Relationship between Environmental Factors and Rheumatic Heart Disease

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Abstract

BACKGROUND: Rheumatic fever and rheumatic heart disease (RHD) are the most common acquired heart diseases in children. Environmental factors have been reported to play an important role in RHD's prevalence.

AIM: The main purpose of this study is to assess the associations between environmental factors and RHD in children.

METHODS: A case-control study was conducted in the Department of Child Health, Haji Adam Malik Hospital from April to June 2017. The case group consisted of children aged 5–18 years with RHD while control group consisted of healthy children. Demographic, anthropometric, and laboratory data were collected along with environmental factors. Statistical analysis was done using Statistical Product and Service Solution. A P value of <0,05 with 95% confidence interval was considered significant.

RESULTS: A total of 39 children were enrolled in each group. Subjects' father who only went to elementary and junior high school had a higher risk of having children with RHD (OR 28; p = 0.032 and OR 15.75; p = 0.011, respectively). Subjects' mother who only went to junior high school had 7 times higher risk of having children with RHD (p = 0.026). Low monthly income increased the risk of RHD (OR 3,68; p = 0,009). Tap water usage, meat consumption more than once per week, and feasibility to buy clothes >1 pair per year decreased the risk of RHD at 0,31 (p = 0,013), 0,3 (p = 0,016), and 0,04 times (p <0,001), respectively.

CONCLUSION: Parent's education, monthly family income, water source, frequency of meat consumption, and feasibility to buy clothes are related to RHD in children.

Introduction

Rheumatic fever (RF) and rheumatic heart disease (RHD) are the most common acquired heart diseases in children. The annual mortality rate in Asia is estimated to be 356,000–524,000 [1], [2]. RF and RHD are complex diseases that were associated with genetic, virulency of the bacteria, and environmental factors [3]. The prevalence of RF and RHD tends to decrease as the socioeconomic status improves [4], [5], [6]. A well-planned pharyngitis treatment program along with sanitation, health infrastructure, and socioeconomic status improvements have been proven to reduce the incidence of RF in other countries [7], [8].

Our objective is to determine the relationship between environmental factors and RHD.

Methods

An observational case-control study was conducted in the Department of Child Health, Haji Adam Malik hospital Medan from April to June 2017. Subjects were obtained using consecutive sampling method. Children aged 5–18 years with diagnosis of RHD were enrolled in the case group while the control group consisted of healthy children. Demographic and anthropometric data were collected along with laboratory results. Environmental factors were obtained from each patient and his/her parents including parents' education background, monthly family income, water source, frequency of meat consumption, feasibility to buy clothes, house's dweller, household's fuel, and house's profiles. All subjects underwent echocardiography evaluation. Children with congenital heart disease were excluded from this study. Informed consent was obtained before conducting the procedure. This study had been approved by the Health Research Ethical Committee, Medical School, Universitas Sumatera Utara.

Statistical analysis was performed using Statistical Product and Service Solution. Chi-square and Fisher's exact tests were used to analyze the relationship between categorical variables. Mann-Whitney test was used to determine the relationship between categorical and continuous variables. The

analysis was conducted at a 95% confidence interval, and p < 0.05 was considered significant.

Results

A total of 78 subjects were enrolled in this study. Male subjects were more dominant with the median age of 13.0 years (range 5.0–18.0 years). Most subjects had normal antistreptolysin O titer and C-reactive protein levels. Baseline characteristics of subjects were described in Table 1.

Table 1: Baseline characteristics of subjects

Characteristics	n = 78
Median age, year (range)	13.0 (5.0–18.0)
Gender, n (%)	
Male	43 (55.1)
Female	35 (44.9)
Mean body weight, kg (SD)	31.6 (10.61)
Median body height, cm (range)	139.0 (60.0–173.0)
Mean hemoglobin level, g/dL (SD)	11.5 (1.74)
Mean hematocrit, % (SD)	35.4 (5.30)
Median leukocyte level, mL^{-1} (range)	9.905,0 (3.900,0–23.690,0)
Mean thrombocyte level, mL^{-1} (SD)	336.346,2 (125.053,2)
ASTO level, n (%)	
≤200 IU	50 (64.1)
>200 IU	28 (35.9)
CRP level, n (%)	
≤0.7 mg/L	52 (66.7)
>0.7 mg/L	26 (33.3)

CRP: C-reactive protein.

Most subject's parents went to senior high school and had monthly income at or lower than minimum regional standard. Median subject's house size was 60.0 m^2 with median house's dwellers of 5.0 persons. Distribution of environmental factors was described in Table 2.

Parent's education, monthly family income, water source, consumption of meat, and feasibility to buy clothes were related with RHD in this study (Table 3).

Discussion

RHD is caused by immunologic response toward *Streptococcus pyogenes* infection. The infection usually manifests as tonsillopharyngitis. The M protein from bacteria's cell wall has similar structure (molecular mimicry) with several proteins in heart valve tissue. The molecular mimicry triggers autoimmune reaction and causes tissue damage [9].

A study in 2012 showed a similar result to our study. The highest prevalence of RHD was observed in children aged 5–16 years, followed by children aged more than 16 years. They found no RHD case in children aged under 5 years [10]. RF and RHD rarely occurred before 4 years old and even rarer before 2 years of age. The underlying cause of this condition is that the peak

Table 2: Distribution of subjects' environmental factors

Characteristics	n = 78
Father's education, n (%)	
University	8 (10.3)
Senior high school	39 (50.0)
Junior high school	26 (33.3)
Elementary school	5 (6.4)
Mother's education, n (%)	
University	9 (11.5)
Senior high school	32 (41.0)
Junior high school	30 (38.5)
Elementary school	5 (6.4)
No formal education	2 (2.6)
Monthly family income, n (%)	
>Minimum regional standard	27 (34.6)
≤Minimum regional standard	51 (65.4)
Median house size, m^2 (range)	60.0 (24.0–180.0)
Median house's dwellers, people (range)	5.0 (2.0–7.0)
House floor material, n (%)	
Bamboo	2 (2.6)
Cement	57 (73.1)
Ceramic	19 (24.4)
House wall material, n (%)	
Palm leaves	2 (2.6)
Wood	7 (9.0)
Brick	17 (21.8)
Wall	52 (66.7)
Latrine possession, n (%)	
Yes	76 (97.4)
No	2 (2.6)
House's electricity, n (%)	
Available	78 (100.0)
Not available	0 (0.0)
Water source, n (%)	
Well	37 (47.4)
Tap water	41 (52.6)
Household's fuel, n (%)	
Firewood	3 (3.8)
Charcoal	3 (3.8)
Kerosene	15 (19.2)
Gas	57 (73.1)
Frequency of meat consumption, n (%)	
Once/week	52 (66.7)
>Once/week	26 (33.3)
Feasibility to buy clothes, n (%)	
1 pair/year	40 (51.3)
>1 pair/year	38 (48.7)
Frequency of meal, n (%)	
<3 times daily	7 (9.0)
≥3 times daily	71 (91.0)

incidence of tonsillopharyngitis occurs between 5 and 15 years of age [11]. There was no gender predilection in RHD as observed in this study.

Parent's education, monthly family income, water source, frequency of meat consumption, and feasibility to buy clothes were related with RHD in this study. Fathers who went to elementary and junior high school had higher risk of having children with RHD at 28.0 times (p = 0.032) and 15.75 times (p = 0.011), respectively, compared to fathers who went to university. Mothers who went to junior high school also had 7.0 times higher risk of having children with RHD (p = 0.026). Lower monthly family income would increase the risk of RHD. Family with monthly income at or lower than minimum regional standard had 3.68 times higher risk of having children with RHD (p = 0.009) compared to family with monthly income higher than minimum regional standard. These findings are confirmed by several studies. A study in 2005 showed that poverty, overcrowding, and lower parent's education were risk factors of RHD [12]. Improvement in socioeconomic status was related to decreasing RHD prevalence in North India [13].

Frequency of meat consumption and feasibility to buy clothes also affected the incidence of RHD. Risk

Table 3: Relationship between demographic and environmental factors and RHD

Factors	RHD	No RHD	OR	95% CI
Median age, year (range)	13.0 (5.0–18.0)	13.0 (5.0–18.0)	N/AA	N/A
Gender, n (%)				
Male	21 (53.8)	22 (56.4)	1.109b	0.454–2.708
Female	18 (46.2)	17 (43.6)		
Father's education. n (%)				
University	1 (2.6)	7 (17.9)	Ref	Ref
Senior high school	12 (41.0)	23 (59.0)	4.870[c]	0.545–43.523
Junior high school	18 (46.2)	8 (20.5)	15.750[c]*	1.652–150.141
Elementary school	4 (10.3)	1 (2.6)	28.000[c]*	1.350–580.591
Mother's education. n (%)				
University	2 (5.1)	7 (17.9)	Ref	Ref
Senior high school	12 (30.8)	20 (51.3)	2.100[c]	0.374–11.807
Junior high school	20 (51.3)	10 (25.6)	7.000[c]*	1.222–40.089
Elementary school	4 (10.3)	1 (2.6)	14.000[c]	0.944–207.597
None	1 (2.6)	1 (2.6)	3.500[c]	0.145–84.694
Monthly family income. n (%)				
>Minimum regional standard	31 (79.5)	20 (51.3)	3.681[b]*	1.355–9.998
≤Minimum regional standard	8 (20.5)	19 (48.7)		
Median house size. m² (range)	60.0(24.0–180.0)	48.0(25.0–144.0)	N/A[a]	N/A
Median house's dwellers, person (range)	5.0 (2.0–7.0)	5.0 (3.0–7.0)	N/A[a]	N/A
House floor material, n (%)				
Bamboo	1 (3.1)	1 (3.7)	Ref	Ref
Cement	31 (96.3)	26 (96.3)	1.192[c]	0.071–20.011
Ceramic	7 (87.5)	12 (92.3)	0.583[c]	0.031–10.863
House wall material, n (%)				
Palm leaves	2 (40.0)	0 (0.0)	Ref	Ref
Wood	3 (60.0)	4 (100.0)	N/A[c]	N/A
Brick	10 (83.3)	7 (100.0)	N/A[c]	N/A
Wall	24 (92.3)	28 (100.0)	N/A[c]	N/A
Latrine possession, n (%)				
Yes	39 (100.0)	37 (94.9)	N/A[c]	N/A
No	2 (5.1)	0 (0.0)		
House's electricity, n (%)				
Available	39 (100.0)	39 (100.0)	N/A	N/A
Not available	0 (0.0)	0 (0.0)		
Water source, n (%)				
Well	24 (61.5)	13 (33.3)	0.313[b]*	0.124–0.790
Tap water	15 (61.5)	26 (66.7)		
Household's fuel, n (%)				
Firewood	2 (5.1)	1 (2.6)	Ref	Ref
Charcoal	1 (2.6)	2 (5.1)	0.250[c]	0.008–7.542
Kerosene	12 (30.8)	3 (7.7)	2.000[c]	0.133–30.162
Gas	24 (61.5)	33 (84.6)	0.364[c]	0.031–4.245
Consumption of meat, n (%)				
Once/week	8 (20.5)	18 (46.2)	0.301[b]*	0.111–0.819
>Once/week	31 (79.5)	21 (538)		
Feasibility to buy clothes, n (%)				
1 pair/year	6 (15.4)	32 (82.1)	0.040[b]*	0.012–0.131
>1 pair/year	33 (84.6)	7 (17.9)		
Frequency of meal, n (%)				
<3 times daily	5 (12.8)	2 (5.1)	0.368[c]	0.067–2.021
≥3 times daily	34 (87.2)	37 (94.9)		

[a]Mann Whitney test, [b]Chi-square test, [c]Fisher's exact test *$p < 0.05$.

of RHD was lower in family which able to consume meat more than once per week (OR 0.3; p = 0.016) and which able to buy clothes more than 1 pair per year (OR 0.04; p < 0.001) compared to their counterparts (Table 3). These variables represent a family's socioeconomic status. The more frequent consumption of meat in a family and the more clothes a family can afford show better socioeconomic status. This allows the family to fulfil adequate nutritional support, complete access to healthcare facility including immunization, and good housing. These factors play important role in preventing streptococcal tonsillopharyngitis as the preceding event of RHD [14], [15].

Bad housing quality and low socioeconomic status will increase the susceptibility of RHD according to a study by Dobson *et al.*, [16] In our study, family that used tap water as the water source was less likely to have children with RHD (OR 0.31; p = 0.013). Families that can afford tap water pipeline generally have better housing quality and socioeconomic status. Better housing quality ensures good hygiene and prevents the incidence and transmission of tonsillopharyngitis.

We found no relationship between overcrowding and RHD in this study. This result is in contrast with several other studies. Okello stated that the risk of RHD increase in overcrowded population [17]. Similar result was also reported by Jaine [18]. These differences may be caused by the high population in Indonesia so that the amount of house's dwellers was similar between case and control groups.

Our study has several limitations. There is no strict classification of socioeconomic status in Indonesia; therefore, we only gathered factors which influence poverty based on Central Bureau of Indonesia Statistics criteria [19]. We did not match subjects in case and control groups and this might cause selection bias. Our data were not normally distributed thus preventing us to perform parametric study. Further studies with more subjects from several centres are needed to confirm the result of this study.

Conclusion

Parent's education, monthly family income, water source, frequency of meat consumption, and feasibility to buy clothes are related to RHD in children. Lower parent's education and monthly family income will increase the susceptibility of having children with RHD. Tap water usage, frequent consumption of meat, and feasibility to buy more clothes are protective factors of RHD.

Acknowledgment

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