version 12, SPSS Corporation, 2004.* Qualitative (nominal) data are presented in number and percentage forms. Quantitative (numerical) data were presented as mean ± Standard Deviation. Sample means were compared with an independent samples Student's "t" test. The probability at 0.05 was used as minimum cut-off points for all significance tests.

**Results**

A total of 50,000 students from both public and private schools, in both studied governorates, were randomly selected to be included in the study. This represents a 10% of school children population in both governorates. Their age ranged between 6 to 18 years. The overall sample was distributed among class levels, with subjects of all class level, in order to ensure variable age distribution, and for each class level, all classrooms were included.

We were able to examine a total of 48,930 students. Their mean age was 11.09±4.51 years, and 49.1% were males. The distribution of the age group is represented in Fig. (1).

Abnormal history and/or cardiac auscultation was confirmed in 2712 pupils (5.5%). History of current use of long acting penicillin was obtained in 383 students (1.1%). Only the adequately imaged echocardiographic examination fulfilling the protocol were included. This established a sample of 1603 students. Echo was reported abnormal in only 264 (16.4%) of those examined.

Of those 1603 examined also was .................

Abnormal combination of mitral valve affection was the dominant feature in 174 (65.9%, n=264); 34 students (12.9%) had thickening of leaflets, 21 had subvalvular thickening, 16 (7.96%) had mitral stenosis, and 86 (35.6%) had variable degree of mitral valve prolapse. Regurgitant jet area of more than lcm2 in two planes was reported in 125 students (47.3%), and 17 (16.4%) had grade I mitral regurge of undertermined etiology.

Definite rheumatic valvular heart disease was documented in only 35 students (2.2%), and probable affection in 107 (6.6%) of the total examined sample who underwent echocardiographic examination (n=1603). Therefore the prevalence rate of rheumatic valvular heart disease in this examined Egyptian population is 0.07% (97 in 10,000).

Aortic valve disease was reported. The remainder abnormal echocardiographic findings were congenital heart disease abnormal in 43 students (16.3%), bicuspid in 6 (0.2%), and regurgitant of grade II severity in 8 students (0.3%) (n=1603). (Atrial septal defect in 10 students, Ventricular septal defect in 2, Pulmonary stenosis in 13, interatrial septal aneurysm in 2, and Patent ductus arteriosus in 2, and dilated coronary sinus in one).

![Fig. (1): Age distribution of sample examined.](image-url)
Discussion

There is little doubt that rheumatic heart disease remains a major cause of morbidity and mortality in developing nations. Recent reports of approximately 15 million cases in the developing world [1,2] may have underestimated the actual burden of this disease, because these estimates are based on prevalence data obtained by comprehensive clinical screening rather than echocardiographic screening. The findings in the current study suggest that echocardiographic screening might be more accurate in detecting cases screened in school-age children.

It was believed that echocardiographic screening of schoolchildren may underestimate the true prevalence of rheumatic heart disease, since the major risk factors for rheumatic fever include poverty, overcrowding, and poor access to medical services, all of which are probably associated with a reduced likelihood of attending school. However, this prevalence rate, we observed in two populations of children with an average age ranging between 6 and 18 years, is similar to community data reported from Australian aborigines, that suggest a much higher prevalence of rheumatic heart disease in children over 15 years of age [1,9].

There are at least two pressing reasons to obtain accurate prevalence data on rheumatic valvular abnormalities in children: To guide regional health service planning and to accurately identify affected children to be targeted for secondary prevention. Although many cases of rheumatic valvular abnormalities in children may resolve spontaneously [10], many will progress to clinically manifested disease in young adulthood ill. Prophylactic antibiotic therapy and regular medical surveillance, if adequately administered, may be highly effective in preventing disease progression, even in children with subclinical disease [3].

The field surveys reported previously planned and coordinated centrally from institutions located in Paris, and the choice of countries for these projects were based in part on contacts and knowledge of governmental and medical services in Cambodia and Mozambique [5]. The initially surprising findings in Cambodia prompted to undertake a similar study in Mozambique, with more rigorous protocols for randomized selection of schools and children, as well as protocols for follow-up of subjects, to assess the generalizability of their findings. Although environmental factors, genetic predisposition, specific virulence factors of group A streptococcus serotypes, management of antibiotic prophylaxis, and access to preventive care may all affect prevalence rates in specific areas, there is no reason to believe that their findings, which were remarkably similar in these two locations, would be valid only in the countries studied. We believe that this pattern is likely to be replicated elsewhere in other developing countries like Egypt, while acknowledging that this question may require considerably more investigation.
Among more than 100 cross-sectional school surveys of rheumatic heart disease reported to date, one study included echocardiography of all surveyed children [iii]. In this study, which was conducted in Kenya, the prevalence of echocardiographically detected trivial mitral-valve regurgitation was 62 cases per 1000 and the prevalence of clinically detected rheumatic heart disease was 2.2 cases per 1000. Because these investigators did not present any data on valve morphology or the characteristics of the regurgitant jet, it was not clear whether the regurgitation was physiologic or was due to rheumatic or congenital disease. Indeed, many authors have emphasized the need to avoid overestimating the prevalence of rheumatic heart disease, which can result from inclusion of all cases of minor valve regurgitation, and to examine potentially affected valves for other structural or functional evidence of a rheumatic cause [5,13].

There has been some debate concerning the echocardiographic signs of early rheumatic heart disease [5,13-15]. Some groups have preferred an echocardiographic definition of rheumatic heart disease based on the length, velocity, and persistence of the regurgitant jet [4,16,17]. However, these features may depend on the gain settings on the ultrasound equipment; thus, diagnosing subclinical rheumatic heart disease when Doppler criteria for abnormalities are also associated with morphologic valve changes would be expected to improve the specific diagnosis of rheumatic heart disease.

In addition, the use of morphologic criteria combined with Doppler criteria for diagnosing rheumatic valve involvement may result in under-diagnosis of subclinical rheumatic heart disease, particularly in children who are screened soon after a first episode of acute rheumatic fever. Although portable ultrasound technology now makes it possible to perform most cardiac diagnostic assessments in schools, our findings support the need for a definitive cardiac ultrasound examination in suspected cases to avoid over-diagnosis.

Two recent reports have also advanced arguments in favor of echocardiographic screening in rheumatic heart disease prevalence studies. Meira and colleagues [10] reported that in 34% of their patients with carditis, clinical examination after the acute phase showed normal findings, although progression to chronic subclinical valvular disease was confirmed by echocardiography in 82% of such cases. Furthermore, the latest report on rheumatic heart disease from the World Health Organization states that in areas where rheumatic heart disease is endemic, echocardiography may be used to diagnose "silent but significant rheumatic carditis of insidious onset" and recommends that such cases be managed as rheumatic heart disease until proved otherwise [4]. Although echocardiographic criteria are still not included in the Jones criteria, this recommendation may represent a new step toward acknowledgment of subclinical lesions.

Even though portable echocardiographic equipment is now highly developed and accurate, echocardiographic screening may not be a practical local solution for case identification under the current financial constraints on provision of diagnostic services in developing nations. However, echocardiographic screening would be a desirable goal to optimize case identification and targeted (secondary) prevention measures. Funds for the purchase of the ultrasound equipment—the major expense of an ultrasound-based screening program for rheumatic heart disease—might be obtainable from charitable organizations. Our results might encourage a strategy of echocardiography-based screening programs for rheumatic heart disease, involving education and both primary and secondary prophylaxis, and based on accurate assessment of the prevalence of rheumatic heart disease [16,18].

Summary:

A cross sectional observational study documented for the first time among Egyptians, the prevalence of rheumatic valvular abnormalities in school-age children, by a comprehensive echocardiographic screening. Because rheumatic heart disease remains a major cause of morbidity and mortality in developing nations, these data have potentially important implications for case finding and early detection, delivery of effective primary and secondary prevention, and adequate planning of health services.

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References


