Relationship between Environmental Factors and Rheumatic Heart Disease

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Abstract: Rheumatic fever and rheumatic heart disease are the most common acquired heart diseases in children and the most common cause of death in the field of pediatric cardiology. Environmental factors play an important role in RHD. The prevalence of RF and RHD tend to decrease as socioeconomic status improves. To determine the relationship between environmental factors and RHD in children. A case-control study was conducted in the Department of Child Health, Haji Adam Malik Hospital from April to June 2017. The case group has consisted of children aged 5-18 years with RHD while the control group has 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 (SPSS). A P value of <0,05 at 95% confidence interval was considered significant. A total of 39 children were enrolled in each group. Subjects' median age was 13.0 years. Males were dominant compared to females. Fathers who went to elementary and junior high school had a higher risk of having children with RHD (OR 28; P value 0,032 and OR 15,75; P value 0,011, respectively). Mothers who went to junior high school had 7 times higher risk of having children with RHD (P-value 0,026). Low monthly income increased the risk of RHD (OR 3,68; P value 0,009). Tap water usage, meat consumption more than once per week, and feasibility to buy clothes more than 1 pair per year decreased the risk of RHD at 0,31 (P value 0,013), 0,3 (P-value 0,016), and 0,04 times (P-value <0,001), respectively. Parent's education, monthly family income, water source, consumption of meat, and feasibility to buy clothes are related to RHD in children.

1 INTRODUCTION

Rheumatic fever (RF) and rheumatic heart disease (RHD) are the most common acquired heart diseases in children and the most common cause of death in the field of pediatric cardiology. Rheumatic heart disease causes permanent damage to heart valve tissue and in a chronic condition may lead to congestive heart disease, stroke, endocarditis, and death (Park, 2008; Seckeler, 2011). A study in India reported an annual mortality rate in children from RF and RHD as high as 3,3%. The estimation of annual death from RF and RHD in Asia lied between 356.000 and 524.000 (Carapetis, 2008; Kumar, 2002).

Rheumatic fever and RHD are complex diseases influenced by genetic, the virulence of bacteria, and environmental factors (Guilherme, 2012). Environmental factors such as overcrowding and lack of ventilation play important role in RHD. The prevalence of RF and RHD tend to decrease as socioeconomic status improves (Ibrahim-Khalil, 1992; Grover, 1993, Cheng, 2009). Low socioeconomic status is marked with a high poverty level, low educational status, high illiteracy rate, and high unemployment rate. Those are related to RF and RHD even though direct relationships have not been proven at present (Kerdemelidis, 2010; Steer, 2002; Vlajinac, 1989; Vlajinac, 1991).

Rheumatic fever and RHD can be prevented with primary and secondary prophylaxis. Primary

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prophylaxis for children with pharyngitis is carried out with a well-planned program along with sanitation, health infrastructure, and socioeconomic status improvements. This is proven to reduce the incidence of RF in Australia, Sweden, and the USA (Carapetis, 2005; Seckeler, 2011).

Our objective is to determine the relationship between environmental factors and RHD in children in Medan, Indonesia.

2 METHOD

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 and diagnosed with RHD were enrolled in case of the group while the control group has 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, monthly family income, water source, frequency of meal, consumption of meat, 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 was approved by the Health Research Ethical Committee, Medical School, Universitas Sumatera Utara.

Statistical analysis was done using computer software. Chi-square and Fisher's exact tests were used to analyze the relationship between categorical variables. Mann-Whitney tests were used to determine the relationship between categorical and continuous variables. The analysis was conducted at a 95% confidence interval and a P value of <0,05 was considered significant.

3 RESULTS AND DISCUSSION

Rheumatic heart disease is caused by an immunologic response toward Streptococcus pyogenes infection. The infection usually manifests as tonsillopharyngitis. The M protein from bacteria's cell wall has a similar structure (molecular mimicry) with several proteins in heart valve tissue. The molecular mimicry triggers an autoimmune reaction and causes tissue damage (Guilherme, 2005).

A total of 78 subjects were enrolled in this study. Male subjects were dominant with the median age of 13,0 years (range 5,0-18,0 years). Most subjects had normal antistreptolysin titer O (ASTO) and C-reactive protein (CRP) levels. 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 (Prajapati, 2013). Rheumatic fever 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 incidence of tonsillopharyngitis occurs between 5-15 years of age (Anderson, 2010). There was no gender predilection in RHD (Anderson, 2010) as observed in this study. 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)

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 as described in Table 2.

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, person (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)
Consumption of meat, 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)

Parent's education, monthly family income, water source, consumption of meat, and feasibility to buy clothes were related to RHD in this study. Fathers who went to elementary and junior high school had a higher risk of having children with RHD at 28,0 times (P-value 0,032) and 15,75 times (P-value 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-value 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-value 0,009) compared to a 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 (Meira, 2005). Improvement in socioeconomic status was related to decreasing RHD prevalence in North India (Negi, 2013).

Consumption of meat and feasibility to buy clothes also affected the incidence of RHD. Risk of RHD was lower in a family which able to consume meat more than once per week (OR 0,3; P value 0,016) and which able to buy clothes more than 1 pair per year (OR 0,04; P-value <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, the better it's socioeconomic status. The better socioeconomic status allows the family to fulfill adequate nutritional support, complete access to healthcare facility including immunization, and good housing. These factors play an important role in preventing streptococcal tonsillopharyngitis as the preceding event of RHD (Feikin, 2009; Abdullah, 2010).

Worse housing quality and low socioeconomic status would increase the susceptibility of RHD according to a study by Dobson, et al (Dobson, 2011). In our study, a family which used tap water as the water source was less likely to have children with RHD (OR 0,31; P value 0,013). Families which 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 is in contrast with several other studies. Okello stated that the risk of RHD was increased in the overcrowded population (Okello, 2012). A similar result was reported by Jaine (Jaine, 2011). The different result may be caused by the high population in Indonesia so that the number of house's dwellers were similar between case and control groups.

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/A	N/A
Gender, n (%)				
Male	21 (53,8)	22 (56,4)	1,109[b]	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, m^2 (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)		

Mann Whitney test [b]Chi square test Fischer's exact test *P<0,05

Our study had several limitations. There is no strict classification of socioeconomic status in Indonesia so we only gathered factors which influence poverty based on Badan Pusat Statistik criteria (Badan Pusat Statistik, 2017). We did not

match subjects in case and control groups and this might cause selection bias. Our data was also not normally distributed, preventing us to perform a parametric study. Further study enrolling more subjects from several centers is needed to confirm the result of this study.

4 CONCLUSION

Parent's education, monthly family income, water source, consumption of meat, 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.

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