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Migration and multiple sclerosis in immigrants to Australia from United Kingdom and Ireland: a reassessment. I. Risk of MS by age at immigration

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Abstract A previous study of the prevalence of multiple sclerosis (MS) in 1981 among immigrants from the United Kingdom and Ireland to Australia found that the prevalence for those with age at immigration (AAI) under 15 years of age did not differ from the older immigrants. We have reanalysed the original materials as well as census data for 1901–1981 for UKI and other high MS risk country immigrants. There was a highly significant trend in the prevalence rates of all Australians from New South Wales (NSW) to South Australia (SA) to Western Australia (WA) to Queensland (QLD). Rates by state among the Australian-born were almost identical to these, but there was no prevalence gradient for the UKI-born. The denominator population at risk of MS by AAI was calculated from special census tables of length of residence in Australia by age 0–79 in 1981 for UKI immigrants 1947–1981. The numerator was limited to the subset of 258 MS (Group II) also immigrating in 1947 and later, and age 0–79 in 1981. The absolute risk of MS for these migrants to the four states entering at age 0–14 was 22/100,000, significantly less than for all older age groups; age 15–39 immigrants had a risk of 54/100,000. Similar risk ratios for 0–14 versus 15–39 by state were 31 versus 61 (NSW), 29 versus 44 (QLD), 11 versus 50 (SA), 15 versus 51 (WA).

Keywords Multiple sclerosis · Prevalence · Immigration · Risk · Australia

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Introduction

In our earlier work[1], the prevalence in 1981 of multiple sclerosis (MS) in migrants from the United Kingdom and Ireland (UKI) to Australia was compared to that in the Australian-born population, and it was found that there was a similar and significant correlation of prevalence with latitude in both groups [1]. However, in contrast to some other studies of migrants from high MS areas to low [2–6] there was no significant difference in the prevalence of MS between those migrating under age 15 and those then older.

In the present study we have re-examined the 1981 data in order to address more specifically in these UKI immigrants to Australia the original proposition [7, 8] that in high frequency MS areas, like UKI, the risk of developing MS has already been determined largely by the age of about 15 years, and emigrants under that age to lower frequency areas, like Australia, would therefore have acquired their disease in their new place of residence and at the lower rate characteristic of this new location.

[1] All current authors had agreed with the conclusions of the 2,000 paper; JFK had been provided the original numerator data and tables at that time.

Methods

Previous publications [9–12] have described the methods of case ascertainment and diagnosis used to estimate the prevalence of MS in Australia on prevalence day, 30 June 1981, in the states of New South Wales (NSW), Queensland (QLD), South Australia (SA) and Western Australia (WA), called in this paper the four states. In each survey approximately 70% of cases were classed as clinically definite MS, with 20% as probable MS and 10% possible MS, according to the diagnostic criteria of Rose et al. [13]. In the present analysis Hobart in Tasmania, included in the previous study [1], was omitted as its high prevalence rate would preclude any differential risk for UKI migrants. In that report the analysis had been restricted to cases aged 20–49 years in 1981 because of limitations in the available census data.

For this presentation, the original data sheets from the study were reassessed. Each MS case had been described by case number; sex; state of residence; country of origin within UKI; ages at migration, 1981 and onset; and duration from immigration to 1981. From these, calendar years of birth, immigration and onset were calculated. All data for each of the four states and their total were evaluated. As with prior assessments, all immigrants with symptoms of MS before immigration were excluded from consideration.

Population denominators for the UKI immigrants to each of the four states had been provided as special cross-tabulations from the 1981 Census of Population and Housing by the Australian Bureau of Statistics. These listed on the *y* axis numbers of immigrants by duration of residence in Australia for single years 0–34 and for 35+ years, and on the *x* axis age groups for residents age 0–79 and for age 80+ in 1981. From these tables, population numbers for each individual age at immigration were calculated for this reassessment. This was carried out by first listing single years of age in 1981 as the average for that particular age group for ages 0–79. The first row, giving age in 1981 for those with <1 year of residence, was thus also the age at immigration for that specific set of immigrants. By then shifting each consecutive row comprising the 1981 age distributions for those with 1, 2, 3… years duration of residence by 1 year to the left, each displaced row then provided the age at immigration for migrants with that specific duration in Australia. For example, persons age 17 in 1981 who had a duration of residence in Australia of 1 year would have been age 16 at immigration. The earliest calendar year of immigration was therefore 1947 for those who had entered 34 years before prevalence day. Summing each new column then provided the population distribution for age at immigration by single years of age from age 0 (= age <1) through age 79 for those UKI immigrants who had entered Australia in 1947 or later and had survived as residents of the cited state into 1981. After collecting them into 5 year age groups, this provided the denominator to calculate risk ratios per 100,000 population for MS at each age at immigration.

Note that this is not a prevalence rate or ratio, but rather an absolute risk ratio for this specific population at risk. To calculate here the absolute risk of MS by age at immigration, the specific population at risk of MS required is (1) the number of UKI immigrants by age at immigration for each of the four states, (2) who had entered Australia from 1947 to 1981, and (3) who had survived at age 0–79 years on prevalence day in 1981. The numerator by age at immigration for this denominator therefore had to be limited to that same specific subset of the MS cases who had the same characteristics of year of entry (1947+), and survival; this is called Group II. The remainder (Group I) were separately assessed and will be the subject of a later report.

In order to place both groups in context and explore further reasons for the occurrence of MS within them, population numbers for each state and census, 1901–1981, were ascertained from Australian Historical and Population Statistics on AusStats (3105.0.65.001). The total resident population for each state at each census is divided into those born in Australia and those born overseas, the latter by specific country of birth. The immigrant populations by state of residence in Australia and country of origin (birthplace) were collected and combined into UKI migrants and migrants from other high MS risk countries, as cited in Table 1 below. Immigrants from the remaining countries were not considered.

Standard descriptive statistics were carried out. Poisson 95% confidence intervals were calculated for each rate or ratio. Age adjustment of rates to the US 1960 population by the direct method was performed, as perhaps giving more distinct comparisons than adjustment to an Australian base.

Results

The denominator

In Fig. 1 is a map of the Commonwealth of Australia by state and territory, with the major cities identified. Canberra, the national capital, lies in the Federal Capital Territory, and is not part of the surrounding state of New South Wales. Populations of Australia and the four states of the study were available for each census year, 1901, 1911, 1921, 1933, 1947, 1954, 1961, 1971, and 1981. In this interval the Commonwealth had grown from under 4 million residents to almost 15 million. The percentage of native-born Australians had risen from 77% in 1901 to 90% in 1947, suggesting little immigration in that interval.

Table 1 Population by birthplace (Australia: UKI; other high risk MS countries) in Four States of Australia, at census day, 1901–1981 (excludes immigrants from other countries)

State	1901	1911	1921	1933	1947	1954	1961	1971	1981
NSW									
Australia	1,079,154	1,377,219	1,772,614	2,245,555	2,681,514	2,960,124	3,290,372	3,643,535	3,992,904
UKI	220,401	205,369	260,426	284,601	222,096	247,102	269,077	342,797	331,741
Other	31,162	31,987	37,301	41,777	45,274	114,987	163,631	184,701	222,264
QLD									
Australia	323,436	446,695	592,163	787,718	992,178	1,160,595	1,341,069	1,549,662	1,906,136
UKI	126,159	120,428	128,234	120,482	82,654	92,951	93,329	114,989	140,816
Other	22,495	21,508	19,955	18,265	13,054	29,879	39,537	50,404	91,608
SA									
Australia	288,815	350,261	436,991	524,609	602,521	686,489	783,228	884,928	980,826
UKI	56,395	44,744	46,326	45,361	32,718	50,477	78,786	146,391	151,832
Other	8,630	8,563	7,221	5,737	4,272	32,511	52,248	53,736	55,090
WA									
Australia	126,952	209,050	248,866	328,946	411,035	489,699	572,182	729,379	904,992
UKI	41,551	50,836	66,739	89,066	69,608	83,814	83,365	153,512	183,680
Other	7,506	9,381	6,661	6,832	5,527	28,589	30,723	42,171	56,062
Total 4									
Australia	1,818,357	2,383,225	3,050,634	3,886,828	4,687,248	5,296,907	5,986,851	6,807,504	7,784,858
UKI	444,506	421,377	501,725	539,510	407,076	474,344	524,557	757,689	808,069
Other	69,793	71,439	71,138	72,611	68,127	205,966	286,139	331,012	425,024

Austria, Belgium, Czechoslovakia, Denmark, Estonia, Finland, France, Germany, Hungary, Latvia, Lithuania, Netherlands, Norway, Poland, Sweden, Switzerland, Canada, United States of America, New Zealand

Source: Australian Historical Population Statistics, 2006, various Data Cubes in Excel File (106) Australian Bureau of Statistics, Canberra, Australia

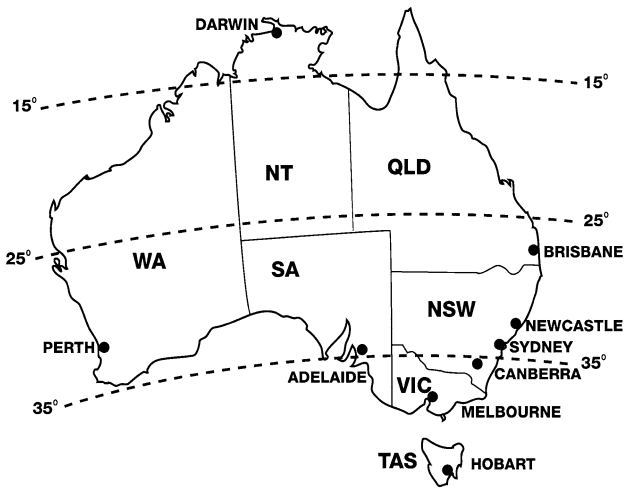

Fig. 1 Commonwealth of Australia in 1981 by state : Queensland (*QLD*), New South Wales (*NSW*), Victoria (*VIC*), South Australia (*SA*), Western Australia (*WA*), Tasmania (*Tas*) and Northern Territory (*NT*). Canberra (Federal Capital Territory), is geographically surrounded by NSW. Major cities are shown

From 1947, increasing numbers of migrants lowered this percentage back to the first figure, with 76% having been born in Australia at the 1981 census.

For this entire period the four states comprised some two-thirds of the total population at each census. Details for each of these states by birthplace and census are given in Table 1, citing the number of residents for the Australian-born, the UKI immigrants, and the immigrants from the other MS high risk countries, as listed in the table. The migrant group from other high risk countries showed little change between 1901 and 1947, after which there was a marked increase. UKI immigrants increased modestly between 1901 and 1933, with then a sharp drop to 1947, and progressive increases thereafter.

The average annual number of new immigrants for each group in each census year 1901–1981 is shown in Fig. 2 for all four states combined. For 1901–1910 the only state gaining appreciable numbers of new immigrants was WA, mostly from UKI. All states had increments in the next period of 1911–1920, almost all from UKI, and most of the annual immigrants were to NSW and WA. Only those two states showed modest gains in the next interval of 1921–1932. For 1933–1946 all the immigrants were from the "other" high risk countries, and all into NSW. Evidence indicates that they came in 1945 and 1946, after the end of World War II, as shown in Fig. 2. For 1901–1946 overall

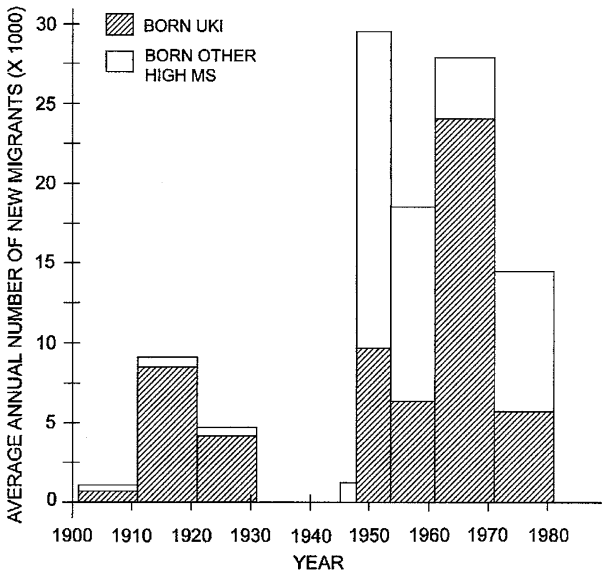

Fig. 2 Average annual number of new immigrants born in MS high risk countries who entered Australia between each census. Numbers (1,000×) indicated by hatched columns for UKI and by open columns above the UKI for the other high risk countries. Data in Table 1

there was a net gain of 150,000 immigrants from high MS risk countries, 90% from UKI, and 90% of the total had entered Australia in 1911–1932. Massive increases then ensued, with 30,000 new entrants each year 1947–1953, two-thirds from the "other" countries; almost half these immigrants settled in NSW. The next period of 1954–1960 saw almost 20,000 more annually, half to NSW and the majority still from the "other" lands. The 1961–1970 period brought an additional 28,000 each year, but this time 84% were from UKI and only about one-third of the total went to NSW. In the last period of 1971–1981, 14,000 a year arrived, predominantly from the other countries, and this time with few entrants to NSW and most to SA. In this 35 year postwar period, there were then a total of 770,000 new residents from high risk MS countries or an average of 22,000 each year, with overall only a modest excess of UKI (54%) over the other immigrant group.

Prevalence in 1981

Prevalence rates by age for MS among the UKI immigrants in each of the four states and their total are given in

Table 2 MS crude prevalence rates per 100,000 population by age and state for Four States of Australia, with age-adjusted (US1960) rates; UKI immigrants 1981

Age	NSW			Queensland			South Australia		
	Pop	*N*	Rate	Pop	*N*	Rate	Pop	*N*	Rate
0–9	12,586	0	–	5,741	0	–	6,110	0	–
10–9	27,221	1	3.67	12,042	0	–	17,459	0	–
20–9	47,203	17	36.01	18,887	2	10.59	26,786	3	11.20
30–9	68,154	50	73.36	28,043	14	49.92	27,567	7	25.39
40–9	50,189	40	79.70	22,130	10	45.19	24,975	19	76.08
50–9	45,961	16	34.81	19,719	13	65.93	21,958	8	36.43
60–9	39,810	15	37.68	18,450	6	32.52	15,074	6	39.80
70+	46,391	2	4.31	22,091	6	27.16	12,205	1	8.19
Total	337,515	141	41.78	147,103	51	34.67	152,134	44	28.92
Age adjusted rate			31.52			24.37			21.45

Age	Western Australia			Four states		
	Pop	*N*	Rate	Pop	*N*	Rate
0–9	10,397	0	–	34,834	0	–
10–9	22,526	1	4.44	79,248	2	2.52
20–9	28,357	2	7.05	121,233	24	19.80
30–9	37,223	15	40.30	160,987	86	55.28
40–9	29,714	21	70.67	127,008	90	74.80
50–9	21,868	10	45.73	109,506	47	47.49
60–9	18,589	12	64.55	91,923	39	47.87
70+	18,768	5	26.64	99,455	14	16.09
Total	187,442	66	35.21	824,194	302	36.64
Age adjusted rate			26.90			29.00

Table 2; cases are from the current reassessment, and populations from the 1981 Census of Population and Housing of the Australian Bureau of Statistics. Both crude rates and rates age-adjusted per 100,000 to the 1960 US population are presented. NSW at 42 crude and 32 adjusted was higher than those in other states but there was no significant gradient. Similar data for MS for all Australians are NSW 36 crude and 35 adjusted, QLD 18 both crude and adjusted, SA 29 crude and 26 adjusted and WA 24 crude and 25 adjusted (data not presented). The prevalence rates are significantly the highest for NSW and lowest for QLD for both crude and adjusted rates. There is a highly significant gradient for the prevalence rates with NSW > SA > WA > QLD. Exploring this gradient will be the topic of a later paper.

General features of MS in two groups of UKI immigrants

As noted in Methods, defining the population at risk for age at immigration required that both numerator and denominator be limited to the immigrants who entered Australia in 1947 or later. The total of 302 (207 female) MS cases in migrants from UKI into the four states were therefore divided into Group I for the earlier cases, the 44 (25 female) who had migrated before 1947, and Group II for the late or post-World War II cases, the 258 (182 female) who entered in 1947 or after. For each set and state their main features are summarized as mean values (Table 3). Within each group there were no significant differences among the states in any of these factors. As expected, years

Table 3 Characteristics of MS in UKI immigrants among the 44 Group I (early immigrant) cases who entered before 1947, and the 258 Group II (late or post-war immigrant) cases who entered in or after 1947, by state of residence in the Four States of Australia

Feature	State				
	NSW	QLD	SA	WA	Total four states
I. Early immigrants (before 1947)					
N(F)	19 (11)	10(5)	5 (3)	10(6)	44 (25)
YOI	1928.5	1927.7	1925.6	1927.8	1927.8
AAI	6.6	16.9	7.8	8.5	9.5
YOO	1960.5	1952.2	1963.0	1955.4	1957.7
AAO	38.6	41.2	45.2	36.3	39.4
Age 81	59.1	70.2	63.2	61.4	62.6
YOB	1921.9	1910.8	1917.8	1919.6	1918.4
Δ O–I	31.9	24.3	37.4	27.8	29.9
II. Post war immigrants (1947+)					
N(F)	122 (86)	41 (28)	39 (27)	56 (41)	258 (182)
YOI	1963.4	1959.8	1962.7	1961.2	1962.3
AAI	21.6	23.0	25.3	26.3	23.4
YOO	1973.2	1969.2	1970.9	1970.4	1971.6
AAO	31.3	32.4	35.4	35.6	33.0
Age 81	39.2	43.7	45.4	46.2	42.3
YOB	1941.8	1937.3	1935.6	1934.8	1938.7
Δ O–I	9.7	9.4	10.1	9.1	9.6
Both					
N(F)	141 (97)	51 (33)	44 (30)	66 (47)	302 (207)
YOI	1958.7	1953.5	1958.5	1956.1	1957.2
AAI	19.6	21.8	23.3	23.6	21.4
YOO	1971.5	1965.9	1970.0	1968.1	1969.6
AAO	32.3	34.1	36.5	35.7	33.9
Age 81	41.8	48.9	47.4	48.5	45.3
YOB	1939.2	1933.3	1933.6	1932.5	1935.9
Δ O–I	12.7	12.3	13.2	11.9	12.5

N Number of cases, *F* females. *YOI* year of immigration, *AAI* age at immigration, *YOO* year of onset, *AAO* age at onset, *age* 81 age in 1981, *YOB* year of birth, *Δ O–I* years between immigration and onset. All values are means

of immigration were much earlier in the Group I with a mean of 1928 versus 1962 for Group II. The years of birth (1918 early, 1939 late) and ages in 1981 (63 early, 42 late) also reflected expectations. What was unanticipated were the major differences found in the other features: age at immigration (9.5 years early, 23.4 late); age at onset (AAO) (39 early, 33 late); and the number of years between immigration and onset (30 years early, 10 years late). In the next paper these differences will be considered in further detail.

Age at immigration and interval to MS onset in Group II UKI immigrants

The characteristics of the MS cases in the Group II migrants for the four states combined are noted by age-groups at immigration (Table 4). About half of them resided in NSW, and the proportions by age at immigration did not differ notably among the four states. Of the 258 cases, 56 or over one-fifth had entered Australia under age 15, while nearly three-quarters were then age 15–39. The ratio for these two age groups was 0.30 (56/189); an apparent difference with a higher ratio in QLD was not significant with the small numbers available. This ratio of 0.30 is artificially high because of the absence of cases at older ages with onset before immigration.

The year of onset (YOO) did not differ notably by age at immigration (AAI), but younger immigrants entered earlier, with a mean of 1954 versus 1963 for the older ones. With increasing AAI, mean AAO increased steadily as the mean interval between immigration and onset decreased, both a consequence of the requirement of symptom onset only after immigration (data not presented).

Figure 3 shows the intervals between immigration and clinical onset of MS for each AAI in the Group II cases. There is a relative paucity of cases with entry under age 15, and especially under age 8, while there seems to be notable clustering for those age 20–35 or so. There is a trend to shorter intervals with increasing AAI, compatible with the relatively fixed mean AAO common to this disease seen world wide.

Table 4 Overview of MS Group II UKI immigrants by age at immigration, Four States combined

AAI	*N* (F)	YOI	YOO	AAO	AAO–AAI
0–4	6 (5)	1953.2	1973.2	22.3	20.0
5–9	26 (21)	1953.8	1974.2	23.9	17.0
10–14	24 (21)	1954.9	1973.0	27.5	15.8
0–14	56 (48)	1954.2	1973.6	25.3	16.8
15–19	30 (19)	1960.8	1971.4	27.9	14.9
20–24	43 (33)	1964.7	1973.4	30.7	8.6
25–29	56 (42)	1964.5	1972.1	35.1	7.8
15–29	129 (94)	1963.7	1972.4	31.9	9.7
30–34	39 (19)	1961.6	1968.2	38.9	7.0
15–34	168 (113)	1963.2	1971.5	33.6	9.1
35–39	21(15)	1964.9	1969.5	40.7	4.6
15–39	189 (128)	1963.4	1971.3	34.3	8.6
40+	13 (7)	1962.8	1967.5	47.8	4.6

AAI age at immigration, *N* number of cases, *F* number of females, *YOI* Year of Immigration, *YOO* Year of onset, *AAO* Age at onset, *AAO–AAI* interval between age at immigration and age of onset

Risk of MS by age at immigration

The population at risk for the denominator and the number of MS cases for the numerator used to calculate the risk ratios are given in 5-year age groups age 0–79 for each state in Table 5. New South Wales contained 47% of the cases (122/258) and 39% of the population at risk (272,813/696,735). Similar percentages for QLD were 16% of cases and 17% of population; for SA 15 and 20%; and for WA 22 and 23%.

The absolute risk ratios for MS cases per 100,000 population for each state among the immigrants under age 15 at entry vs those age 15–39 were 31.0 versus 61.4 for NSW; 29.0 versus 44.3 for QLD; 10.7 versus 50.1 for SA; and 15.0 versus 50.7 for WA.

Table 6 summarizes the risk ratios with their 95% confidence intervals for the combined four states. For the 56 immigrants who entered Australia under age 15, the risk of MS was 22.3/100,000, with a 95% confidence interval of 16.9–29.0. Even for the next age group, the 30 entrants age 15–19, the risk was significantly higher at 57.3 (95% CI 38.7–81.8), and consecutive older 5-year age groups retained both the differential and the significance. For example the risk ratio for those age 15–39 was 53.9 (CI 46.5–62.1) and for all age 15+ it was 45.3 (CI 39.2–52.0). The preplanned comparisons for this reassessment had been for MS in immigrants under age 15 at entry versus those then older, but the more appropriate comparison is between those age 0–14 versus—at most—age 15–39, since the exclusion of those already affected before immigration, an increasing number of which are seen with increasing age, artificially minimizes the contrast. But even with the oldest immigrants included, the results still indicate clearly a highly significant decrease in the risk of MS for migrants under age 15 at entry into Australia.

Discussion

The calculated risk of MS in migrant populations is dependent not only on a sufficiency of people who change their residence from one risk area to another but also on

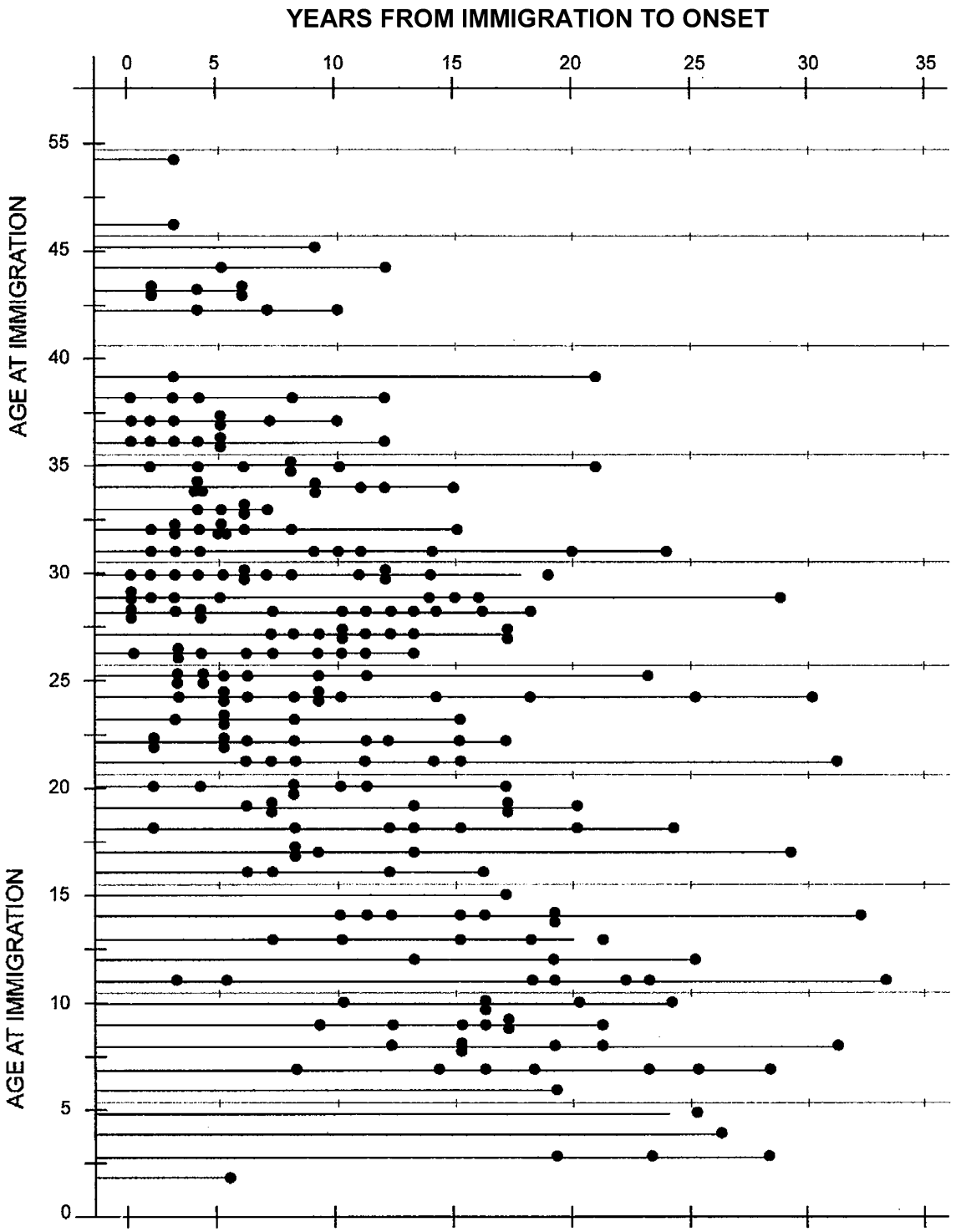

Fig. 3 MS in UKI immigrants to Four States of Australia by age at immigration and years from immigration to clinical onset in Group II (entry 1947+) migrants

their ages at immigration, their length of stay in their new land, and their ages at prevalence day [14]. The true population at risk according to age at survey and age at migration and age at clinical onset can be very difficult to define, and the choice of denominator or the type of rate required can get quite involved. The desired population denominator is generally not available from routine sources [15]. Here we were able to estimate the specific risk of developing MS by age at immigration for the UKI immigrants, by restricting both numerator and denominator to

Table 5 Risk of MS per 100,000 population by age at immigration for Group II UKI immigrants, those age 0–79 in 1981 who had immigrated in 1947 or later, by state of residence

AAI	NSW			QLD			SA			WA		
	Pop	*N*	Risk	Pop	*N*	Risk	Pop	*N*	Risk	Pop	*N*	Risk
0–4	36,550	2	5.47	15,857	3	18.92	20,921	0		22,928	1	4.36
5–9	32,654	14	42.87	14,618	5	34.20	20,482	4	19.53	21,636	3	13.87
10–14	24,306	13	53.48	10,826	4	36.95	145.21	2	13.77	15,332	5	32.61
15–19	22,494	20	88.91	9,111	2	21.95	9,297	3	32.27	11,433	5	43.73
20–24	36,473	26	71.29	13,809	4	28.97	11,497	6	52.19	17,793	7	39.34
25–29	36,551	23	62.93	15,101	9	59.61	14,607	11	75.31	20,019	13	64.94
30–34	28,359	15	52.89	1,293.7	7	54.11	15,459	6	38.81	17,844	11	61.65
35–39	21,148	5	23.64	9,995	5	50.03	13,023	6	46.07	13,828	5	36.16
40–44	13,874	3	21.62	6,779	2	29.50	8,321	1	12.02	8,586	5	58.23
45–48	7,651	1	13.07	3,856	0	–	4,261	0	–	4,750	0	–
50–54	4,238	0	–	2,209	0	–	2,278	0	–	2,941	1	34.00
55–59	3,037	0	–	1,617	0	–	1,768	0	–	2,460	0	–
60–64	2,608	0	–	1,440	0	–	1,572	0	–	2,272	0	–
65–69	1,803	0	–	1,057	0	–	1,076	0	–	1,642	0	–
70–74	794	0	–	546	0	–	417	0	–	723	0	–
75–79	273	0	–	168	0	–	111	0	–	198	0	–
Total												
All	272,813	122	44.72	119,926	41	34.19	139,611	39	27.93	164,385	56	34.07
0–39	238,535	118	49.47	102,254	39	38.14	119,807	38	31.72	140,613	50	35.56
0–14	93,510	29	31.01	41,301	12	29.01	55,924	6	10.73	59,896	9	15.03
15–39	145,025	89	61.37	60,953	27	44.30	63,883	32	50.09	80,917	41	50.67
15+	179,303	93	51.87	78,625	29	36.88	83,687	33	39.43	104,489	47	44.98

Table 6 Comparison of absolute risk of MS per 100,000 population with 95% confidence intervals by age at immigration: age 0 to 14 versus older ages

AAI	At risk population	MS	Risk	95% CI	Significance
Total	696,735	258	37.03	32.64–41.84	
0–14	250,631	56	22.34	16.88–29.02	**Reference**
15–19	52,335	30	57.32	38.68–81.84	+
15–24	131,907	73	55.34	43.38–69.60	+
15–29	218,185	129	59.12	49.36–70.25	+
15–34	292,784	168	57.38	49.03–66.74	+
15–39	350,778	189	53.88	46.47–62.13	+
15–44	388,338	200	51.50	44.61–59.16	+
15–49	408,856	201	49.16	42.60–56.45	+
15–54	420,522	202	48.04	41.64–55.14	+
15+	446,104	202	45.28	39.25–51.98	+

UKI immigrants (Group II) with MS onset after migration who entered Australia in or after 1947 and were age 0–79 in 1981, Four States combined

the same set of immigrants, those who had entered Australia in 1947 or later and had survived (at age 0–79) into 1981, and by calculating from special population data the actual denominator, the number of such immigrants by each year of age at immigration. This revealed in addition that the UKI MS cases comprised two subsets, defined as those with entry before and at/after 1947. They had been combined in the earlier assessment, and this is the main reason why a differential age at immigration was not then demonstrated. There had also been an inadvertent double-counting of 21 cases from NSW, most of whom had had young ages at immigration.

The previous study of MS in UKI migrants to Australia [1] demonstrated that with the exception of Hobart the prevalence of MS was less than that in their country of origin—due, in part at least, to the exclusion of cases with onset before migration. Among the native-born Australians there was then reported a higher prevalence of MS in NSW and lower prevalence in QLD. This has been confirmed in the present analysis. In fact, there is a highly significant gradient of prevalence rates from NSW to SA to WA to QLD for the native born. Possible reasons for this gradient will be explored in the third of our reassessments, that for the native-born Australians.

Prevalence rates of MS in UKI up to 1980 have been reviewed [16–18]. It is difficult to compare the prevalence

of MS in UKI migrants to Australia with the prevalence in their non-migrating countrymen because prevalence rates are higher in northern England and Scotland than in the southern regions and there has been a ten-fold increase in prevalence over the last 50 years [19]. Rates for UKI, with the exception of the Orkney and Shetland Islands, were mostly in the range of 40–50/100,000 population in 1950–1965 [20–24] with more recent ones in 1970–1986 in the 60–80/100,000 range, still well above our findings in the UKI migrants [25–28]. A study of enlisted men who had served in the Army of the United States in World War II [29] had found a very strong correlation of the risk of MS with high educational level and socioeconomic status of preservice occupation: highest quartile 2.3 times the lowest. A similar correlation of higher MS risk with higher levels of education and socioeconomic status has also been found in over 2,000 Australian cases [30]. It is likely that UKI residents would be more apt to migrate if their prospects, especially after the war, were limited at home. This would result in a bias toward lower frequency MS among such immigrants than was found among their countrymen—perhaps as low as 40%; one possible explanation for their MS rates, but a confounding factor in defining risk among migrants. In fact, it was only by measuring the absolute risk of MS that we were able to demonstrate the highly significant difference between those under age 15 and those older at immigration.

The present reassessment of the Australian immigration data conforms to the findings of most of the earlier studies, cited in the introduction, that migrants from high-risk to low- risk zones who are under 15 years of age at migration are significantly less likely to develop MS than those who migrate at an older age—in contrast to our previous report [1]. The nature of the environmental factors that contribute to the prevalence of this disease, whether in natives or in migrants, remains speculative; but this is a topic discussed more fully by Compston and Confavreux [19] in their extensive and perceptive review of the epidemiology of multiple sclerosis.

Conflict of interest None.

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