

# Pattern of rheumatic heart disease in Southern Yemen

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## ABSTRACT

**Objectives:** To determine the pattern of rheumatic heart disease in Aden city and surrounding areas by assessing its frequency distribution, severity and complications.

**Methods:** We conducted this research in a sole regional echocardiographic department for Southern Yemen governorates at a referral hospital located in Aden city, from January 1999 to December 2003. It was a retrospective study focused on echocardiographic findings in 805 patients affected by rheumatic heart disease.

**Results:** Out of 805 patients, 383 (47.6%) were male and 422 (52.4%) were female (age range, 4-70 years; mean age,  $28.6 \pm 14.5$ ). Heart valve damage was distributed among patients as follow: mitral 459 (57.1%), aorta 70 (8.7%) and both valves 276 (34.2%); isolated lesions 55.2% and multiple 44.8%; mitral regurgitation 464 (57.6%), mitral stenosis 405 (50.3%), aortic regurgitation 327 (40.6%) and aortic stenosis 54 (6.7%). All children aged less than 10 years had regurgitation. Stenosis and multiple valve lesions predominated in adolescents and young adults. Complications were detected in 20.8% of cases. Pulmonary hypertension was the most common complication (80.4%). Lesions with moderate and severe degree were detected in 51% cases. Only 34.8% of patients at severe stage were operated.

**Conclusion:** Rheumatic heart disease takes an aggressive course in Southern Yemen. Children, adolescents and young adults of both gender are the victims. Complications appear early with scanty opportunity to reach advanced age. There is a little chance for palliative treatment.

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Rheumatic heart disease (RHD) is a residual and progressive valve deformity resulting in stenosis or a combination of stenosis and insufficiency, which appears between 2-10 years after an episode of acute rheumatic fever. Its pattern has changed in developed countries and appears to undergo changes in certain developing countries probably in association with the use of antibiotic and improvement of socioeconomic conditions.<sup>1,2</sup> In these countries, degenerative heart diseases are increasing while heart diseases related to infection are decreasing. Therefore, rheumatic heart diseases have become rarer, progressive and their symptoms appear between the ages of 45 and 64 years. On the other hand, in developing areas, where predisposing factors to rheumatic fever persist and prophylactic penicillin therapy is inadequate, rheumatic heart disease is still a major public health problem and remains the most common cardiovascular cause of death among children and young adults.<sup>3</sup>

The recurrent episodes of acute rheumatic heart disease may cause the rapid progressive damage of the heart valves, chronic residual deformity resulting in early stenosis or a combination of stenosis and insufficiency. Pure mitral incompetence and mixed mitral valve disease were the most common valvular lesions.<sup>4</sup> The severity of the disease increases with age, but may be present in children as young as 6 to 12 years.<sup>3,5</sup> Females are more prone to rheumatic heart disease than males. Socioeconomic class has a direct impact on the occurrence of this disease.<sup>6</sup> Complications such as atrial fibrillation, thrombus formation, infective endocarditis, and heart failure are common.<sup>7</sup>

Rheumatic heart disease remains one of the most common health burdens in Yemen, it is one of the most important cardiovascular disease seen in medical practice; however, its prevalence rate at the community level remains unknown. It is known that a hospital-based consecutive sample cannot provide accurate prevalence data, but it is the only available information regarding the diseases in undeveloped countries.<sup>8</sup>

The objective of this study is to determine the pattern of rheumatic heart disease in Aden city and nearby areas, by assessing its frequency distribution, severity and complications. Echocardiography was used as a tool

for diagnosis as it has superior sensitivity in detecting rheumatic carditis missed by clinical examination<sup>9</sup> and it is the most accurate technique for quantifying the severity of valve stenosis, regurgitation and estimation of pulmonary arterial pressure and heart function<sup>10, 11</sup>

**Methods.** This research was conducted in a sole regional echocardiographic department for Southern Yemen governorates (Aden, Lahij, Al-Dala Abyan and Shabwa), at a referral hospital (Algamhuria Teaching Hospital) located in Aden city, from January 1999 to December 2003. The persons with suspicion of heart disease were referred for echocardiography scanning in order to get the diagnosis. These patients had never been diagnosed by echocardiography. The patients that had one or more heart valves lesion (anatomical damage) with certain dysfunction (mitral regurgitation, mitral stenosis, aortic regurgitation or aortic stenosis) were included in this study. Those with trivial regurgitation, simple thickening of the heart valve without dysfunction, and lesions attributed to degenerative valve diseases were excluded. Out of 9452 scanned cases, 805 (8.5%) fulfill the criteria of rheumatic heart disease.

Transthoracic echocardiography scanning was performed to all patients. M-mode and 2-dimensional echocardiography were used to display the anatomical pathology feature of the lesions and heart dimensions. Color flow Doppler imaging, pulsed and continuous-wave Doppler was performed to evaluate the characteristics and severity of the transvalvular flow. Valve lesions were classified as purely regurgitant, purely stenotic, or mixed. In order to evaluate the severity of the valve lesion, the following criteria were applied:<sup>12,13</sup> Quantification of mitral stenosis severity was based on the size of mitral area calculated by 2-D or Doppler: severe  $\leq 1$  cm<sup>2</sup>, moderate  $>1$  to 2 cm<sup>2</sup>, mild  $\geq 2$  cm<sup>2</sup>. According to the value of the peak pressure gradient across the aortic valve, the aortic stenosis was classified into mild  $\leq 50$  mm Hg, moderate 50-79 mm Hg and severe  $\geq 80$  mm Hg. The severity of aortic valve regurgitation was evaluated according to the width of the vena contracta (in mm) and the percentage of width of aortic regurgitant jet to the left ventricle; it was considered: mild  $\leq 3.0$  mm and  $<25\%$ , moderate 3.0-5.9 mm and 25-64%; and severe at a wider area and when regurgitant jet reached the entire enlarged left ventricle. In case of mild mitral regurgitation the percentage of width of mitral regurgitant jet to the left atrial area was 20%, moderate 20-40% and severe when regurgitant jet diffuse into the enlarged left atrium, with systolic backward flow into pulmonary veins. Pulmonary artery systolic pressure (PASP) was estimated from the peak velocity of the tricuspid regurgitation jet plus the estimated right atrial pressure.<sup>14</sup> Patients with PASP  $\geq$

30 mm Hg were classified into 3 groups of pulmonary hypertension: mild  $<50$  mm Hg, moderate 50-79 mm Hg and severe  $\geq 80$  mm Hg.<sup>15</sup> Atrial fibrillation, infective endocarditis, atrial thrombus, pulmonary hypertension, were considered complications related to RHD. Patients with severe form of RHD who had surgical intervention were recorded. The collected data were fed in a database, which were analyzed retrospectively expressed by percentages and averages (mean  $\pm$  standard deviation). Answers to questions were evaluated using the Chi-square test and were expressed by the significance level. A *p* value of  $<0.05$  was considered significant.

**Results.** Out of 805 patients with rheumatic heart disease, 383 (47.6%) were male and 422 (52.4%) were female (age range, 4-70 years; mean age,  $28.6 \pm 14.5$ ). The mean age was  $29 \pm 14.4$  years for male and  $27.9 \pm 14.7$  years for female. Mitral and aortic valves were affected by rheumatic lesions, its distribution by patients were: mitral valve 57.1%, aortic valve 8.7% and mixed valves 34.2%. The frequency distribution of valve lesions is shown in Table 1. Regurgitation was the most frequent dysfunction in both valves. Either regurgitation or stenosis was a frequent dysfunction in the mitral valve while aortic valve was mainly affected by regurgitation. In general, both gender were affected by different type of valve lesions, without statistical significance ( $p>0.05$ ) with the exception of aortic regurgitation which was predominated in male ( $p<0.0000$ ).

The frequency distribution of patients by age and number of valve lesions is shown in Table 2. At examination time, 90% of patients were under 50 years, most of them were adolescent and young. The number of patients detected decreased gradually while age increased. One to 4 lesions was found. An isolated lesion was found in the majority of cases followed by a combination of 2 lesions; 3 or more lesions were less frequent. The majority of children had an isolated lesion; however, 2 lesions were occasionally found as well. Only few patients, those who received medical or surgical treatment, reached an age between 60-70

**Table 1** - Frequency distribution of valve lesions by gender.

Valve dysfunction	No. of patients (%)		
	Male N=383	Female N=422	Both gender N=805
Mitral regurgitation	211 (55.1)	253 (60)	464 (57.6)
Mitral stenosis	185 (48.3)	220 (52.1)	405 (50.3)
Aortic regurgitation	195 (50.9)	132 (31.3)	327 (40.6)
Aortic stenosis	27 (7)	27 (6.4)	54 (6.7)

years. In general, there was no statistically significant association between age and number of valve lesions ( $p=0.26$ ).

Table 3 shows the frequency distribution of rheumatic valve lesions by age group. Isolated or multiple rheumatic valve lesions were observed in the spectrum of rheumatic heart disease. Isolated valve damage was detected in 55.2% of patients, (mitral valve 47.4% and aortic valve 7.8%). Regurgitation without stenosis was detected in 46.2% of patients and stenosis with or without regurgitation in 53.8%. Lesions of the mitral valve (isolated or associated with aortic valve lesions) were detected in 91.3% of them. Mitral regurgitation and mitral stenosis (with or without aortic regurgitation) were found in 71% of cases. Regurgitation was found in all children aged less than 10 years. Isolated mitral regurgitation or in association with aortic regurgitation was the most common finding detected among children

and adolescents (87.5% of age group 4-9 years and 62.9% of 10-19 years). Mitral valve stenosis was less frequent in these age groups. Although mitral and aortic stenosis and multiple valve lesions can appear in adolescents, its frequency increased in young adult patients. Sixty percent of the aortic valve lesions were associated with mitral valve lesions.

Table 4 shows the degree of severity of RHD according to the valve lesions. The 4 types of valve lesions were found in mild, moderate and severe forms. Fifty-one percent of the lesions fell under moderate and severe degree. Moreover, in mild degree lesions, the mitral and aortic regurgitation prevailed, while in the severe form mitral stenosis stand out. There was close association between the affected valve, the type of lesion and the degree of severity.

Complications were found in 20.8% of the patients, 19.6% in male and 21.8% in female. Table 5 shows the

**Table 2** - Frequency distribution of patients by age and number of valve lesions.

Age group (Years)	No. of patient (%)				
	I	II	III	IV	Total
4-9	26 (3.2)	7 (0.9)	0 (0)	0 (0)	33 (4.1)
10-19	131 (16.3)	73 (9.1)	13 (1.6)	4 (0.5)	221 (27.5)
20-29	111 (13.8)	79 (9.8)	16 (2)	1 (0.1)	207 (25.7)
30-39	83 (10.3)	66 (8.2)	16 (2)	4 (0.5)	169 (21)
40-49	50 (6.2)	33 (4.1)	9 (1.1)	0 (0)	92 (11.4)
50-59	24 (3)	15 (1.9)	6 (0.7)	0 (0)	45 (5.6)
60-70	19 (2.4)	14 (1.7)	4 (0.5)	1 (0.1)	38 (4.7)
<b>Total</b>	<b>444 (55.2)</b>	<b>287 (35.7)</b>	<b>64 (8)</b>	<b>10 (1.2)</b>	<b>805 (100)</b>

**Table 3** - Percentage distribution of valve lesion by age groups.

Valve lesion (s)	Age in years (%)							
	4-9 N=33	10-19 N=221	20-29 N=207	30-39 N=169	40-49 N=92	50-59 N=45	60-70 N=38	Total N=805
MR	(75)	(43)	(21.3)	(17.8)	(10.9)	(11.1)	(13.2)	(26.5)
MS	(0)	(8.1)	(23.2)	(28.4)	(38)	(22.2)	(23.7)	(20.9)
MR + AR	(12.5)	(19.9)	(14)	(5.9)	(6.5)	(4.4)	(13.2)	(12.4)
MS + AR	(0)	(5)	(15)	(17.8)	(12)	(8.9)	(7.9)	(11.2)
MR+MS	(6.2)	(6.3)	(8.2)	(13)	(13)	(17.8)	(7.9)	(9.7)
AR	(6.3)	(8.1)	(9.2)	(2.4)	(5.4)	(20)	(5.3)	(7.3)
MS + MR + AR	(0)	(3.6)	(4.8)	(7.1)	(6.5)	(11.1)	(5.3)	(5.3)
MS+MR+ AR + AS	(0)	(1.8)	(0.5)	(2.4)	(0)	(0)	(2.6)	(1.2)
AR + AS + MR	(0)	(1.4)	(1.4)	(0.6)	(3.3)	(0)	(0)	(1.2)
MS + AS + AR	(0)	(0.9)	(1)	(1.2)	(0)	(0)	(5.3)	(1)
AR + AS	(0)	(0.9)	(0.5)	(1.8)	(0)	(0)	(2.6)	(0.9)
AS + MR	(0)	(0.9)	(0.5)	(0)	(1.1)	(0)	(5.3)	(0.9)
MS + AS	(0)	(0)	(0)	(0.6)	(3.3)	(2.2)	(0)	(0.6)
AS	(0)	(0)	(0)	(0.6)	(0)	(0)	(7.9)	(0.5)
MS +AS + MR	(0)	(0)	(0.5)	(0.6)	(0)	(2.2)	(0)	(0.4)

MR - mitral regurgitation, MS - mitral stenosis, AR - aortic regurgitation, AS - aortic stenosis, N - number of patients.

complications detected by echocardiography according to the type of valve lesions. The majority of complications occurred in mitral valve (97.6%); mitral stenosis (pure or mixed) was the most complicated lesion. Pulmonary hypertension was the most detected complication, almost always related to mitral lesions (mainly stenosis). Other complications were less frequent. Atrial fibrillation and left atrium thrombi were the characteristic complications of mitral stenosis. Infective endocarditis was found in patients with regurgitation, mainly in the mitral valve. There was significant association between the affected valve, the type of lesion and complications ( $p=0.0000$ ).

Table 6 shows that out of 362 patients with severe valve lesions, requiring surgical intervention, only 34.8% was operated. Mitral valve was replaced in 77 cases (70 cases by metallic and 7 by biologic prosthesis) and mitral valvuloplasty was made in 12 cases. The number of patients operated for aortic valve lesions were relatively higher than patient with mitral valve lesions. Those with double valve lesion were unlucky. In all surgically operated individuals, the aortic valve was replaced by metallic prosthesis.

**Discussion.** Two definite pattern of rheumatic heart disease are established, one observed in developed countries and the other in underdeveloped countries. The pattern in developed countries, which have a more privileged socioeconomic and health care status has

changed significantly in the last decades. In the United States,<sup>15</sup> Europe<sup>16</sup> and Japan<sup>17</sup> for example, the severe form of rheumatic valve disease is generally present in people in their late forties or above, manifesting itself as mitral stenosis with or without concurrent regurgitation. Moreover, in developing countries with a high socioeconomic level, this pattern has also changed. In the Arabian Peninsula, after the discovery of petroleum, the socioeconomic conditions of the population have been improved and the access to free medical care has been unrestricted, so the incidence of rheumatic fever (RF) and the pattern of RHD have changed. The results obtained by a national rheumatic heart disease survey show that the prevalence of the disease in Oman is approaching that of industrialized countries.<sup>18</sup> Studies reveal no significant differences between the status of the disease in Arabian Gulf countries and other countries of similar socioeconomic status.<sup>19</sup> Significant slowing down in the rate of progression of MS following an attack of acute RF in Saudi Arabia has been documented.<sup>20</sup> In countries with low economic standards but with a relatively high cultural level and where the government apply health programs, such as Cuba<sup>21</sup> and Costa Rica,<sup>22</sup> the prevalence and pattern of RHD is similar to that of developed countries. In these countries, acute rheumatic fever is diagnosed early in children and young patients and disappear by using antibiotics.

**Table 4** - Degree of severity of rheumatic heart disease according to the valve lesions.

Valve lesion	No. of patients Degree of severity			Total
	Mild	Moderate	Severe	
Mitral regurgitation	325 (26)	81 (6.5)	58 (4.6)	464 (37.1)
Mitral stenosis	51 (4.1)	119 (9.5)	235 (18.8)	405 (32.4)
Aortic regurgitation	209 (16.7)	58 (4.6)	60 (4.8)	327 (26.2)
Aortic stenosis	28 (2.2)	17 (1.4)	9 (0.7)	54 (4.3)
<b>Total</b>	<b>613 (49)</b>	<b>275 (22)</b>	<b>362 (29)</b>	<b>1250* (100)</b>

\*Some patients had more than one lesion

**Table 5** - Complications of rheumatic heart disease according valve lesions.

Complications	No. of patients				Total
	Mitral valve		Aortic valve		
	Stenosis	Regurgitation	Regurgitation	Stenosis	
Pulmonary hypertension	101 (60.1)	33(19.6)	0(0)	1 (0.6)	135 (80.4)
Atrial fibrillation	15 (8.9)	1(0.6)	0(0)	0 (0)	16 (9.5)
Endocarditis	0 (0)	7(4.2)	3(1.8)	0 (0)	10 (6)
Atrial thrombus	7 (4.2)	0(0)	0(0)	0 (0)	7 (4.2)
<b>Total</b>	<b>123 (73.2)</b>	<b>41(24.4)</b>	<b>3(1.8)</b>	<b>1 (0.6)</b>	<b>168 (100)</b>

It is obvious that due to adequate preventive measures including the usage of prophylactic penicillin therapy and avoiding recurrences, only a few cases develop chronic valve lesions.<sup>23</sup> The educational and cultural levels of the population together with government decisions are determinant factors in the eradication of this disease. On the other hand, the pattern of RHD before the discovery of penicillin and currently in developing countries is characterized by high incidence of mitral regurgitation, mitral stenosis in young people, pulmonary hypertension and low incidence of atrial fibrillation.<sup>24,25-27</sup> Thus, 2 definite patterns of RHD can be defined, one for developed countries and other for developing ones. Nevertheless, both patterns can be seen in one country; for example, in South Africa, under the apartheid system, rheumatic fever decreased among the more privileged socioeconomic class; while among the socio-politically deprived black majority, the trend was comparable with third world countries.<sup>28</sup>

Yemen is a poor and most populated country in the Arabian Peninsula. According to our results, the pattern of RHD in Yemen is entirely different from that of its wealthy neighboring countries. Pure mitral incompetence and mixed mitral valve disease are the most common valvular lesions; also mitral stenosis is a frequent finding among adolescents and young adults. The severity of the disease increases with age but moderate to severe forms may exist since childhood.<sup>3,5</sup> Complications such as pulmonary hypertension, atrial fibrillation, infective endocarditis, heart failure and atrial thrombus formation are present.<sup>7</sup> This pattern is closely similar to that observed in developing countries.<sup>4,28</sup> Real prevalence and incidence of RF and RHD is unknown but according to our results, the pattern of the disease is comparable only to patterns found in studies from Africa,<sup>4</sup> and India<sup>25</sup> where young patients with severe degree of mitral regurgitation (juvenile mitral stenosis) and serious complications were reported. The virulent

nature of this RHD pattern is strongly related to the RF recurrence, the poor socioeconomic status, high prevalence of group A *Streptococci*, inadequate medical services and non-compliance to chemoprophylaxis.<sup>28</sup> This suggest that in Yemen, like in developing countries, rheumatic fever is left untreated and lesions may progress rapidly to a severe form of pure mitral regurgitation. Undoubtedly, the main reasons of the severity of the disease in Yemen are: the absence of a specific programme for the prevention and control of RHD, the lack of government decisions to adopt such a programme and the inadequate use of penicillin by general practitioners because of fear of over allergic reactions or lack of precise information regarding its indication, dose and duration.

A monthly injection of Benzathine Penicillin G is the most effective and a cheaper method of preventing recurrences of rheumatic heart disease; its cost is acceptable by the majority of the population. The definitive form of primary prevention of rheumatic fever would be a streptococcal vaccine but unfortunately, it is not available yet, so rheumatic fever will continue to have a high prevalence, recurrence rate and aggressive pattern in Yemen. Consequently, it is expected that a large number of young patients will be affected with severe RHD in the next years. Unfortunately, only a few of them will have the chance of getting a surgical intervention. The recent introduction of cardiac surgery in Yemen is an advanced step as palliative treatment. A group of patients have already been operated but the waiting list is getting longer every day. The cost of operation and post-operation is a new burden for the family and the already poor economy; so a preventive programme should remain one of the main objectives.

We conclude that the spectrum of rheumatic heart disease in Southern Yemen is similar to that of developing countries suffering from deteriorated socioeconomic and hygienic conditions; it has an aggressive course for both genders from early age. Children, adolescents and young adults are the principal victims with scanty chance of reaching an advanced age. Unfortunately, the affected patients had little chance for palliative treatment. The traditions and hygienic level of the population are generally homogenous in spite of different economic conditions and social status. Therefore, our results can be generalized for the entire country. A specific programme for the prevention and control of rheumatic fever and rheumatic heart disease is strongly recommended. A proper evaluation of individual lesions must be combined with a frequent overall clinical evaluation in order to schedule appropriate medical treatment and surgical interventions.

**Table 6 -** Percentage of surgical intervention for patients in severe stage of rheumatic heart disease according affected valve.

Affected valve	Total affected patients	Operated	
		N	(%)
Mitral	293	89	(30.3)
Aortic	58	27	(46.5)
Mitral and aortic	69	10	(14.4)
<b>Total</b>	<b>362</b>	<b>126</b>	<b>(34.8)</b>

## References

1. Carroll JD, Feldman T. Percutaneous mitral balloon valvotomy and the new demographics of mitral stenosis. *J Am Med Assoc* 1993; 270: 1731-1736.
2. Chen H, Fan W, Jin X, Wang Q, Pan X, Chen X et al. Changing pattern of heart diseases in Shanghai from the 1950s to 1980s. *Chin Med J (Engl)* 1999; 112: 14-17.
3. Joswig BC, Glover MV, Handler JB, Warner SF, Vieweg WV. Contrasting progression of mitral stenosis in Malaysians versus American-born Caucasians. *Am Heart J* 1982; 104:1400.
4. Onwuchekwa AC, Ugwu EC. Pattern of rheumatic heart disease in adults in Maiduguri north east Nigeria. *Trop Doct* 1996; 26: 67-69.
5. Thakur JS, Negi PC, Ahluwalia SK, Vaidya NK. Epidemiological survey of rheumatic heart disease among school children in the Shimla Hills of northern India: prevalence and risk factors. *J Epidemiol Community Health* 1996; 50: 62-67.
6. Agarwal AKarim, Yunus M, Ahmad J, Khan A. Rheumatic heart disease in India. *J R Soc Health* 1995; 115: 303-304, 309.
7. Rowe JC, Bland EF, Sprague HB, White PD. The course of mitral stenosis without surgery: ten and twenty year perspectives. *Ann Int Med* 1960; 52: 741-749.
8. Joint WHO/ISFC meeting on rheumatic fever/rheumatic heart-disease control with emphasis on primary prevention, Geneva, 7-9 September 1994. Geneva, World Health Organization, 1994 (WHO Document WHO/CVD 94.1).
9. Wilson NJ, Neutze JM. Echocardiographic diagnosis of subclinical carditis in acute rheumatic fever. *Int J Cardiol* 1995; 50: 1-6
10. Wang A, Ryan T, Kisslo KB, Bashore TM, Harrison JK. Assessing the severity of mitral stenosis: Variability between noninvasive and invasive measurements in patients with symptomatic mitral valve stenosis. *Am Heart J* 1999; 138 : 777-784.
11. Jaffe WM, Roche Ahmed, Coverdale H A, McAlister HF, Ormiston J A, Greene ER. Clinical evaluation versus Doppler echocardiography in the quantitative assessment of valvular heart disease. *Circulation* 1988; 78: 267-275.
12. World Health Organization. Rheumatic fever and rheumatic heart disease. Report of a World Health Organization Expert Consultation on Rheumatic Fever and Rheumatic Heart Disease. World Health Organization technical report series; 923. Geneva, 29 October-1 November 2001.
13. Helmcke F, Nanda NC, Hsiung MC, Soto B, Adey CK, Goyal RG et. al. Color Doppler assessment of mitral regurgitation with orthogonal planes. *Circulation* 1987; 75: 175-183.
14. Berger M, Haimowitz A, Van Tosh A, Berdoff RL, Goldberg E. Quantitative assessment of pulmonary hypertension in patients with tricuspid regurgitation using continuous wave Doppler ultrasound. *J Am Coll Cardiol* 1985; 6: 359-365.
15. Olson LJ, Subramanian R, Ackermann DM, Orszulak TA, Edwards WD. Surgical pathology of the mitral valve: a study of 712 cases spanning 21 years. *Mayo Clin Proc* 1987; 62: 22-34.
16. Shaw TRD, Sutaria N, Prendergast B. Clinical and haemodynamic profiles of young, middle aged and elderly patients with mitral stenosis undergoing mitral balloon valvotomy. *Heart* 2003; 89: 1430-1436.
17. Kawakita S, Rheumatic fever and rheumatic heart disease in Japan. *Jpn Circ J* 1986; 50: 1241-1245.
18. Aly A Hasab, Ali Jaffer, Abdulla M Riyami. Rheumatic heart disease among Omani schoolchildren. *East Mediterr Health J* 1997; 3: 17-23.
19. Eltohami EA, Hajar HA, Folger GM. Acute rheumatic fever in an Arabian Gulf country. Effect of climate, advantageous socioeconomic conditions, and access to medical care. *Angiology* 1997; 48: 481-489.
20. Andy JJ, Soomro RM. The changing incidence of juvenile mitral stenosis and natural history of rheumatic mitral valvulitis in Al Baha, Saudi Arabia. *Ann Trop Paediatr* 2001; 21: 105-109.
21. Nordet P. Fiebre reumática en Cuba: incidencia, prevalencia, mortalidad y características clínicas. [Rheumatic fever and rheumatic heart disease in Cuba: incidence, prevalence mortality and clinical characteristics.] *Revista Cubana de Cardiología y Cirugía Cardiovascular. Cuban Journal of Cardiology and Cardiovascular Surgery* 1991; 5: 25- 33.
22. Arguedas A, Mohs E. Prevention of rheumatic fever in Costa Rica. *J Pediatr* 1992; 121: 569-572.
23. Massell BF, Chute CG, Walker AM, Kurland GS. Penicillin and the marked decreasing morbidity and mortality from rheumatic fever in the United States. *N Engl J Med* 1988 ; 318: 280-286.
24. Rizvi SF, Khan MA, Kundi A, Marsh DR, Samad A, Pasha O. Status of rheumatic heart disease in rural Pakistan. *Heart* 2004; 90; 394-399.
25. Chopra P, Bhatia ML. Chronic rheumatic heart disease in India: a reappraisal of pathologic changes. *J Heart Valve Dis* 1992; 1: 92-101.
26. Besterman EM, Some notes on the history of rheumatic carditis. *West Indian Med J* 2001; 50: 180-182.
27. Bland EF, Jones TD. Rheumatic fever and rheumatic heart disease. A twenty year report on 1000 patients followed since childhood. *Circulation* 1951; 4: 836-843.
28. Richard H Marcus, Pinhas Sareli, Wendy A Pocock, John B Barlow. The spectrum of severe rheumatic mitral valve disease in developing country. Correlations among clinical presentation, surgical pathologic findings, and hemodynamic sequelae. *Ann Int Med* 1994; 120: 177-183.