

Prevalence and Predictors of Rheumatic Heart Disease among School Children in Mansoura District, Egypt

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Abstract

Background: Rheumatic heart disease (RHD), a long-term complication of acute rheumatic fever (ARF), is still the main cause of paediatrics acquired heart disease, premature deaths and disabilities among indigenous Egyptian populations. It influences mostly children and young adults. **Objective:** This study aimed to estimate the prevalence of RHD detected by echocardiographic screening among school children (age 5-18) in Mansoura District at Dakahlia governorate, Egypt. **Method:** This descriptive cross-sectional study included 4847 school children recruited from the governmental urban & rural schools considering the pattern of population distribution in rural and urban areas in Mansoura. A predesigned structured questionnaire was given to parents of children. All children were examined by echocardiographic examination to detect RHD. **Results:** The prevalence of RHD among studied group was 0.9 %. The most significant predictive factors for RHD were urban residence, overcrowding, positive surgical history of tonsillectomy and being on long acting penicillin. **Conclusion:** The utilization of echocardiographic screening for diagnosing RHD can prevent both its over- and under-diagnosis

Keywords: *Rheumatic heart disease – school children- echocardiographic Doppler examination*

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Introduction

RHD is the commonest acquired cardiovascular disease worldwide. It results in congestive heart failure, stroke as well as dysrhythmia. Almost eliminated in high-income countries but it still exists in low- and middle-income countries. It is a major cause of heart failure among children and young adults leading to disabilities and premature deaths.¹

The prevalence of RHD varied greatly between countries and even between different ethnic groups within the same country during the last 10 years of the last century in developing countries, the large

number of cardiac surgical procedures is due to RHD which constitute a significant burden on the individual, the family and the community at large and a drain of the economy.²

Currently, the yearly incidence varied from < 0.5/100 000 in high income countries to > 100/100 000 in poor countries.³ The incidence of acute rheumatic fever and RHD is elevated among children aged 5 - 14 years. In some cases, the first episode could happen in those aged two to three years.⁴

RHD disproportionately influences children living in poor, unhygienic and

overcrowded environments. Factors including deficient resources for providing quality health-care, insufficient knowledge of health-care providers and poor awareness about RHD are linked to its occurrence.⁵

Attempts to tackle the burden of RHD, have not been successfully implemented in low- and middle-income countries due to structural weaknesses of the health system. Currently, RHD is still the leading aetiology of heart-related mortalities in poor nations.¹ Early detection of subclinical RHD is essential in order to detect cases at a time when penicillin has the ability to prevent progression to valvular disease in early adult life.⁶

There is increased utilization of portable echocardiography for screening of RHD. Minimal echocardiographic characteristics of RHD have recently been elucidated.⁷

Echocardiography is known to be more sensitive than auscultation for the detection of pathologic valve disease, and the recent availability of high-quality portable ultrasound equipment makes it possible to screen large numbers of children at schools in developing nations.⁸

Having updated estimate up to date estimation of the prevalence of RHD among school children is highly desirable to facilitate health care planning. The current study aims to determine the prevalence of RHD detected by echocardiography among school children (age 5-18) in Mansoura District at Dakahlia governorate in Egypt and to find out the determinants of RHD among them.

Method

A descriptive cross-sectional study was performed on school children aged 5-18 (primary, preparatory and Secondary schools) in Mansoura District at Dakahlia governorate in Egypt during the period from September 2019 to December 2019.

Exclusion criteria included congenital heart disease, other autoimmune disease affecting valves as SLE or juvenile rheumatoid arthritis, end-stage LCF or RF which was uncommon and malignancy mainly blood diseases.

The calculated sample size was 4227 participants at 5% level of significance and 95% power of the study, using G*Power 3 sample size calculator.

Prevalence of RHD in Egyptian school children (2.2%) (EL-Aroussy, et al, 2013). It was increased to 5000 participants for compensation for incomplete data and to boost the power of the study. 153 child refused to do echocardiography. So the total number of the studied group was 4847 with response rate 96.9%.

The study was carried out in the governmental urban & rural schools that were selected randomly. Considering the pattern of population distribution in rural and urban areas in Mansoura, one third of the sample size was obtained from the urban schools. The other two thirds was obtained from the rural ones. Then cluster sampling of classes was done to select 5000 child.

A predesigned structured questionnaire was given to parents of children. It included socio-demographic characteristics such as age, sex, residence, father and mother's job, income and crowding index, medical history of long acting penicillin and surgical history of tonsillectomy.

Calculating crowding index: According to our quantitative analysis of crowding data from Central Agency for Public Mobilization and Statistics (CAPMAS) in 2006, and based on the international definitions and measurements for crowding, the average crowding index in Egypt was < 1.5 subjects/room; medium crowding was 1.5 - 1.7 subjects/room; and overcrowding was > 1.8 subjects/room.

General, local examination and Complete Transthoracic ECHO were done.

Table (1): Socio-demographic characteristics, Crowding index, surgical and medical history among studied students (N= 4847).

Socio-demographic characteristics	The studied group (n=4847)
Age (years)	
Mean ± SD	9.51±2.9
Min-Max	5-15
Sex	
Male	2266 (46.8%)
Female	2581 (53.2%)
Residence	
Urban	1599 (33.0%)
Rural	3248 (67.0%)
Education	
Nursery	628 (13.0%)
Primary	3254 (67.1%)
Preparatory	923 (19.0%)
Secondary	42 (0.9%)
Father job** (n=4824)	
Worker	4739 (98.2%)
Non worker	85 (1.8%)
Mother job** (n=4844)	
Worker	669 (13.8%)
Housewife	4175 (86.2%)
Income	
Insufficient	4002 (82.6%)
Sufficient	845 (17.4%)
Crowding index(subjects/room)	
Mean ± SD	1.46±0.39
Min-Max	0.5-6
Acceptable	844 (17.4%)
Medium crowding	3993 (82.4%)
Over crowding	10 (0.2%)
Tonsillectomy	
Positive	499 (10.3%)
Negative	4348 (89.7%)
Long acting penicillin	
Positive	706 (14.6%)
Negative	4141 (85.4%)
ECHO findings	
Normal	4803 (99.1%)
RHD	44 (0.9%)

**23 of fathers and 3 of mothers were died.

The results were obtained using Vivid E portable Echo and it was done under supervision of consultant echocardiographer. *2D mode:* To assess morphology of mitral valve apparatus &

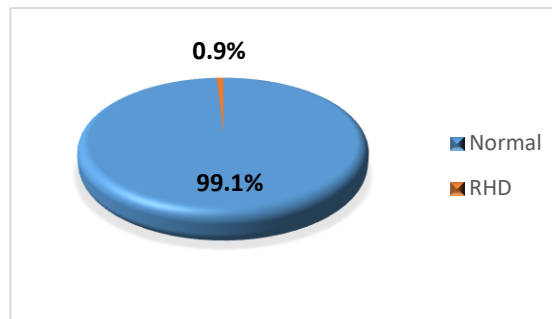


Figure (1): Prevalence of RHD by echocardiography among school children

Aortic valve mainly as regards thickening & Mobility of leaflets /Tips, chordae, commissures, papillary muscles & valve opening/area by planimetry.

M-mode: to assess LA/LV dimensions, AV cusp opening and MVL excursion.

Doppler study: Pulsed wave Doppler of MV /AV flow to assess low velocity flow or Continuous Doppler of MV /AV to assess mean/peak Gradient, MVA by PHT. Heart underwent examination in parasternal long axis, short axis and apical four chamber views.

Criteria utilized for defining subclinical RHD by Echocardiography WHO, 2012:

The combined criteria:

Doppler criteria: A regurgitant jet > 1 cm in length, a regurgitant jet in at least two planes, a mosaic color jet with a peak velocity >2.5 m/s, the jet persists throughout systole and diastole B)

Morphological signs:

Leaflet restriction, Sub valvular thickening, Valvular thickening, Beading\ nodularity of leaflet tips.

Statistical Analysis

This was done using Statistical Package for Social Sciences (Standard version 24). Qualitative data were represented as number and %. Chi-square (χ^2) test compared between the groups. Quantitative data were represented as mean (SD) after normality testing by Kolmogorov-Smirnov test. Independent sample *t*-test was utilized

Table (3): Socio demographic characteristics, Crowding index, surgical and medical history among students with RHD versus normal students

Socio-demographic characteristics	RHD (n=44)	Normal (n=4803)	Test of significance (p value)	COR (95%CI)
Age (years) Mean ± SD	9.46±2.95	9.84±2.52	0.85 (0.396)	-
Sex				
Male (r)	18 (0.8)	2246 (99.2)	0.60 (0.438)	1.3 (0.7-2.3)
Female	26 (1)	2557 (99)		
Residence				
Urban	24 (1.5)	1575 (98.5)	9.33 (0.002*)	2.5 (1.3-4.5)
Rural (r)	20 (0.6)	3228 (99.4)		1
Education				
Nursery (r)	3 (0.5)	625 (99.5)	-	1
Primary	36 (1.1)	3218 (98.9)	2.09 (0.15)	2.3 (0.7-7.6)
Preparatory	5 (0.5)	918 (99.5)	0.03 (0.86)	1.1 (0.3-4.7)
Secondary	0 (0)	42 (100)	Undefined	Undefined
Father job				
Worker (r)	41 (0.9)	4698 (99.1)	FET (0.528)	1.4 (0.2-10)
Non worker	1 (1.2)	84 (98.8)		
Mother job				
Worker	9 (1.3)	660 (98.7)	1.65 (0.199)	1.6 (0.8-3.4)
Housewife (r)	35 (0.8)	4140 (99.2)		
Income				
Insufficient	39 (1)	3963 (99)	1.14 (0.286)	1.6 (0.6-4.2)
Sufficient (r)	5 (0.6)	840 (99.4)		
Crowding index (subjects/room)				
Acceptable (r)	8 (0.9)	836 (99.1)	-	1
Medium	32 (0.8)	3961 (99.2)	0.2 (0.67)	0.8 (0.4-1.8)
Over crowding	4 (40)	6 (60)	108(≤0.001**)	69 (16-295)
Tonsillectomy				
Positive	16 (3.2)	483 (96.8)	32.7 (≤0.001**)	5.1 (2.7-9.5)
Negative (r)	28 (0.6)	4320 (99.4)		
Long acting penicillin				
Positive	25 (3.5)	681 (96.5)	63.7 (≤0.001**)	7.9 (4.4-14.5)
Negative (r)	19 (0.5)	4122 (99.5)		

*significant $p \leq 0.05$, **highly significant ≤ 0.001 , COR: crude odds ratio, CI: confidence interval

Table (2): Echocardiographic findings of rheumatic patients (n=44)

Echocardiographic findings	RHD (n=44)
Mitral regurgitation (MR)	39 (88.6%)
Mild	35 (89.7%)
Moderate	1 (2.6%)
Trivial	3 (7.7%)
Aortic regurgitation (AR)	5 (11.4%)
Mild	5 (100%)

to compare between groups. Binary stepwise logistic regression analysis predicted the independent variables. Significant predictors in univariate analysis were entered into regression model. Odds ratios and their 95% CI underwent calculation. “p value≤0.05”was statistically significant result.

Ethical consideration

The study protocol obtained its approval by IRB (Institutional Research Board) of Faculty of Medicine (No. MS/17.05.131). Written consent was taken from parents of entire participants. Confidentiality was maintained throughout the study.

Results

The study was conducted on 4847 school children. The mean age was 9.51±2.9 years with almost equal distribution as regards the sex. Approximately 67% of children were rural. Most of them (67%) were in primary grades. Most of their fathers (98.2%) were working whereas only 13.8% of their mothers were working. Nearly 82.6% of their parents had insufficient income. The mean crowding index was 1.46±0.39 with nearly 82.4% of their houses were considered as medium crowding. Nearly 10% of students reported that they had surgical history of tonsillectomy and 14.6% were on long-acting penicillin. The prevalence of RHD among studied group was 0.9 % as shown in table (1) and figure (1).

Valvular involvement in RHD children was predominately mitral regurgitation (88.6%), while aortic regurgitation represented only (11.4%) as shown in table (2).

On comparing both RHD versus normal groups regarding their socio demographic characters in (table 3), residence and crowding index were found to have statistically significant association with

Table (4): Multivariate Logistic regression analysis of independent predictors of RHD

Predictor	β	P - value	AOR (95%CI)
Residence			
Urban	0.967	0.002	2.6 (1.4-4.9)
Rural (r)			
Crowding index	4.112	≤0.001	61 (11-313)
Over crowded			
Tonsillectomy			
Positive	0.907	0.009	2.5 (1.2-4.9)
Negative (r)			
Long acting penicillin	1.919	≤0.001	6.8 (3.6-13)
Positive			
Negative (r)			
Constant	=-5.9		
Model	χ ² = 82.49, p≤0.001		
Predicted %	= 99.1%		

AOR: Adjusted odds ratio

RHD among studied group. RHD was 2.5 more times among urban and 69 more times in overcrowded houses. Also, RHD was 5.1 and 7.9 more times among those with surgical history of tonsillectomy and those with medical history of long-acting penicillin; respectively. Among all significant variables in univariate analysis, urban residence, overcrowding, positive surgical history of tonsillectomy and being on long-acting penicillin were found to be independent risk factors for CHD, with estimated odds ratio of (2.6, 61, 2.5 and 6.8., respectively) as shown in logistic regression analysis (table 4)

Discussion

In Egypt, epidemiological surveys showed that RHD was the commonest serious heart disease as it was estimated to exist in approximately 0.8-2% in spite of long acting penicillin administration.⁹ The current study reported that echocardiographic prevalence of RHD was 0.9 % (9 /1000 students) which is near to the prevalence that was reported by WHO control program in 2004 (9.8 per thousand

school children 6-12 years old *WHO*¹⁰ and by *Baroux et al.*¹¹ in New Caledonia in west pacific where the prevalence was 8.9 cases per 1000 (95% CI) (7.3–10.6). A recent study by *Musuku et al.*¹² in Zambia stated that RHD prevalence was 11.8 per 1000.

This current prevalence result is higher than that found among school children by *Deraz et al.*¹³ in Dakahlia in Egypt and *Nair et al.*¹⁴ in south India with estimated prevalence rates were 1/1000 and 5.83/1000; respectively. This discrepancy may be due to application of different approach as echocardiography was applied only on those who had clinical positive finding in those previous studies

On the other hand, earlier studies utilizing echocardiographic screening reported greater prevalence of RHD in school-age children, including studies by *Marijon et al.*¹⁵ in Cambodia (30.4 per 1000), *Carapetis et al.*¹⁶ in Tonga (33.2 per 1000), *Sadiq et al.*¹⁷ in Pakistan (21.9/1000) and *Saxena et al.*¹⁸ (14/1000).

Systematic screening using echocardiography revealed greater prevalence of RHD in comparison with clinical screening. Different echocardiographic criteria for RHD diagnosis may result in difference of RHD prevalence and essentially make epidemiological comparisons invalid. So, to close this gap, World Heart Federation (WHF) published the first internationally endorsed evidence-based criteria for echocardiographic diagnosis of RHD in 2012.⁶ These guidelines removed clinical examination from diagnosis and divided RHD into definite and borderline as well as providing subcategories within each for different combinations of diseases (isolated valvular regurgitation, isolated morphological alteration, etc.). But it allowed quick detection of RHD in patients with no history of ARF.

Valvular involvement in RHD children in this current study was predominately mitral regurge (88.6%) and this is consistent with other local and worldwide studies *El-Aroussy et al.*¹⁹, *Elamrousy et al.*²⁰ and *Ghamrawy et al.*²¹ in Egypt and by *Lubega et al.*²² in Uganda and *Badiani et al.*²³

By using multivariate Logistic regression analysis, the current study reported that RHD was 2.6 more times among urban children. These results go with finding of *Riaz et al.*²⁴ and *Ghamrawy et al.*²¹ Many Egyptian villages have shown rapid urbanization, resulting in congested socio-economically depressed localities.²¹ This explains why urban residency in our study linked to RHD. However RHD was more common among cases from rural locations in studies done by *Carapetis et al.*²⁵ and *Baker et al.*²⁶ The current study also showed that RHD 69 more times in overcrowded houses. This also runs with previous reports from around the world by *Watkins et al.*²⁷ and *Sharma et al.*²⁸

RHD was 2.5 and 6.8 more times among those with surgical history of tonsillectomy and those with medical history of long-acting penicillin; respectively and this was in accordance with the results of *Ghamrawy et al.* (2020). Though the majority of children having repeated attacks of tonsillitis were instructed to perform tonsillectomy prior to the study, a considerable number ultimately developed ARF in its different presentations. In Egypt, family makes a decision to perform tonsillectomy to prevent recurrent respiratory infections or frequent attacks of tonsillitis, although ARF and its complications may have been already developed. Families that had their children tonsillectomized do not look for therapy for succeeding attacks of pharyngitis since they believe that tonsillectomy will eradicate infection and prevent ARF and RHD. This reveals a minimal awareness regarding the

disease as well as insufficient expertise of health-care providers. There is significant evidence that tonsillectomy does not change the susceptibility to streptococcal infection or its outcomes. Once that infection is established, the existence or nonexistence of tonsils does not change the clinical course. Furthermore, it seems that streptococcal infection is less readily identified in tonsillectomized subjects and, thus, is more likely to escape therapy appropriate for ARF prevention *Powell et al.*²⁹

Conclusions

The echocardiographic prevalence of RHD among studied group was 0.9 %. The most significant predictive factors for RHD were urban residence, overcrowding, positive surgical history of tonsillectomy and being on long-acting penicillin.

Recommendation: Sustained outreach RHD screening campaigns as well as school-based clinics employing echocardiography must be carried out in marginalized communities for early RHD determination. Formulating national guidelines, applying a well-organized national strategy, upgrading national registry system through applying REDCap (Research Electronic Data Capture), capacity building, better access to echocardiography, promoting research for new streptococcal vaccine candidates, and adopting proper investigations must be ensured.

Study limitations: our study did not focus on finding new factors which might have an enhanced risk, rather looked for the identified risk factors and how these operate in Egyptian population. Data regarding housing conditions were deficient and were dependent upon interview with participants and have not been ascertained through

household visits because of time and resource constraints.

Conflicts of Interests: None

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Availability of data and material: The study's data are available from the corresponding author on reasonable request

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