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ORIGINAL ARTICLE

Epidemiology of acute rheumatic fever in New Zealand 1996–2005

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Aim: Acute rheumatic fever (ARF) and its sequela chronic rheumatic heart disease remain significant causes of morbidity and mortality in New Zealand, particularly among Māori and Pacific peoples. Despite its importance, ARF epidemiology has not been reviewed recently. The aims of this study were to assess trends in ARF incidence rates between 1996 and 2005 and the extent to which ARF is concentrated in certain populations based on age, sex, ethnicity and geographical location.

Methods: This descriptive epidemiological study examined ARF incidence rates using hospitalisation data (1996–2005) and population data from the 1996 and 2001 censuses. Rates were compared by using rate ratios and 95% confidence intervals.

Results: New Zealand's annual ARF rate was 3.4 per 100 000. ARF was concentrated in certain populations: 5- to 14-year-olds, Māori and Pacific peoples and upper North Island areas. From 1996 to 2005, the New Zealand European and Others ARF rate decreased significantly while Māori and Pacific peoples' rates increased. Compared with New Zealand European and Others, rate ratios were 10.0 for Māori and 20.7 for Pacific peoples. Of all cases, 59.5% were Māori or Pacific children aged 5–14 years, yet this group comprised only 4.7% of the New Zealand population.

Conclusion: ARF rates in New Zealand have failed to decrease since the 1980s and remain some of the highest reported in a developed country. There are large, and now widening, ethnic disparities in ARF incidence. ARF is so concentrated by age group, ethnicity and geographical area that highly targeted interventions could be considered, based on these characteristics.

Key words: epidemiology; New Zealand; rheumatic fever.

Introduction

Acute rheumatic fever (ARF) and its sequela chronic rheumatic heart disease (CRHD) remain significant causes of morbidity and mortality in New Zealand, particularly among Māori and Pacific peoples.[1] Although ARF incidence rates declined in New Zealand throughout most of the 20th century,[2] these rates have failed to significantly reduce over the last 20 years.[1] The New Zealand rate of notified disease, 2.8 per 100 000 for the 1995–2000 period, exceeds that reported for other developed countries.[1]

Key Points

1. Acute rheumatic fever (ARF) rates in New Zealand have failed to decrease since the 1980s and remain some of the highest reported in a developed country.
2. There are large, and now widening, ethnic disparities in ARF incidence, with Māori and Pacific peoples showing far higher rates than New Zealand European and Others.
3. ARF is so intensely concentrated by age group (5- to 14-year-olds), ethnicity (Māori and Pacific peoples) and geographical area (upper North Island) that highly targeted interventions could be considered, based on these characteristics.

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ARF is an autoimmune response to infection with group A *Streptococcus* bacteria. The ensuing generalised inflammatory response affects only certain organs: the heart, joints, central nervous system and skin. Carditis can cause long-lasting damage to the heart valves. This damage can lead to CRHD later in life. Recurrences of ARF can cause further cardiac valve damage leading to worsening CRHD.[3]

ARF and CRHD are important causes of inequalities in New Zealand. Māori and Pacific peoples display ARF rates that are among the highest in the world.[4] Māori rates are 22 times that of New Zealand Europeans, while rates for Pacific peoples are over 75 times the New Zealand European rate.[5] Even when the differences in rates are accounted for, Māori and Pacific peoples have greater ARF recurrence rates and higher CRHD rates.[3] These findings clearly show the importance of ARF and CRHD in creating and maintaining ethnic inequalities in New Zealand.

ARF and CRHD contribute sizeable costs to patients, their families, communities and the New Zealand health system. These costs can be measured in a reduction in quality of life, reduced productivity, financial loss and intangible emotional impacts. In the early 1990s, the annual cost to the Auckland Area Health Board alone was estimated at $3.6 million.[6] Further impacts of ARF are displayed in the high rates of CRHD in New Zealand. Throughout most of the 1990s, there were more than 120 deaths per year from CRHD.[7] For communicable diseases in New Zealand, only AIDS causes greater premature death for those aged under 65 years.[8]

Despite the obvious importance of this disease, population-based statistics in the international literature are rare.[4] This is also the case for New Zealand where the epidemiology of ARF has not been comprehensively reviewed in recent years. Therefore, the aims of this study were to assess trends in ARF incidence rates between 1996 and 2005 using the most complete available data sources. Further, we aimed to assess inequalities in ARF and the extent to which ARF is concentrated in certain defined populations, based on age group, sex, ethnicity and geographical location.

Methods

Case data

This descriptive epidemiological study examined ARF incidence rates in New Zealand for the 10-year period from 1996 to 2005. We reviewed two sources of case data: hospitalisations and notifications. ARF hospitalisation data were obtained from the New Zealand Health Information Service, which collates data on all publicly funded hospital discharges in New Zealand. ARF is also a notifiable disease, meaning that medical practitioners making such a diagnosis are required to notify cases to their local medical health officer. These notifications are collated nationally by the Institute of Environmental Science and Research Ltd. on behalf of the Ministry of Health.

Definitions

Incident cases

Incident cases were defined as the first known admission to hospital for ARF for the 10-year-period from 1996 to 2005. Such cases had ARF (International Classification of Diseases (ICD).9 390-392 or ICD.10 I00-I02) recorded as their principal diagnosis. ICD.9 codes were used until mid-1999, while ICD.10 codes were used after this. ICD.9 and ICD.10 codes matched exactly. Data back to 1992 were used to ensure readmissions of ARF were not being misclassified as first admissions. The year assigned to a case was based on the date of admission. Data from 2006 were used to identify any cases admitted in 2005 but not discharged until 2006. All non-New Zealand residents were excluded.

Recurrences

Recurrences were defined as all ARF readmissions occurring more than 30 days after a previous ARF discharge. Any day admissions in this period have been excluded.

District Health Board

The geographical analysis was based on the District Health Board (DHB) of residence of the case. There are 21 DHBs in New Zealand. These organisations are responsible for providing publicly funded health and disability support services to the populations of their geographical region.[9]

Seasonal distribution

Overall counts for every month and week (based on date of admission) were calculated to determine the seasonal distribution of ARF.

Ethnicity

This analysis used prioritised ethnicity as this is consistent with the Ministry of Health ethnicity data protocols.[10]

Population data

Population data were obtained from Statistics New Zealand for the 1996 and 2001 censuses. To calculate average annual rates for the entire period from 1996 to 2005, the 2001 census data were used as denominator populations. Where rates are given per year, yearly estimates of the denominator populations were calculated by using linear interpolation and extrapolation from the 1996 and 2001 censuses.

Age-standardised rates were calculated by using the direct method with the 2001 New Zealand population as the standard population.[11]

Statistical methods

The ARF hospital case data were used to calculate frequencies, rates, rate ratios and confidence intervals.[11] Rates of ARF were examined in relation to individual characteristics (age, sex, ethnicity, DHB, season of onset). Linear regression analysis was used to examine trends of ARF rates across most variables. The χ^2-test for trend was used to test trends over time. Data analysis was carried out with Epi Info version 3.3.2 (Epi info, Centers for disease Control and Prevention (CDC), Atlanta, GA, USA), Windows Excel 2000 (Microsoft Corporation, Redmond, WA, USA), STATA 9.2 (Stata Corp, College Station, TX, USA) and SPSS version 9 (SPSS Inc., Chicago, IL, USA).

Results

Incidence

There were 1875 hospital admissions with a principal diagnosis of ARF over the 10-year period from 1996 to 2005. Removing non-New Zealand residents (74) and readmissions (552) left 1249 first admissions (i.e. new cases) of ARF. Over the same period, there were 974 notifications of ARF. Of these, only 40 were recorded as 'not hospitalised'. Among the group with unknown hospitalisation status, the majority of these (337/499) were reported by hospital-based practitioners, suggesting that these cases were hospitalised. Therefore, we decided to use hospitalisations as this was the more comprehensive dataset.

Over the decade, 1996–2005, there was an average of 125 ARF first admissions per year, giving an average annual rate of 3.4 per 100 000 (age-standardised to the 2001 New Zealand population).

Time trends and seasonality

Annual age-standardised rates increased slightly over the study period (Fig. 1), although this increase was not statistically significant.

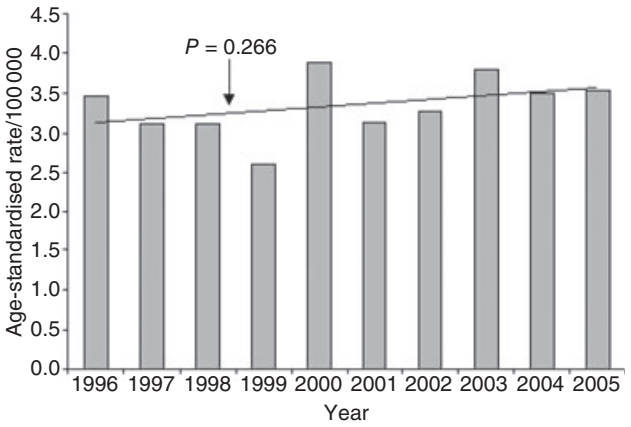

Fig. 1 Annual rates of acute rheumatic fever first admissions, New Zealand, 1996–2005 (age-standardised).

When annual rates were analysed by ethnicity, it was clear that Māori and Pacific peoples consistently had far higher rates than New Zealand European and Others (NZEO) and trends over time were different for these ethnic groups (Fig. 2). From 1996 to 2005, the rate for NZEO decreased significantly with the 2005 rate close to one-third of the 1996 rate (0.4 per 100 000 compared with 1.2 per 100 000). Conversely, rates for Māori showed a significant increase over this period. Although Pacific peoples' rates demonstrated a similar-sized increase to that seen in the Māori population, this trend was not significant. This lack of significance, at the 5% confidence level, could be explained by the smaller population of Pacific peoples.

By month, the number of ARF cases peaked in May, June and July (late autumn and early winter) (Fig. 3). Incidence was lowest in October, November and December (late spring and early summer). This distribution was similar for both the total population and the 5–14 years age group. Cases were analysed by week to determine whether there were variations by school-term time and school holidays. Apart from the noted seasonal distribution, there was no consistent trend in cases by week.

Geographical distribution

When comparing rates of ARF by DHB, it is clear that disease incidence was highest in the upper half of the North Island and in some DHBs in particular (Fig. 4). Age-standardised rates reached almost 10 per 100 000 in both Counties Manukau and Tairawhiti. Rates were also high in Northland, Auckland, Lakes and Bay of Plenty. To control for the different ethnic structures of the DHBs, rates for the specific subpopulation of Māori and Pacific peoples aged 5–14 years were compared. The highest rates were observed in the same six DHBs, although the relative position of Tairawhiti dropped while the relative Auckland DHB rate increased. Rates in this subpopulation in Auckland and Counties Manukau exceeded 70.0 per 100 000.

Age, sex and ethnicity

Of the 1249 cases, 55% were male. The average annual, age-standardised rate from 1996 to 2005 was 3.6 per 100 000 for males and 3.1 per 100 000 for females. By age group, the largest proportion of cases was in the 5–14 years age group (Fig. 5). This group accounted for 69% of cases, with the 15–24 years age group producing the second highest proportion of 15%. Cases of ARF outside these age groups were uncommon.

Of the total 2001 New Zealand population, Māori comprised 14.1% and Pacific peoples 5.4%. These proportions have been consistent throughout the study period, with only the Pacific peoples' proportion rising slightly from 4.8% (1996) to 5.8% (2005). Of the case population, 83% were of Māori or Pacific ethnicity with Māori accounting for almost 50% of the total number of cases. The Māori and Pacific peoples' proportion rose to 91% in the most recent years (2003–2005), reflecting the relative increase in rates in these populations compared with NZEO. Rates varied greatly between the ethnic groups (Fig. 6). Total population age-standardised rate ratios compared with NZEO were 10.0 for Māori and 20.7 for Pacific peoples (Table 1). Overall, 59.5% of all cases over the 1996–2005 period were children aged 5–14 years of Māori or Pacific ethnicity. This group comprised only 4.7% of the total 2001 New Zealand population, which gives an indication of how concentrated this disease is in this specific population.

Recurrences

Over the 1996–2005 period, there were 61 recurrences of ARF. Of these, 55 were single recurrences while the remaining six were from two recurrences in three individuals. The overall recurrence proportion was 4.9% (61/1249) and the average annual rate of recurrences over the decade was 0.16 per 100 000. Although annual rates varied because of small numbers, there was no consistent trend in recurrence rate. Māori and Pacific peoples were more likely to suffer recurrences than NZEO. The recurrence proportions for Māori and Pacific peoples were both markedly higher than for NZEO (Table 2). The median time interval from first admission to recurrence was 15 months with a range from 1 to 136 months.

Discussion

This study showed that ARF rates in New Zealand have failed to decrease since the 1980s and remain some of the highest reported in a developed country. The average annual rate of 3.4 per 100 000 in this study was higher than rates previously reported in the 1990s.[1,5] This difference may be due to the use of hospitalisation data, which appeared more comprehensive than the notification data used in these previous analyses.

One of the most striking features of ARF epidemiology in New Zealand is the enormous ethnic inequality that exists. This present study again highlighted these vast – and now diverging – disparities. The respective rates for Māori and Pacific peoples were 10.0 and 20.7 times higher than NZEO rates. Rates of 8.0 and 16.6 per 100 000 for these ethnic groups equate to the ARF rates in many developing countries.[12] With 83% of ARF cases being of Māori or Pacific ethnicity and rising to 91% in the most recent years (2003–2005), this disease is becoming almost exclusively confined to these ethnic groups. These ethnic differences in New Zealand have been reported for over a century.[2,5,13]

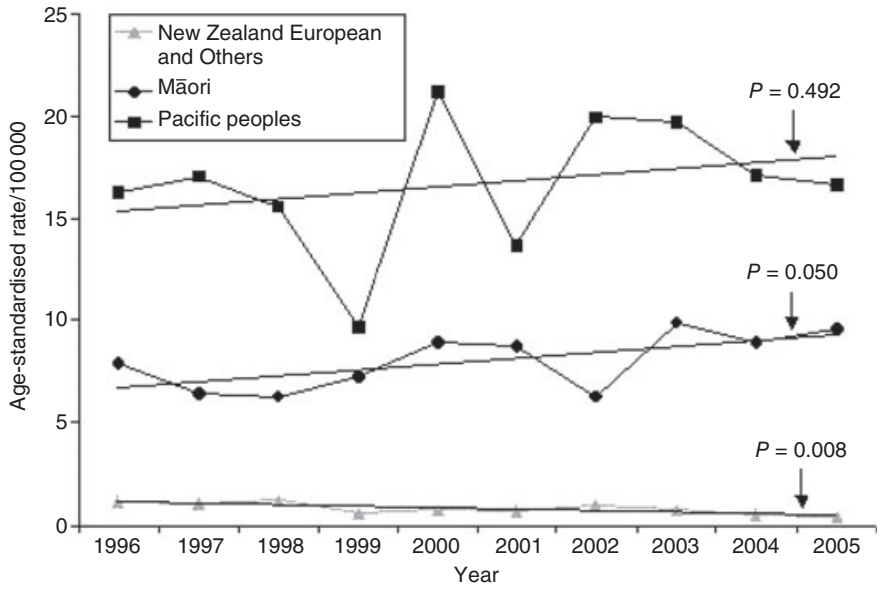

Fig. 2 Annual rates of acute rheumatic fever first admissions by ethnicity, total population, New Zealand, 1996–2005 (age-standardised).

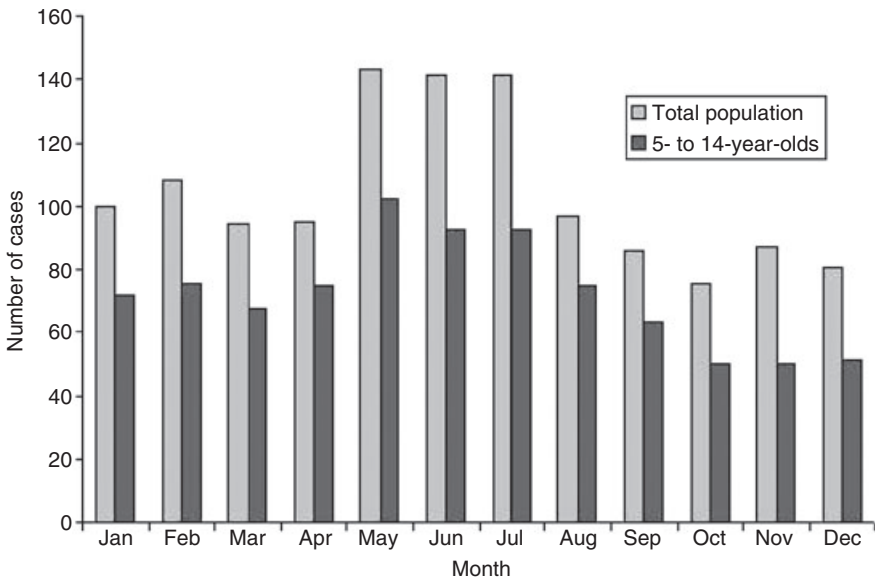

Fig. 3 Number of cases of acute rheumatic fever first admissions by month, total population and 5–14 years age group, New Zealand, 1996–2005.

What this present study shows, for the first time, is a significant diverging trend in rates between ethnicities. Not only did the NZEO ARF rate decrease significantly, but the rates for Māori and Pacific peoples also increased over this period (the Māori trend was significant).

By age group, 5- to 14-year-olds bear the greatest burden of ARF in New Zealand as in other countries where this disease is important. While the rate of 14.9 per 100 000 is comparable with other New Zealand studies,[1,5] it remains high internationally. There were substantial ethnic differences in rates within this age group. Despite being the highest risk age group, the 5- to 14-year-old rate for NZEO of 3.0 per 100 000 was lower than the overall New Zealand rate. Rates for the same age group for Māori and Pacific peoples were exceedingly high (34.1 and 67.1 per 100 000 respectively). These were the highest rates of any subpopulation in New Zealand and are some of the highest anywhere in the world.

The results from this study have many implications for the prevention and management of ARF in New Zealand. The continuing high rates imply that primary prevention of ARF is inadequate. Findings also suggest that a primary prevention programme targeted at high-risk populations (rather than the total population) may provide a feasible and efficient means to approach this cause of health inequality. For example, programmes could be developed in primary schools in Counties Manukau, Northland and the East Cape to diagnose and treat streptococcal sore throats in children. The effectiveness of such programmes to date has been variable. In an Auckland study,

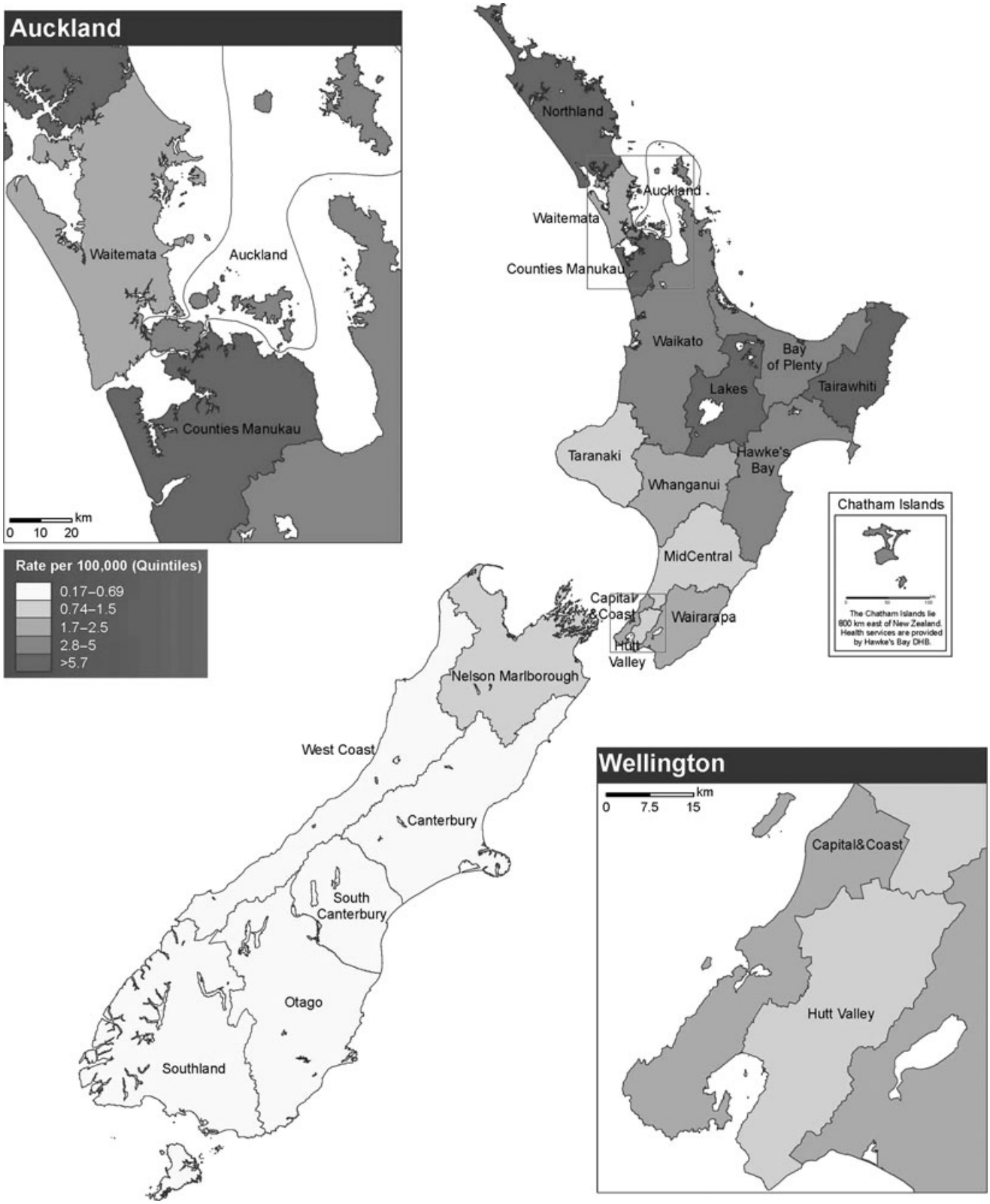

Fig. 4 Rates† of acute rheumatic fever first admissions by District Health Board (DHB), New Zealand, 1996–2005 (age-standardised). †Rate is average annual, per 100 000 population, age-standardised to the New Zealand population from 2001 census figures.

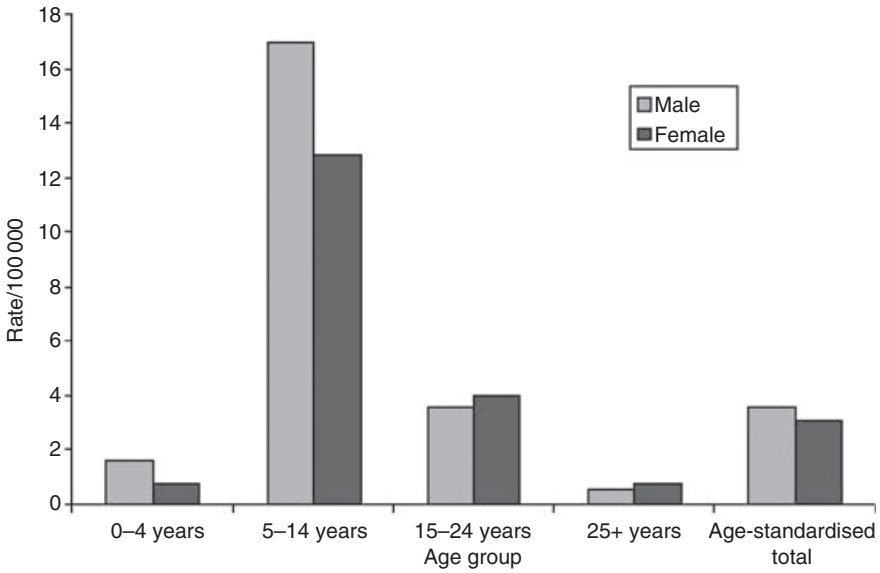

Fig. 5 Average annual rates of acute rheumatic fever first admissions by sex and age group, New Zealand, 1996–2005.

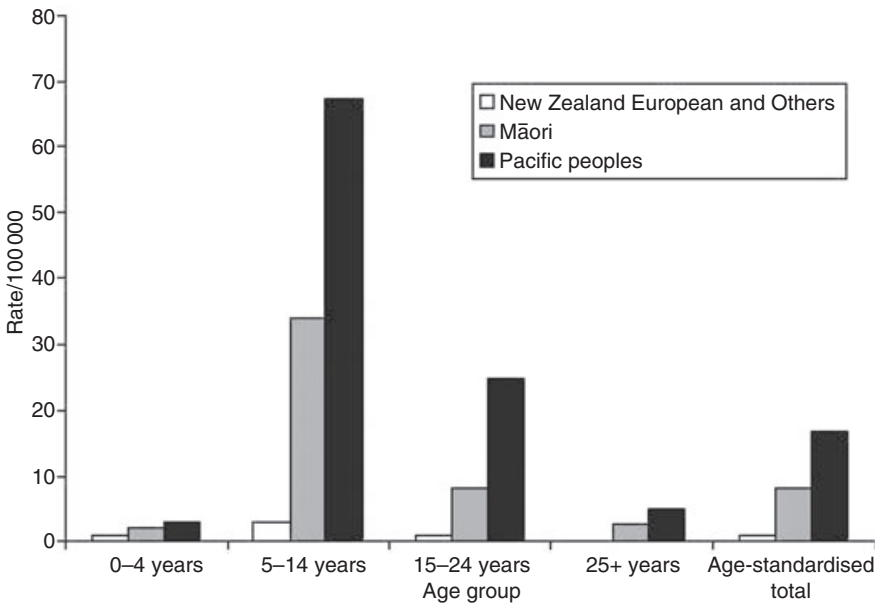

Fig. 6 Average annual rates of acute rheumatic fever first admissions by prioritised ethnicity and age group, New Zealand, 1996–2005.

randomly assigned intervention and non-intervention schools displayed no difference in ARF incidence.[14] However, an intervention in a small Northland community has managed to eradicate ARF entirely since the start of the programme.[15]

ARF recurrence rates appear low in New Zealand with an average of only six ARF recurrences per year from 1996 to 2005. This finding provides some cause for optimism as it suggests that a relatively small proportion of ARF cases are experiencing the recurrent episodes that lead to CRHD. This result is presumably because of the successful operation of secondary prevention programmes in New Zealand.[1] However, with overall ARF rates still high, these programmes must be continued to maintain low recurrence rates. There is also a suggestion that secondary prevention programmes are associated with a reduction in rates of first cases of ARF.[16] Well over 90% of recurrences are individuals of Māori or Pacific ethnicity, and secondary prevention programmes should be appropriately targeted to these groups with high risk of ARF.

This analysis has several limitations that may have affected the findings. ARF is a difficult disease to accurately diagnose. Currently, there is no laboratory diagnostic test for ARF, and diagnosis is a clinical decision.[3] Although there are explicit diagnostic guidelines, it is still possible to under- or over-diagnose the disease. Differences in diagnosis between clinicians may have affected these results. For example, because of the relative lack of ARF cases in the South Island, ARF could be under-diagnosed compared with a high-incidence area such as South Auckland (where ARF may be more salient in a clinician's mind).

Table 1 Acute rheumatic fever first admissions, rates and rate ratios according to key explanatory variables, New Zealand, 1996–2005

Category	Cases	Rate*	Rate ratio (95% CI)	
Age group (years)				
0–4	32	1.2	1.7	(1.2–2.5)
5–14	860	14.9	21.4	(18.1–25.3)
15–24	191	3.8	5.4	(4.4–6.7)
25+	166	0.7	1.0	ref.
Sex				
Female	568	3.1	1.0	ref.
Male	681	3.6	1.2	(0.1–26.7)
Ethnicity				
New Zealand European and Others	214	0.8	1.0	ref.
Māori	588	8.0	10.0	(1.7–58.3)
Pacific peoples	447	16.6	20.7	(12.9–33.1)
Health district/DHB				
South Island†	41	0.5	1.0	ref.
Northland	88	6.0	13.2	(3.3–53.3)
Waitemata	88	2.1	4.5	(0.0 to >100.0)
Auckland	169	5.0	10.9	(0.8 to >100.0)
Counties Manukau	387	9.3	20.4	(5.1–81.6)
Waikato	95	2.8	6.2	(0.0 to >100.0)
Lakes	58	5.7	12.5	(3.6–43.6)
Bay of Plenty	88	4.9	10.8	(1.5–76.7)
Tairawhiti	47	9.7	21.3	(13.6–33.5)
Hawke's Bay	55	3.7	8.2	(0.7–96.6)
Taranaki	9	0.9	1.9	(0.0 to >100.0)
Midcentral	15	1.0	2.1	(0.0 to >100.0)
Whanganui	11	1.7	3.6	(0.1 to >100.0)
Capital and Coast	61	2.6	5.6	(0.1 to >100.0)
Hutt	20	1.5	3.3	(0.0 to >100.0)
Wairarapa	7	1.9	4.1	(0.2–66.8)

*Average annual rates per 100 000 population, age-standardised to New Zealand population from 2001 census figures, except age group that is crude, average annual rates per 100 000 population. †Comprises the six South Island DHBs. CI, confidence interval; DHB, district health board; ref., reference value.

Table 2 Acute rheumatic fever recurrences, recurrence proportions and risk ratios, by ethnicity, New Zealand, 1996–2005

Ethnicity	Recurrences	Total cases	Recurrence proportion	Risk ratio (95% CI)	
New Zealand European and Others	4	214	1.9	1.0	ref.
Māori	34	588	5.8	3.1	(1.1–8.6)
Pacific peoples	23	447	5.2	2.7	(1.0–7.9)

This study has used hospitalisation data to calculate rates of ARF. This dataset may not be complete if cases are not hospitalised or if ICD codes are incorrectly assigned. Current New Zealand recommendations advise that all suspected ARF cases be hospitalised for investigation, confirmation of diagnosis, treatment and education.[3] It is therefore expected that hospitalisation data would capture the vast majority of ARF cases. This dataset appeared more comprehensive than notification data. It seems unlikely that transcription errors could cause major misclassification in this study. Diagnostic coding of this disease has also been stable over the period of the study with similar coding distinctions used in both ICD-9-CM and ICD-10-AM.

Classification of ARF recurrences was problematic using hospitalisation data. This study used a fairly arbitrary cut-off for a recurrence as a hospitalisation occurring at least 30 days after a previous discharge. Precautions were taken to prevent recurrences being misclassified as first admissions by taking hospitalisation data from 1992. It is possible, however, that some cases classified as first admissions in the period 1996–2005 were recurrences after a first admission prior to 1992.

Ethnicity is a fundamentally important risk factor associated with ARF. Accurately coding ethnicity in the hospitalisation data is imperative. Unfortunately, official datasets often undercount Māori.[17,18] If this were so here, then our analysis would underestimate Māori ARF rates and the ethnic inequalities. The same may also have occurred for Pacific peoples. In general, ethnicity coding appears to have improved over the study period.[18] Although this may have affected the ethnic time trends shown here, it is unlikely that improved ethnicity coding could fully account for these results.

This study also raises issues for further research. An important new finding was the growing disparity in the already large inequalities in ARF incidence between Māori and Pacific peoples and NZEO. Along with supporting interventions targeting Māori and Pacific peoples, further research should closely monitor these ethnic differences. Such research could also examine possible causes for the ethnic disparities in ARF incidence. We also recommend further research to assess and improve the quality of ARF surveillance data. This research could integrate hospital discharge and notification data to measure the sensitivity of these information sources and estimate total ARF incidence. As part of this investigation, it would be useful to audit a portion of patient records to assess the way in which ARF diagnostic criteria are being applied. One study in an Australian Aboriginal population found that almost 30% of first hospital admissions for ARF had established CRHD on echocardiogram.[19] It would be important to know if such under-ascertainment of ARF first attacks was also occurring in New Zealand.

This study has shown that ARF rates in New Zealand are not decreasing and are still high for a developed country. This situation imposes long-term health consequences (CRHD) on those affected. In addition, this study has shown that ethnic inequalities have been widening in recent years, with a rising incidence of ARF in Māori and Pacific populations. Addressing this preventable cause of illness and health inequalities should be a public health priority.

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