

ORIGINAL RESEARCH

Screening Rheumatic Heart Disease in 1530 New Caledonian Adolescents

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BACKGROUND: In New Caledonia, a South Pacific archipelago whose inhabitants comprise Melanesians, Europeans/whites, Wallisians, Futunans, Polynesians, and Asians, the prevalence of rheumatic heart disease (RHD) is 0.9% to 1% at ages 9 and 10. It could be higher at the age of 16, but this remains to be verified.

METHODS AND RESULTS: A total of 1530 Melanesian, Métis, white, Wallisian, Futunan, Polynesian, and Asian adolescents benefited from a transthoracic echocardiogram. Definite or borderline RHD, nonrheumatic valve lesions, congenital heart defects, family and personal history of acute rheumatic fever, and socioeconomic factors were collected. The prevalence of cardiac abnormalities was 8.1%, made up of 4.1% RHD including 2.4% definite and 1.7% borderline RHD, 1.7% nonrheumatic valve lesions, and 2.3% congenital anomalies. In whites and Asians, there were no cases of RHD. RHD was higher in the Wallisian, Futunan, and Polynesian group (7.6%) when compared with Melanesians (5.3%) and Métis (2.9%). The number of nonrheumatic valve lesions was not statistically different in the different ethnicities. The prevalence of RHD was higher in adolescents with a personal history of acute rheumatic fever, in those living in overcrowded conditions, and in those whose parents were unemployed or had low-income occupations, such as the farmers or manual workers.

CONCLUSIONS: RHD was 4 times higher in adolescents at age 16 than at ages 9 and 10 (4.1% versus 0.9%–1%). No cases of RHD were observed in whites and Asians. The determining factors were history of acute rheumatic fever and socioeconomic factors.

Key Words: epidemiology ■ ethnicity ■ socioeconomic position ■ valve

Rheumatic heart disease (RHD) is the long-term damage to the heart valve that follows acute rheumatic fever (ARF). ARF is an autoimmune disease that follows throat infection or reinfection with the bacterium group A streptococcus.¹ It is estimated that 60% of all those contracting ARF will develop RHD. Although RHD has almost disappeared from industrialized and wealthy countries, it remains the most frequent heart disease in children worldwide.

In 2015, RHD was estimated at 33.4 million cases, with 300 000 to 350 000 new cases per year and resulting in 319 400 premature deaths² from stroke, infective endocarditis, heart failure, and arrhythmias. The risk of developing RHD was found to be twice as high for females than males.^{3,4}

In the Western Pacific Region, RHD is concentrated in China and indigenous populations living in Australia, New Zealand, and the Pacific Island states.⁵ Recent school surveys using echocardiographic screening have reported a 2% to 5.5% incidence of RHD in asymptomatic school children across developing countries, such as Fiji and New Zealand.^{2,6,7}

In New Caledonia, Baroux et al⁸ and Corsenac et al⁹ found up to a 5% prevalence of RHD depending on whether the subjects' place of residence was either Noumea and its suburbs, the north territories, or the Loyalty Islands.

Lifestyle, socioeconomic,¹⁰ and environmental factors such as poor housing and nutrition, household overcrowding,^{4,11} low educational attainment, and

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CLINICAL PERSPECTIVE

What Is New?

- In New Caledonia, when adolescents were age 16, the estimated prevalence of rheumatic heart disease was 4 times higher than at ages 9 and 10 (4.1% versus 0.9%–1%); 95 of the lesions were mitral; and Melanesians, Wallisians, Futunans, and Polynesians were more at risk than other ethnicities.
- A personal history of acute rheumatic fever, overcrowded living conditions, and parents who were unemployed, farmers, or manual workers were determining factors.

What Are the Clinical Implications?

- A second screening with transthoracic echocardiography and monitoring of definite and borderline rheumatic heart diseases in Wallisians, Futunans, Polynesians, Melanesians, and Métis at the age of 16 is highly recommended.

Nonstandard Abbreviations and Acronyms

ARF	acute rheumatic fever
RHD	rheumatic heart disease

reduced access to medical care are well-known contributors to the incidence, magnitude, and severity of ARF and RHD.¹² Host genetic susceptibility, virulence factors of the infection, and specific autoimmune reaction/defense are also significant factors.^{13–15}

The prevention, control, and elimination or eradication of RHD is increasingly being recognized as an important developmental issue by Member States of the World Health Organization.¹⁶ The World Health Organization recommended echocardiographic screening for RHD in high-prevalence regions. Indeed, beginning at an early age, RHD in most cases is asymptomatic.

Since 2005, a number of countries, including Australia, Fiji, New Zealand, and Samoa, have embarked on large-scale echocardiography-based RHD screening programs. Since 2007, the Health and Social Agency of New Caledonia established the same aim, an echocardiography-based screening program for school children ages 9 or 10. Between 2008 and 2010, Baroux et al⁸ measured a prevalence of 0.89% cases, mainly in Melanesians (72%) and Polynesians (22%) when compared with whites, whereas Corsenac et al⁹ found about a 1% prevalence of RHD.

The prevalence of RHD increases with age^{9,17} because of the cumulative effect of repeated exposures

to infection. In New Caledonia, Mirabel et al¹⁸ highlighted in 2015 that a significant proportion of children with normal echocardiograms at school presented 2 years later with either definite (0.9%) or borderline (1.8%) RHD. It was suggested to repeat screening to increase the case detection rate. From 2012 to 2015, in 1411 New Caledonian sportsmen and women, Chatard et al¹⁹ pointed out that a 1.5% incidence of RHD was found mainly in Melanesians, Polynesians, and Métis. No cases of RHD were found in whites. However, Ledos et al,²⁰ in an older population (ages 18–22), found a prevalence of only 0.6% of definite RHD, increasing up to 1.7% when including borderline RHD.

Based on these elements, a prospective echocardiographic screening study was conducted in New Caledonia to evaluate the estimated prevalence of RHD in a school-teenager population aged 16±1 (mean±SD) years. The aim was to determine if a second, later screening should be recommended. Another purpose was to study some known risk factors of RHD, such as family and personal medical histories of ARF, sex, race, and lifestyle.

METHODS

Subjects

From October 2017 to April 2018, the parents of 1530 adolescents aged 15.8±0.7 (mean±SD) years, 783 females and 747 males, and randomly chosen in 14 colleges of New Caledonia (Figure 1), gave written informed consent after institutional review board approval; <1% refused to participate. Attention focused on Melanesians (50%); Métis (29%); whites (12%); Wallisians, Futunans, and Polynesians (9%); and a small number of Asians (<1%). The term “Métis” was used when at least 1 parent or 1 of the 4 grandparents was not the same race as the others. Almost all of the studied adolescents, including whites, were native to New Caledonia.

New Caledonia is an archipelago and a French collectivity located in the South Pacific 1200 km east of Australia and 1500 km northwest of New Zealand. It has close links with Wallis and Futuna, another archipelago and French collectivity that is smaller with 11 600 inhabitants. Genetically, Melanesians or Kanaks are black people from Melanesia, a wide area of the Pacific stretching from New Guinea as far as the islands of Vanuatu and Fiji. Wallisians and Futunans are from Polynesia, which encompasses an extensive area of the Pacific, including many islands and countries such as Hawaii, Samoa, the Cook Islands, Tonga, and French Polynesia.

From the 2017 census, New Caledonia has ≈271 400 inhabitants. Each year group from the ages of 9 to 16 is composed on average of 4400 children.

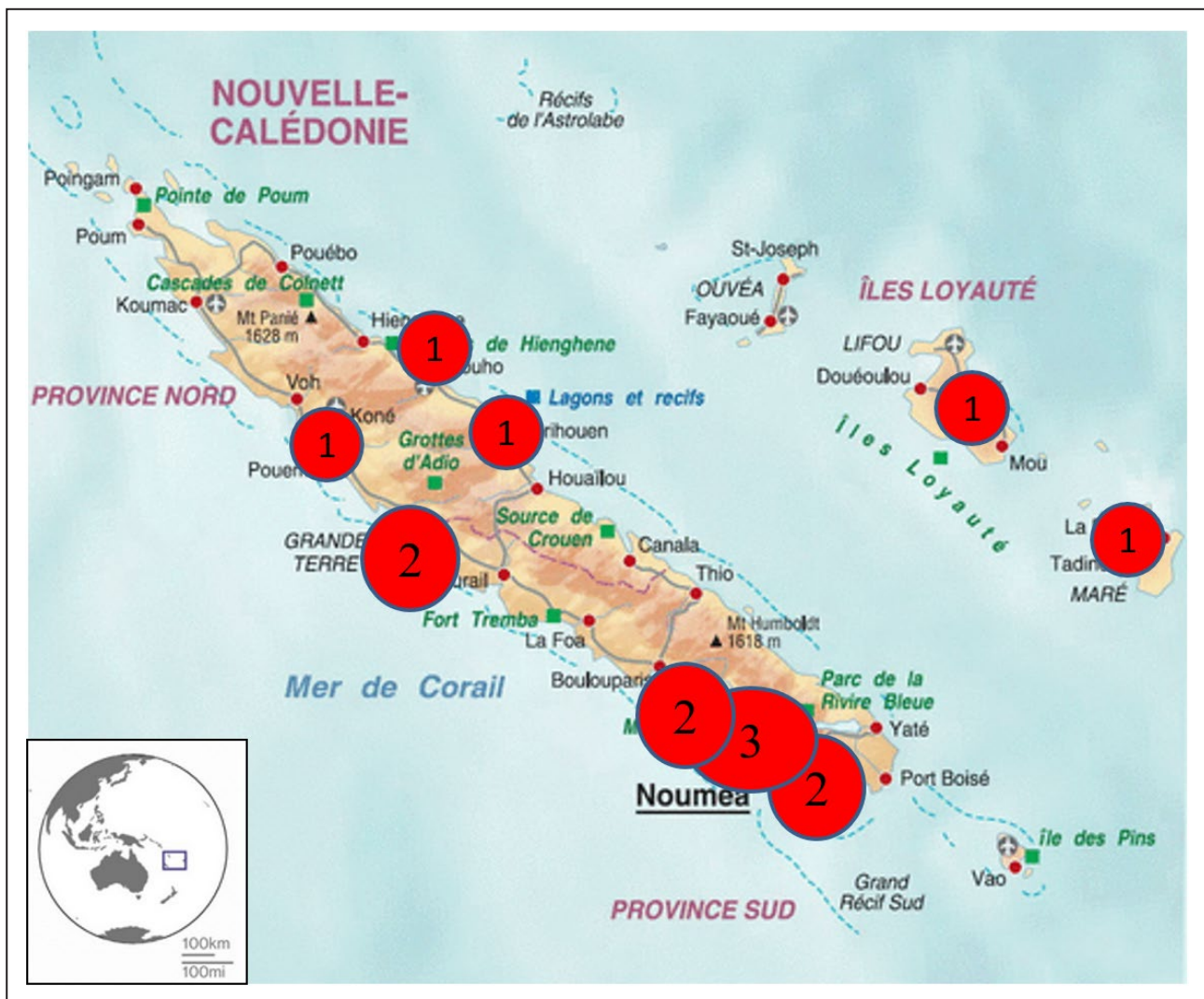


Figure 1. Locations of the 14 screening sites in New Caledonia.

The age of 16 was considered because it is the oldest age where attendance at school is close to 100% as school is compulsory. Age groups older than 17 are difficult to survey as some of them start to work.

Of the whole population, 52% live in Noumea and its suburbs, 35% in other districts on the main island, and 13% on the Loyalty Islands and the Isle of Pine. Of the population, 40% is Melanesian, 30% white, 15% Métis, 13% Polynesian, and 2% Asian.

Data Collection

For each participant, the collected data were age, height, weight, sex, race, city of residence, parents' occupation, and living conditions, whether it be in a private house, an apartment, hut, squat, or boarding school. Also taken into consideration were the number of people living in the family house, the number of people sleeping in the same bedroom, and whether

the subject participated regularly in competitive sports. Data concerning medical, family, and personal histories of ARF or other cardiac diseases, former arthritis, symptoms of ARF during childhood, and former echocardiography in the RHD screening program for schoolchildren aged 9 and 10 years were also collected.

Echocardiographic Protocol

The same cardiologist (T.D.) carried out all echocardiograms at school in a dedicated room using a portable Vivid I machine manufactured by General Electric Healthcare (Boston, MA). A 5 to 1 MHz transducer was used. A standardized set of loops and images was recorded over 3 heart cycles in parasternal long axis, parasternal short axis at the aortic and mitral valve levels, and in apical 4, 5, 2, and 3 chamber views with ECG monitoring. Color pulsed

and continuous Doppler was used in each view to assess velocity and spectral envelope of trans valve flow and regurgitation. In accordance with World Heart Federation 2012 criteria,²¹ color Doppler was also used with the highest aliasing velocity allowed by the machine to take into account the adolescent's morphology. To measure the thickness of the anterior mitral valve leaflet, images were recorded with and without second harmonic frequency in the parasternal long axis.

The World Heart Federation 2012 criteria²¹ for echocardiographic diagnosis of definite or borderline RHD were applied. Congenital cardiac defects were easily differentiated from RHD as they have unique identifying features (eg, bicuspid aortic valve). Degenerative conditions are rare in the young, and other acquired conditions (eg, infective endocarditis) can be differentiated from RHD on the basis of clinical findings. Other valve lesions were also recorded as they are more common at this age.

RHD predominantly affects the left-sided cardiac valves causing regurgitation, stenosis, or mixed hemodynamic effects. The tricuspid valve and seldom the pulmonary valve can also be affected, but rarely without mitral valve involvement (99.3% on echocardiography and 100% on postmortem examination have coexisting disease of the mitral valve). Similarly, arteriovenous stenosis is rare in isolation (0%–0.5%). Hence, neither right-sided valve lesions nor aortic stenosis were included in the diagnostic criteria.

When abnormalities were detected, the adolescent underwent a second echocardiography using a non-portable machine, the EPIQ 7 Ultrasound from Philips (Amsterdam, the Netherlands), that was carried out by local experienced cardiologists specialized in the diagnosis of RHD confirming or not definite or borderline RHD. Secondary prophylaxis employing benzathine penicillin G was initiated in all positive cases of definite RHD. A total of 7 adolescents did not show up for the second examination. When the first operator (T.D.) had some doubts

about the diagnosis of RHD, a review of loops was given by up to 4 local expert cardiologists. Contentious issues were discussed, and a final diagnosis was given.

Statistical Analysis

Multivariate ANOVA and 1-way ANOVA were carried out between RHD; age; race; sex; parents' occupation; living conditions whether it be a private house, an apartment, hut, squat, or boarding school; the number of people living in the family house; the number of people sleeping in the same bedroom; participation in sports; and medical, family, and personal histories of ARF. An *F* test (Tukey) was used to determine the location of the differences. A *P* value of 0.05 was chosen as the level of statistical significance. Excel Microsoft, Stat-view, and Stata 11 software were used.

The odds ratios were calculated with contingency tables using the calculator of the web site (<https://select-statistics.co.uk/calculators/confidence-interval-calculator-odds-ratio/>).

The data that support the findings of this study are available from the corresponding author upon reasonable request.

RESULTS

Population

The main characteristics of the 1530 adolescents are presented in Table 1. The races of the adolescents closely matched the whole New Caledonian population: Melanesians (50% versus 40%), Métis (29% versus 15%), and the Wallisian Futunan Polynesian group (9% versus 13%). However, whites (12% versus 30%) and Asians (<1% versus 2%) were underrepresented. Adolescents were from Noumea and its suburbs (60%), the North Region (22%), and the Loyalty Islands (18%).

The morphological characteristics of the adolescents were different within the 5 races. Wallisians,

Table 1. Mean±SD of the Main Characteristics of the 1530 Adolescents in Relation to Their Race

	Melanesian (n=760), 50%	Métis (n=448), 29%	White (n=181), 12%	WFT (n=131), 9%	Asian (n=10), <1%	Total (n=1530), 100%
Age, mean±SD, y	15.9±0.7	15.8±0.6	15.6±0.6	15.8±0.7	15.6±0.5	15.8±0.7
Percent of people with low incomes	79 ^{*†}	57 [§]	20 [¶]	78	44	66
Percent of people living in a private house	46 ^{*†‡}	80	83	75	60	63
No. under the same roof, mean±SD	5.5±2.0 ^{†‡}	4.8±1.9 [§]	4.1±1.2 [¶]	6.1±2.7	3.3±0.8	5.1±2.1
No. in the same bedroom, mean±SD	2.1±1.8 ^{*†‡}	1.4±1.0 [§]	1.1±0.4 [¶]	1.4±1.5	1±0	1.7±1.5
Percent boardroom	46.2 ^{*†‡}	15.6||	9.4 [¶]	6.5	0	29.7
Percent in sports	48.8 ^{*†}	38.9 [§]	55.1 [¶]	35.1	30	45.1

The number of people earning low incomes, living in a private house, living in a boardroom, or practicing sports are expressed in percentages. Low-income occupations included unemployed people, farmers, and hand workers. WFT, Wallisians, Futunans, and Polynesians.

Comparisons were performed between the 4 main races. When *P*<0.05, an asterisk was indicated as follows: ^{*}Melanesian vs Métis; [†]Melanesian vs white; [‡]Melanesian vs WFT; [§]Métis vs white; ^{||}Métis vs WFT; [¶]white vs WFT. Asians <1% were excluded from the statistical analysis.

Futunans, and Polynesians were taller and heavier ($P<0.05$) than the others, whereas whites and Asians were lighter without being shorter than others.

Parents' occupations were manual workers (56%), managers or equivalent (13%), teachers (10%), farmers (6%), market sellers and traders (5%), health professionals (5%), or unemployed (4%).

The adolescents' living conditions were also different within the 5 races. On average, 83% of the whites lived in a house, and 17% in an apartment or hut versus 46% and 54% for the Melanesians. Whites had a lower number of people living under the same roof, 3 to 4 versus 5 to 6 people for the others ($P<0.05$). Their sleeping conditions were also less crowded: on average, 1 person per bedroom versus 2.2 for the Melanesians; 1.7 for the Wallisians, Futunans, and Polynesians; and 1.4 for the Métis ($P<0.05$). Melanesians had a higher proportion of adolescents living at boarding school, whereas whites and Melanesians had the higher number of sportsmen and women ($P<0.05$).

Cardiac Abnormalities

Cardiac abnormalities were found in 8.1% ($n=124$) of adolescents, including 4.1% ($n=63$) RHD, 2.4% ($n=37$) definite, and 1.7% ($n=26$) borderline RHD (Figure 2). Two cases of severe valve lesions that necessitated surgical treatment were detected: 1 severe mitral regurgitation and 1 severe aortic regurgitation. Mitral lesions represented >95% of all the valve lesions (60 mitral regurgitations [54 mild, 4 moderate, 2 severe] and 2 mitral stenoses), whereas 18 were associated with an aortic lesion. Only 3 aortic lesions were isolated incidences. Of the 63 adolescents, only 2 adolescents were symptomatic.

The prevalence of the non-RHD valve lesions was 1.6%, whereas the prevalence of the other congenital cardiac abnormalities was 2.3%, some of which, like pulmonary stenosis or transposition of the great vessels, were previously diagnosed by the questionnaire on family and personal histories. Echocardiograms of these cases showed no abnormalities after their surgical correction.

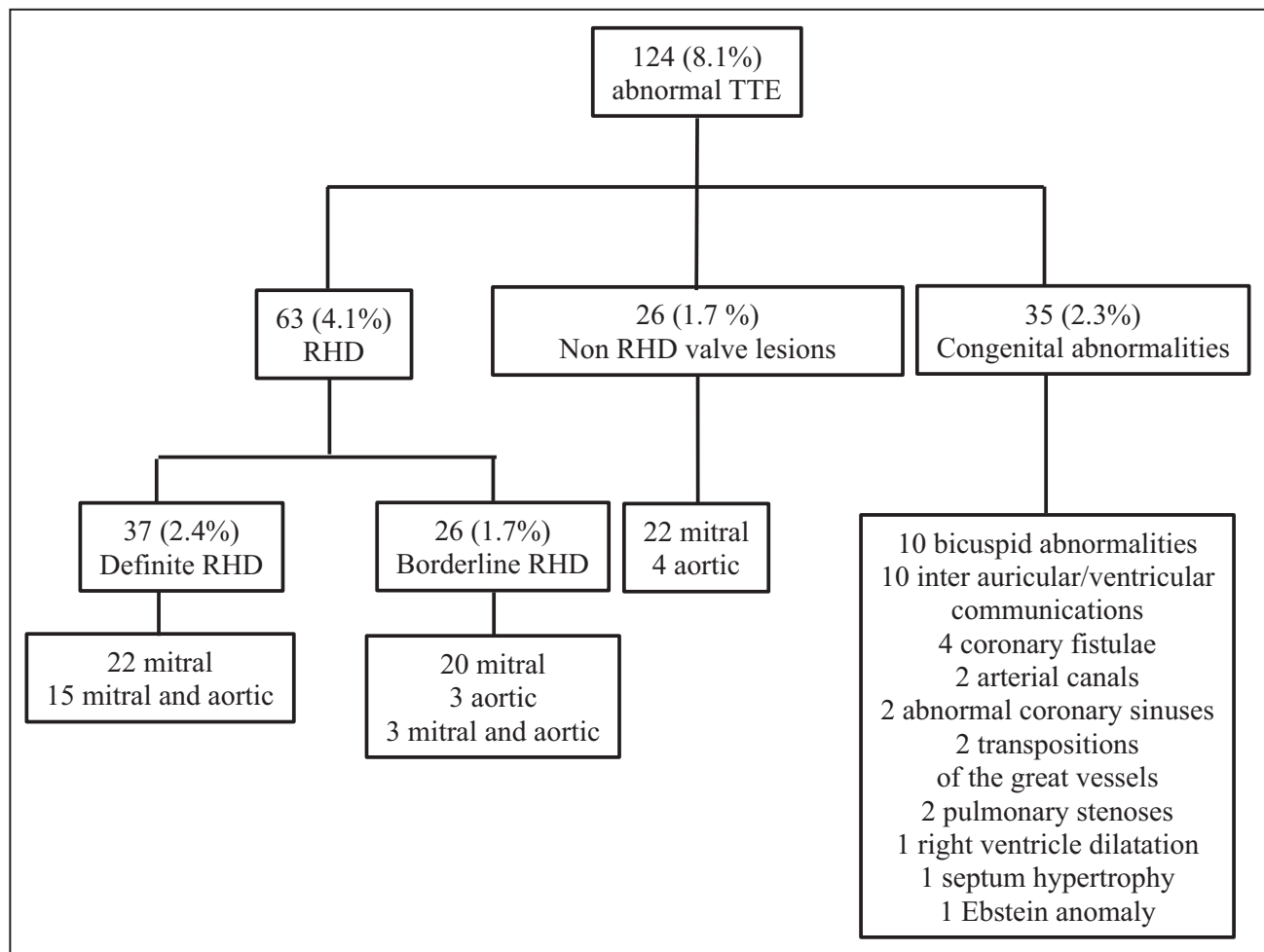


Figure 2. Definite and borderline rheumatic heart diseases (RHD) compared with non-RHD valve lesions and congenital abnormalities found after screening 1530 adolescents by transthoracic echocardiography (TTE).

Racial Influence

In the white and Asian groups, no RHD, definite or borderline, was detected. On the contrary, RHD prevalence was significantly higher ($P<0.05$) in the groups of Wallisians, Futunans, and Polynesians (7.6%); Melanesians (5.3%); and Métis (2.9%) (Table 2). Non-RHD valve lesions were not statistically different within the 4 main races; the few numbers of Asians were excluded from the statistical analysis.

Most of the adolescents (at least 90%) had undergone a previous echocardiography screening at ages 9 and 10. At the time of this screening age 9 to 10, 78% of the RHD found in the present study at 16 ± 1 year were not apparent.

Personal and Family Histories and Sex

Personal history of ARF was a contributing factor. Indeed, definite and borderline RHD were 8-fold to 9-fold higher in adolescents with a personal history of ARF ($P<0.05$) than in others. They were 2-fold higher for those with a family history of ARF. However, this difference was not significant. RHDs were not different between males and females.

Lifestyle, Socioeconomic, and Environmental Factors

The incidence of RHD was higher in adolescents living in the Loyalty Islands (5.0%) when compared with those from the North Region (4.5%) and the suburbs of Noumea (3.7%). However, the differences were not significant.

Living in overcrowded conditions was a discriminating factor ($P<0.05$ for number of people living in the same bedroom, and $P<0.06$ for number of people living under the same roof). Living at a boarding school increased the risk of having a RHD by 27%, whereas being a sportsman decreased it by 17%. However, the differences were not significant.

RHD was 2-fold higher (5.2% versus 2.3%) in adolescents ($P<0.05$) whose parents were unemployed or had low-income occupations such as farmers or manual workers when compared with adolescents whose parents were managers, trades people, health professionals, or teachers.

Multivariate analysis indicated that of the studied risk factors, occupation and overcrowded conditions were related to race, whereas race and personal history of ARF were the 2 main risk factors related to RHD.

DISCUSSION

The main findings of the present study were:

1. At the age of 16, the estimated prevalence of RHD was 4 times higher than at ages 9 and 10 (4.1% versus 0.9%–1%).
2. No case of RHD was found in whites, whereas the frequency reached up to 5.3% in Melanesians and 7.6% in Wallisians, Futunans, and Polynesians.
3. Socioeconomic and environmental factors mainly related to race increased the prevalence of RHD.

Table 2. Main Characteristics of the 1530 Adolescents in Relation to RHD Detected After Transthoracic Echocardiography Screening and Questionnaire

	RHD (n=63), 4.1%	Odds Ratio	95% CI	Non-RHD (n=1467), 95.9%
Melanesian, n	40 (5.3%)*†	1.96	1.13–3.46	720 (94.7%)*
Métis, n	13 (2.9%)*‡§	0.70	0.33–1.24	435 (97.1%)*
White, n	0	...	...	181 (100%)||
WFP, n	10 (7.6%)	2.1	0.93–4.30	121 (92.4%)
Asian, n	0	...	...	10/100%
Female	51%	0.98	0.57–1.69	51%
Family history >0	11%	1.96	0.90–4.23	7%
Personal history >0	17%¶	8.82	3.81–19.10	2%
Low income	81%¶	2.30	1.20–4.79	65%
Hut or apartment	42%	1.24	0.71–2.14	37%
No. under the same roof, mean±SD	5.6±2.0 ^{P<0.06}	...	...	5.1±2.1
No. in same bedroom, mean±SD	2.1±1.6¶	...	...	1.7±1.5
Boarding school	38%	1.46	0.82–2.54	29%
Sports practice	38%	0.73	0.42–1.27	46%

Low-income occupations included unemployed people, farmers, and hand workers. RHD indicates rheumatic heart disease; and WFP, Wallisians, Futunans, and Polynesians.

Comparisons were performed between the 4 main races. When $P<0.05$, an asterisk was indicated as follows: *Melanesian vs white; †Melanesian vs WFP; ‡Métis vs white; §Métis vs WFP; ||white vs WFP. ¶RHD vs non-RHD. Asians <1% were excluded from the statistical analysis.

Prevalence of RHD in New Caledonian Adolescents

The estimated prevalence of definite and borderline RHD was 4.1% in the adolescent group aged 16±1 (mean±SD) years corresponding to a 4-fold increase over the 0.89% to 1% observed at ages 9 and 10. This corresponds to a cumulative effect of the yearly incidence of RHD in childhood. Indeed, the peak of ARF is at the age of 12, whereas the RHD peak arrives later during adulthood at ages 25 to 34.¹

Kane et al,¹⁷ by comparing 2 different age groups in Senegal, found more frequent and severe valve lesions than at a younger age. The same results were found in the present study, where 2 cases of severe valve lesions necessitating surgery were detected. Moreover, several cases of mitral stenosis were discovered, which is rare at ages 9 and 10, and 78% of the newly discovered cases of RHD were not apparent when screened at ages 9 and 10.

In the same way, Rothenbühler et al,⁷ in a meta-analysis, showed a prevalence of definite RHD that progressively increases from 0.47% at the age of 5 (95% CI, 0.0–11.2) to 2.1% at the age of 16 (95% CI, 6.8–35.1). This rate of 2.1% is in agreement with the 2.4% found in the present study.

These findings suggest that a second echocardiographic screening in New Caledonian adolescents should be mandatory in colleges or high schools at the age of 16, confirming previous observations.⁹ Early detection detects fewer cases than later detection but allows an early antibiotic prevention, whereas the second screening would detect more cases with more severe forms. Overall, the first and second detections would reduce the morbidity associated with RHD, especially among young women whose valve lesions become more serious during their first pregnancy with sometimes dramatic human and financial consequences.

Surprisingly, the 2/3 increased risk of RHD often found in girls^{3,4} was found only in definite RHD, contrasting with data found in borderline RHD in New Caledonians.⁹

No RHD in Whites and Role of Socioeconomic and Environmental Factors

A second important finding of the present study was the lack of RHD detected in the white group. This could be partially explained by a selection bias as only 12% of the adolescents of the present study were white versus 30% in the whole New Caledonian population.

However, whatever the impact of the selection bias, other considerations such as lifestyle, socioeconomic, and environmental factors also explained a part of these differences, confirming previous data.¹² Indeed,

RHD has almost disappeared in high-income countries during the past 5 decades, but current migration flows from developing countries with a high prevalence of RHD to Europe has favored its reappearance. For example, a prevalence of 4% of RHD in 603 young refugees ages 16 to 18 in Rome has been observed, which is comparable with the present study (G. de Maio et al, unpublished poster data, 2018).

In the white group, unemployment and manual work were not so common when compared with Melanesians and other groups. These groups were not in the habit of consulting physicians either for minor ailments or for more serious complaints. For example, some adolescents were found with serious advanced infection in their feet or legs as they were walking barefoot. Among Melanesians and other groups, it was more common to find individuals with multiple occupations living under 1 roof, overcrowded sleeping arrangements, and individuals living in boarding accommodations when compared with whites.

Overall, in the present study, Melanesians and the group of Wallisians, Futunans, and Polynesians were at a higher risk of having definite RHD when compared with whites or Asians, confirming previous studies.^{8,9}

The genetic and family susceptibilities of these groups could also explain another part of the observed differences. Indeed, RHD affects indigenous groups in high-income countries such as New Zealand particularly in Maori, Pacific Islander people,¹¹ and Australia.²² Only some children with specific family histories,²³ monozygotic twins compared with dizygotes,²⁴ or Melanesians will develop ARF and RHD.²⁵ No one knows why only a small fraction of these populations, 3% to 8%, will develop an abnormal immunity response.^{14,15} Human Leukocyte Antigen (HLA) genotypes and different rheumatogenic species of streptococcus could be involved.¹³

Implications for RHD Screening

To date, echocardiography has a major role in defining RHD disease. By identifying previously undiagnosed cases of RHD, it enables these patients to commence secondary prophylaxis. However, the expectation that echocardiographic screening will directly lead to reductions in RHD disease burden has yet to be proven.²¹ In addition, an urgent need to evaluate the clinical relevance of “definite RHD” and of “borderline RHD” exists. Indeed, the lack of only 1 functional or morphological criterion may classify an RHD either as definite or borderline with an important treatment decision in both cases. Definite RHD receives antibiotic treatment, whereas borderline RHD does not. Some criteria such as Doppler pan-systolic/diastolic jet in at least 1 complete envelope in regurgitation, valve or chordal thickening, or commissural fusion are difficult to measure.

Some criteria are subjective, such as an excessive or restricted leaflet motion. Some are probably dominant, such as morphological criteria, especially restricted leaflet motion. It is pointed out that restricted leaflets are pathognomonic of RHD in young people with good cardiac function.

It is thus suggested to add to the World Heart Federation criteria a general impression based on echocardiography but also on adolescent history. For example, the report could indicate RHD “highly suspected” although all the functional and morphological criteria were not completely measured/observed.

Use of Handheld Echo Machines

An important debate around asymptomatic RHD concerns the most appropriate model for undertaking screening. Despite the increased affordability of portable echocardiography machines during the past 5 years, they remain exorbitantly priced. The ultraportable handheld machines that have been marketed for point-of-care echocardiography in intensive care and trauma units might provide a cheaper option.²¹ Although these pocket-sized imaging devices are capable of producing 2-dimensional and color images and are simple to use by inexperienced staff, they currently cannot perform either real-time measurements or continuous-wave Doppler echocardiography. These devices still require extensive testing, careful validation, and further technological refinements before widespread independent use can be recommended.

CONCLUSIONS

RHD was 4 times higher in adolescents at age 16 than that already known in New Caledonia for children ages 9 and 10 (4.1% versus 0.9%–1%). No case of RHD was observed in whites. The determining factors were personal history of acute rheumatic fever, overcrowded living conditions, and parents who were unemployed, farmers, or manual workers. In the case of Wallisian, Futunan, Polynesian, Melanesian, and Métis adolescents, the screening and regular monitoring of all RHDs are recommended. The evolutionary severity of the disease remains to be studied.

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