

Socioenvironmental Factors of Rheumatic Heart Disease among School-Going Children in Sarawak, Malaysia: A Mixed-Method Study

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Abstract Socioenvironmental elements could explain the primordial and primary prevention of Rheumatic Heart Disease (RHD) in the local context. A well-planned, encompassing way to deal with RHD in the local setting is essential. Therefore, this study sought to investigate the socioenvironmental determinants of RHD among school-going children and to investigate the aetiology of RHD in the local setting. This study was conducted as a sequential explanatory mixed-methods design. A cross-sectional study was conducted in the first phase, followed by a qualitative study based on the grounded theory approach. The study was conducted in Kuching, Samarahan and Miri divisions in Sarawak among primary and secondary school-going children. The cross-sectional data collection was conducted via face-to-face interviews, while the qualitative phase was conducted via in-depth interviews. There was a preponderance of low socioeconomic status and large family size with RHD. Based on the grounded theory approach, the causes of rheumatic heart disease were classified into internal and external factors. After integrating the findings, the qualitative findings confirmed the quantitative results by confirmation and expansion without discordance. The findings would be vital for the management of RHD in

terms of implementations in practice, theory, and subsequent research, as the factors were explained in the local context.

Keywords Rheumatic Heart Disease, Acute Rheumatic Fever, Children, School-Going, Factors

1. Introduction

The number of Rheumatic Heart Disease (RHD) cases has been declining for decades. However, more than 33 million of RHD cases were estimated in the endemic regions, while over 200,000 were reported in the non-endemic areas [1]. This chronic heart disease is caused by unresolved Acute Rheumatic Fever (ARF) [2] in susceptible individuals [3]. In Malaysia, the number of RHD cases reported has reduced, but the number of heart valve procedures due to RHD complications has increased [4]. In multiple studies, ARF and RHD have been linked to socioenvironmental factors such as income, crowding, and neighbourhood [1, 5-7]. These findings were reported from low- and middle-income developing countries and certain

developed countries. Despite the importance of these findings for the management of ARF and RHD in Malaysia, the exact approach taken by the previous studies may not be appropriate locally due to the unique concerns and challenges in this country [8]. Targeting children for early screening is important to prevent the disease complication in their life later. Therefore, a study on RHD among the children in the local setting needs to be conducted and an appropriate approach for the RHD management for this population can be planned accordingly.

Even though RHD is caused by non-medical factors, not much intervention utilising these modifiable factors has been conducted. Therefore, a clear explanation of illness prevention's non-medical components would appeal to health authorities and those concerned with economic development and sustainability, the environment, and human capital development. Furthermore, when important players like the government understand the current RHD predicament, a future commitment to control the disease may be undertaken [9]. Hence, the modifiable socioenvironmental factors would be elaborated according to the local setting to better understand the primordial and primary prevention of RHD to establish well-thought-out, comprehensive ways to manage RHD in the local population [5]. Therefore, this study sought to investigate the socioenvironmental determinants of RHD among school-going children and to investigate the aetiology of RHD in the local setting.

2. Materials and Methods

Setting, Population, and Place of Study

This study was conducted as a sequential explanatory mixed-methods design that started and ended in early 2020 and 2022, respectively. It involved a two-phase design whereby a cross-sectional study was conducted in the first phase, and then the results were analysed and used in the second qualitative phase, which was conducted based on the grounded theory approach [10]. The quantitative results were used to identify the types of respondents to be purposefully chosen and to identify the questions to be asked to the participants in the qualitative phase. The overall purpose of this design was to have the qualitative data help explain the initial quantitative results in more detail. Like any typical sequential explanatory mixed-methods design, the procedure involved collecting survey data in the first phase, analysing the data, and following up with qualitative interviews to help explain the survey responses. Both phases were conducted in the randomly selected divisions of Kuching, Samarahan, and Miri in Sarawak.

Sampling, Data Collection and Analysis

The primary and secondary school-going children aged between five and twenty with Malaysian citizenship were included in the quantitative phase through the multistage sampling technique after the sample size for frequency in a population was calculated using the formula proposed by Sullivan [11]. Meanwhile, children without documentation and signed consent to prove their citizenship and age were excluded. The total sample was divided according to the percentages of children from the primary and secondary school-going age groups in each division. The sampling strategy is depicted in Figure 1. The cross-sectional data collection was conducted via face-to-face interview, while the data entry and analysis to test the associations were performed using Microsoft Excel 365 and Statistical Package for Social Science Version 22, respectively. For descriptive statistics, the mean and standard deviation were presented for continuous data, and frequency and percentage were presented for qualitative data. For inferential statistics, the chi-square test of independence and Fisher's exact test were done. At the same time, an echocardiographic survey was conducted alongside this study to estimate the RHD prevalence among the targeted population.

After quantitative data analysis, data collection for the qualitative phase was conducted via in-depth interviews among the children diagnosed with RHD from the echocardiographic survey. Since there was no predetermined formula for qualitative data sampling, the sample size was determined throughout the data collection until theoretical saturation was achieved [12]. Hence, episodes of in-depth interviews were conducted with the respondents, followed by transcription, translation, and coding process. Following theoretical saturation, the sampling or recruitment process was deemed satisfactory. Theoretical saturation occurs when collecting more data about a theoretical category yields no new properties or theoretical insights [13].

The in-depth interviews were conducted by two team members in the local dialect led by an interviewer while being observed by an assistant. The audio was captured using the recording application of the Apple iPad, and note-taking was conducted traditionally using a pen-and-paper method. The transcriptions were manually conducted by the team members who were fluent in English and the local dialect. Following these, the transcribed verbatims were translated into English. Before each data management process, soft copies of every documentation were sent to the respective respondents to ensure that every documentation would capture the context and means of the respondents. Qualitative analyses were conducted independently by the main researcher and another team member. Both findings were compared and agreed upon with the third member in case of a dispute.

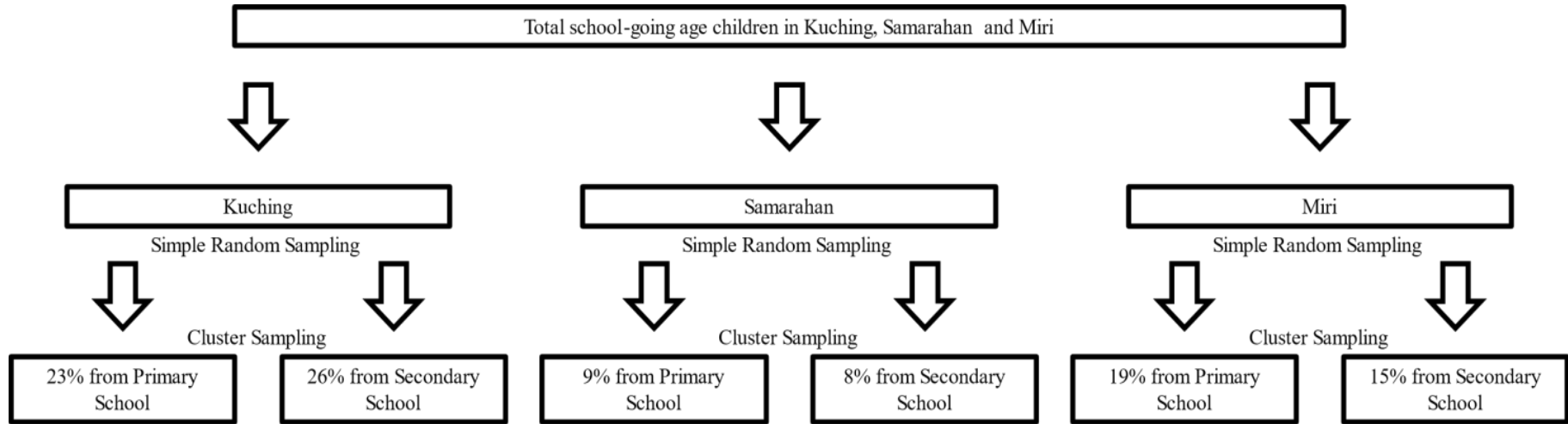


Figure 1. Schematic diagram of the sampling procedure

Trustworthiness

Unique components of qualitative research concerning qualitative rigour were safeguarded throughout the process, including credibility, dependability, confirmability, and transferability for the study to be trustworthy [14, 15]. Credibility was assessed to ensure that the findings from the respondents' perspectives were true, credible, and believable. Meanwhile, dependability ensured the findings were repeatable when the inquiry occurred within the same cohort of participants, coders, and context [2]. Credibility was assured by training the research team to perform their roles through adequate knowledge, research skills, prolonged engagement, and debriefings conducted with the respondents throughout the studies. Meanwhile, dependability was ensured with detailed study drafts throughout the study and by establishing an audit trail of detailed track records of the data collection process. Confirmability aimed to extend the confidence that the results would be confirmed or corroborated by other researchers, and this was achieved through reflexivity and triangulation [2, 14]. Reflexivity was performed by memo writing and team discussion throughout the study, while triangulation was undertaken by comparing the findings during the data analysis. Lastly, transferability was ensured by the application of purposive sampling in recruiting the respondents and by assessing the point of saturation in data analysis [2]. Qualitative data management and analysis were performed using Microsoft Word 365 and Atlas.ti 22.

Data Integration and Explanation

After integrating the data, the qualitative findings would explain the quantitative results. The key conclusions from the qualitative phase would either confirm or refute the conclusions from the quantitative phase. The main points of the Good Reporting of a Mixed Methods Study (GRAMMS) by O'Cathain et al. [16] are covered in this article's conclusion.

3. Results

A total number of 995 school-going children participated in the quantitative phase, and ten respondents enrolled in the qualitative phase. The mean (SD) of the respondents was 11 (4), with the youngest was 5 years old and the oldest was 20 years old.

Quantitative Analysis

Among the respondents enrolled during the survey, fourteen were diagnosed with RHD. The estimated prevalence was 14 per 1000 population. The median age was 14 with minimum and maximum age of five and 17. The demographic characteristics for the quantitative phase are depicted in Table 1.

Table 1. Characteristics of the children (n=995)

Characteristics	N	%	
Age group (years)			
5–9	398	40.0	Median=6
10–14	321	32.3	Median=14
15–20	276	27.7	Median=16
Gender			
Male	527	53.0	
Female	468	47.0	
Ethnicity			
Orang Ulu	251	25.2	
Iban	244	24.5	
Malay	193	19.4	
Chinese	158	15.9	
Melanau	84	8.4	
Bidayuh	45	4.5	
Others*	20	2.0	
Religion			
Christian	617	62.0	
Islam	281	28.2	
Buddhism	76	7.6	
None	16	1.6	
Others**	5	0.5	

*Other ethnicities included Indian, Dusun, Kadazan, Jawa, and Bruneian

**Other religions included Hindu and Baha'i

Analysis revealed that variables of proxy economic status appeared to be statistically significant ($p < .05$) associated factors of Rheumatic heart disease. That is, low economic conditions were important factors for Rheumatic heart disease. There was a preponderance of RHD diagnoses with fewer bedrooms. Respondents living further from the healthcare facility had a preponderance of RHD diagnosis and supported a statistically significant

association. Despite having no statistically significant association with RHD, respondents' homes with more children, home occupants, and children sharing a room had a preponderance of RHD diagnosis ($p > .05$). Children who shared a bed had a preponderance of RHD and the association of the number of people per bed was statistically significant with RHD ($p < .05$) (Table 2).

Table 2. Relationship between home environment and rheumatic heart disease (n=995)

Environmental characteristics	RHD Diagnosis				fp-value
	Yes		No		
	n	%	N	%	
Flood occurrence					
Never	12	1.3	894	98.7	.361
Ever	2	2.2	87	97.8	
Electric source					
Electric supply	11	1.1	969	98.9	<.001
None	3	20.0	12	80.0	
Water source					
Tap water	8	0.9	866	99.1	.004
None	6	5.0	115	95.0	
Toilet type					
Pour flush	10	1.0	953	99.0	<.001
Non-pour flush	4	12.5	28	87.5	
Roof material					
Ceramic	1	0.2	426	99.8	.005
Metal and wood	13	2.3	555	97.7	
Wall material					
Brick	4	0.5	742	99.5	<.001
**Others	10	4.0	239	96.0	
Floor material					
Cement	7	0.8	888	99.2	<.001
***Others	7	7.0	93	93.0	
Distance from the nearest health facility (km)					
12 and less	9	1.0	910	99.0	.003
More than 12	5	6.6	71	93.4	
Number of children					
2 and less	2	0.6	352	99.4	.157
More than 2	12	1.9	629	98.1	
Number of occupants					
4 and less	2	0.9	216	99.1	.746
More than 4	12	1.5	765	98.5	
Number of persons per room					
2 and less	9	1.2	772	98.8	.196
More than 2	5	2.3	209	97.7	
Number of persons per bed					
1	7	0.9	809	99.1	.006
More than 1	7	3.9	172	96.1	

fp-value obtained from Fisher's exact test

*p-value of less than 0.05 was statistically significant

**Other wall materials included wood and mixed brick and wood

***Other floor materials included wood and mixed cement and wood

Qualitative Analysis

The qualitative analysis utilised the grounded theory approach, identifying free coding in each transcript and merging processes into the initial coding, producing subthemes [10]. The coding processes were carried out until the saturation point. After establishing subthemes, intermediate coding was conducted by grouping subthemes into themes. Then, by employing advanced coding, all themes were categorised into a coherent storyline [12]. According to the respondents, two key domains could have caused RHD based on the grounded theory approach. In a brief description, internal and external factors lead a child to have RHD (Table 3).

Theme Categories: Internal Factors

Internal factors are considered factors that could be handled to improve an individual's or a family's capacity. When internal factors are left unaddressed, individual factors, socioeconomic situation, and knowledge application would decline in a damaging or harmful direction, making someone susceptible to diseases and infirmity. Therefore, the individual and their family can improve the individual factors to prevent themselves from being at risk of getting ARF or worsening into RHD. Individual factors, socioeconomic situation, and knowledge application generated the themes from internal factors. Therefore, all the initial codes would reflect that these situations would be unique among respondents as an individual.

Individual Factors

Individual factors could be among health determinants as different people have different practices, beliefs, and immunity levels. Likewise, a child with low immunity would be prone to diseases.

Maybe his immunity is low, but maybe, can give him vitamins and eat more vegetables. If his immunity is strong, maybe he can avoid getting the illness. (R3, F, A)

When there is a lack of hygiene practice, this situation might make someone prone to infection and vice versa.

... But maybe because he hangs out with his friends near the house within the housing area. When I saw there were boys, his friends, they didn't seem to take care of personal hygiene as well. I am afraid if they're carrying dirty germs as well. (R3, F, A)

... That's the problem with it. This toilet was a toilet that went straight to the river. It was a bit dirty back then (R1, M, A)

So, the villagers are more dependent on the river. So, the water from the river would be channelled through the village pipes. So that water is used for cooking and washing. (R10, F, A)

The same is true for spirituality as personal religious views and practises vary between individuals. When someone prays more, their desire for betterment influences their behaviour towards favourable aspects of health.

... for me, doctor, there is no other way for me to just pray. That's the key for my child (R4, M, A)

Table 3. Thematic map of qualitative analysis (n = 10)

Theme category	Theme	Sub-theme	n	%
Internal factors	Individual factors	Hygiene practice	5	50.0
		Immunity	1	10.0
		Spirituality	1	10.0
	Socioeconomic situation	Income	6	60.0
		Crowding	8	80.0
	Knowledge application	Lack of knowledge	10	100.0
		Other unexplained cause	5	50.0
External factors	Environment	Unfavourable environment	8	80.0
	Healthcare	Healthcare accessibility	8	80.0

Socioeconomic Situation

When a person comes from a low socioeconomic background, they seem to be more at risk of having poor health and illnesses like RHD. The proxy indicators of socioeconomic status were low income and house crowding. Usually, low income might be related to home crowding because the family could not get a space of their own. As a result, the child's health would be determined by their socioeconomic situation. As a result of not living in a better home environment, this situation may not foster health but rather creates diseases.

... *Because there is no place left to stay. Indeed, that place is our people's home. Not mine, but my father's for a long time. So, I got a job in the plantation, the oil palm plantation also within the stream of Sungai Adong.* (R1, M, A).

... *My wife is a housewife. I work with the company, building the road—just a driver.* (R4, M, A).

... *That's not there, nothing. Therefore, used a generator.* (R1, M, A).

Most respondents said their home had many residents. So, when someone gets sick in a crowded house, it affects the rest of the house. Similarly, when people get sick from outside, they put other people in danger.

... *Yes. This too, I can comment a little on this. If the house is too crowded and there are many families in the house. That too can cause this problem. Because we don't know what they're dealing with. Sometimes they have a fever or flu.* (R10, F, A).

... *During the school days, they mostly stay in dormitories. Maybe it's crowded in their dormitory. Because she was in a dormitory from primary school to secondary school.* (R4, M, A).

Knowledge Application

When there was an inadequate or absence of knowledge, the respondent would not be able to tell the cause of RHD. As a result, those without knowledge could not take preventative measures against the disease. Using RHD knowledge, the respondent may identify and avoid the causes of ARF and RHD. This lack of knowledge would also allow the condition to remain undetected by humans. Moreover, the respondents would be able to shunt misconceptions about RHD when the proper knowledge has been applied during the interview and throughout their lifetime.

... *So, I'm not sure if the home environment plays a role or not. We might not have any problem with the area within the house* (R3, F, A).

I don't know. How? I have no idea either. What does the doctor think? (R9, F, A).

I don't know how to avoid it because I also don't know what the cause is. So, it's hard to avoid it (R5, F, A)

Honestly, Doc, I'm not sure. (R8, F, A)

Knowledge application was also challenging as the respondents had different concepts of understanding. For example, the children mentioned all possible causes that they felt as they had experienced the condition that might be related to RHD. Despite the inputs given, many respondents said they were unsure.

... *Maybe she was too fat since childhood.* (R7, F, A).

... *Maybe because it was too strong, maybe the kick was strong. Maybe, it's possible.* (R6, F, A).

... *It already existed before birth. His heart was disabled.* (R1, M, A).

Theme Categories: External Factors

External factors are considered factors that could not be handled to improve an individual's or a family's capacity. Therefore, these factors are beyond their control. External factors require something or a collection of powers to manage or control, such as authority or community collaboration. Health can be preserved or achieved with the help of authorities or a good cooperative effort. When the environment is unhealthy, so is human health. Their general health is influenced by the community and the environment. External factors include the environment and healthcare accessibility.

Environment

The environment includes all areas outside the home wall, within the house compound, and beyond the house compound within a residential area or village. The exposure can occur outside of their immediate home area. Having healthy personal spaces within the home compound does not ensure the surrounding area or residential areas will be healthy, owing to other people's practices. As for the respondents, some of their neighbours took care of the surroundings, thus improving the respondent's home. The respondents' environment should be from the pooled results of everyone in a residential area or anyone who ever existed in that same area.

Yes. Since I was young, there have been people who have smoked cigarettes near our place (R2, F, T).

... *But maybe the environment outside the house, because I don't even know how far he went playing with his friends.* (R3, F, A).

... *Usually on the football field with his friends.* (R4, M, A).

Because we here are living in a house located by the roadside. It's indeed dusty. Most likely, that was the cause too. We can't deny it. (R9, F, A).

One factor considering the area of our house is sometimes, among the residents they will throw garbage everywhere, or throw it by the river. There is a drought, so the trash will be stopped without drifting away. (R10, F, A).

Healthcare

Due to geographical constraints, access to healthcare will always be an issue, especially in Sarawak. Aside from the lack of infrastructure and basic facilities, children’s health will suffer due to limited access to healthcare. Also, because RHD is frequently asymptomatic, parents would assume all is fine. This would reduce the opportunity for the respondents to improve their health. Moreover, no early screening could be provided since healthcare access was difficult.

This village has many factors that the residents need to take care of, especially these children. The reason is that these children when they are in the village, they are not aware that the village environment is not clean anymore. (R10, F, A).

So, there was no health check whatsoever. We all won't know. (R5, F, A).

Maybe have them got checked earlier. But during their younger age, they never miss any nurse and doctor's appointment. Maybe during that time, doctor should scan their heart. I guess. (R8, F, A).

Maybe from a young age, she lived in a village far from the hospital (R5, F, A).

Data Integration and Explanation

Environmental determinants were associated with RHD, while the socioeconomic determinants and home crowding factors were the otherwise after Fisher’s exact tests were conducted between determinants and RHD diagnosis. The integration of both findings showed that the quantitative association of environmental determinants with RHD was confirmed by the qualitative findings, explained by both theme categories from the qualitative findings, internal and external factors. Meanwhile, the quantitative

non-association of socioeconomic determinants and home crowding factors with RHD expanded. Despite the non-association, the lower end of socioeconomic determinants and a greater number of home occupants had a preponderance of RHD, and both theme categories expanded these findings. The qualitative findings generally confirmed these quantitative findings, and some aspects within the socioeconomic and home crowding contexts showed an expansion (Table 4).

4. Discussion

The preponderance of the lower end of socioeconomic status and more people living in space would support the point that low socioeconomic status and home crowding caused the respondents to have ARF and be diagnosed with RHD [5]. Similar to those reports by Dobson et al. [17], Okello et al. [18], and Tobing et al. [19], the home environmental association with RHD was established. Internal and external factors were some of the issues that could and could not be handled affecting health and consequently causing RHD. Cole et al. [20] suggested a similar scenario in determining the likelihood of engaging in a behaviour that encourages or discourages health-relevant behaviours. Furthermore, external factors also would be beyond an individual’s or a family’s control and may require extra force, power, or authority to manage. The integration of quantitative and qualitative findings showed that qualitative findings explained the quantitative results by confirmation and expansion without discordance. The integration of the findings was in line with Coffey et al. [5], Dobson et al. [17], and Okello et al. [18], whereby in general, RHD is due to poor socioenvironmental conditions.

Table 4. Joint display of quantitative and qualitative findings

Quantitative Findings	Corresponding Qualitative Findings and Quotes
Socioeconomic determinants were found to have no association with RHD	<i>She sells vegetables. (R2, F, T)</i>
	<i>If you would say our economy is not good, so far, praise God. (R3, F, A)</i>
	<i>Her mother was a teacher. His father was a civil servant. (R7, F, A)</i>
Environmental determinants were found to be associated with RHD	<i>Some parts are clean, and there are no floods. (R2, F, T)</i>
	<i>No, it did not flood. (R9, F, A)</i>
	<i>That's not there, nothing. Therefore, we used a generator. (R1, M, A)</i> <i>This toilet was a toilet that went straight to the river. (R1, M, A)</i> <i>Maybe from a young age, she was living in a village far from the hospital, so there was no health check whatsoever. We all won't know. (R5, F, A)</i>
Home crowding was found not to be associated with RHD	<i>We are a family of eight. (R4, M, A)</i>
	<i>When the child grew up, there weren't many people at home. The child had two younger siblings, then just parents. (R5, F, A)</i>
	<i>She does live in a dormitory. It's crowded there indeed. (R9, F, A)</i>

The mixed method for this study was justified given the low prevalence of RHD among the targeted population, making advanced quantitative analyses unable to proceed. Moreover, a fresh perspective according to the local context would not be elicited without a qualitative component. Rather, this study had several limitations that needed to be addressed. The first limitation was the data collection in the quantitative phase, whereby recall bias was a common problem in quantitative studies. Since measuring socioeconomic conditions in health research has inherent limitations, the concept of "one size does not fit all" would be appropriate for understanding this [21]. Since the target population in qualitative data collection was exclusively children with RHD, the findings would be less generalisable unless non-RHD respondents were included. The qualitative analysis findings would benefit from the input from healthy individuals or households without RHD.

5. Conclusions

By understanding the modifiable socioenvironmental factors according to the local setting, the stakeholders could prioritise efforts on RHD management. Furthermore, given that fresh perspectives were consistent with the available evidence, the political power and influence, with the help of the multiple government agencies, could integrate and collaborate to manage RHD, especially in addressing the non-medical aspects and factors of health and general wellbeing.

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Conflict of Interest

All authors declare that there is no competing interest associated with this research.

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