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Age–sex distribution of *Toxoplasma* antibody in the South Australian population

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SUMMARY

Sera from 1071 patients in nine age categories were screened for *Toxoplasma* antibody by indirect immunofluorescence. Thirty per cent of the sera contained antibody at a titre $\geqslant 1/16$. The percentage of sera containing antibody rose from 3% in the 6 months–5 years age group to a maximum of about 40% in the 31–40 years age group. It remained constant thereafter. Eleven per cent of the 84 sera with *Toxoplasma* antibody titres $\geqslant 1/128$ had *Toxoplasma* IgM titres $\geqslant 1/32$. No significant difference was found in the possession of antibody between the sexes.

INTRODUCTION

Toxoplasma gondii is now recognized as one of the most common human parasites and many studies have been performed to determine the prevalence of *Toxoplasma* antibody in communities in Europe, Africa and America. Few have been made on the Australian population and, as far as is known, no studies have been published on the South Australian population.

The incidence of *Toxoplasma* antibody varies from as low as 6% in Navajo indians to as much as 80% in the inhabitants of Tristan da Cunha (Feldman & Miller, 1956; Fleck, 1965). The prevalence of *Toxoplasma* antibody in the Australian population appears to be relatively uniform at about 30% (Johnson, 1979). Knowledge on the age of acquisition or possible differences in the possession of antibody between the sexes is limited. Garven (1957) found that the incidence of *Toxoplasma* antibody in the Victorian and New South Wales population reached a plateau of 30% at 30 years of age. Other studies suggested that the percentage of antibody possessed by the New South Wales and Queensland population reached a plateau of 30% in the 10–15 years age group (Cook, 1959; Jennis, 1963).

The present study was undertaken to determine the prevalence of *Toxoplasma* antibody in various age groups of the South Australian population and to determine whether differences in the possession of antibody exist between the sexes.

MATERIALS AND METHODS

Study population

Plasma or serum samples were collected from donors to the Red Cross Blood Transfusion Service or patients of the Flinders Medical Centre or Adelaide

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Children's Hospital. Only patients suffering from symptoms other than those suggestive of toxoplasmosis were included in the survey.

Methods

The RH strain of *T. gondii* was grown in mice so as to achieve optimum parasite numbers at time of harvest (Johnson, McDonald & Neoh, 1979*a*). The tachyzoites were killed by incubation in 1% formalin saline at room temperature for 30 min and fixed to multi-spot glass slides (Flow Laboratories, Irvine, Scotland). Indirect fluorescence testing for *Toxoplasma* total antibody was carried out as previously described (Johnson *et al.* 1979*b*). IgM antibody to *T. gondii* was measured in serial dilutions of patient's serum from 1/32 to 1/1024 using fluorescein-labelled goat anti-Human IgM (Oxford Laboratories Inc., Foster City, California) in the method of Remington, Miller & Brownlee (1968).

Analysis of data

The results of each test together with the age and sex of each patient were transferred to computer disk. The stored data were then analysed using the programme SPSS 6, 'A statistical package for the social sciences' (Nie *et al.* 1975) on a Digital Equipment DEC-10 computer of Flinders University.

Climate (South Australian Year Book, 1978)

South Australia is a state of 984000 square kilometres in the middle of the southern coast of Australia. It is the driest Australian state with four fifths of it receiving an average of less than 250 mm of rain annually. Of the total state population of 1245000, 69% live in Adelaide, the capital city, 16% live in other urban centres and the remainder live in rural areas. Adelaide is Australia's driest capital city having a mean annual rainfall of 528 mm and a mean annual humidity of 54%.

RESULTS

Prevalence of antibody

Of the 1071 sera tested, 30% had a *Toxoplasma* antibody titre $\geqslant$ 1/16 (Table 1). Twenty-eight per cent of the females and thirty-two per cent of the males possessed antibody. The χ^2-test failed to demonstrate a statistically significant difference between the figures for males and females at the 10% level.

Eleven per cent of the sera with antibody titres $\geqslant$ 1/128 possessed IgM antibody at a titre of 1/32 or greater (Table 2). The *Toxoplasma* IgM titres ranged from 1/32 to 1/128.

Age distribution of titres

The distribution of *Toxoplasma* antibody titres according to age group and sex can be seen in Table 3. The difference between the number of sera possessing antibody in the 6 months to 5 years age group (2/73) and in the 6 to 10 years age group (7/51) is statistically significant ($P < 0{\cdot}05$). Similarly, the difference between the number of sera with titres $\geqslant$ 1/16 in the 21 to 30 years age group (60/238)

Table 1. *The percentages of the South Australian population possessing indirect immunofluorescent antibody to Toxoplasma gondii at a titre* $\geqslant 1/16$, *according to age and sex*

Age group (years)	Positive (%)		
	Males	Females	Total
$\frac{6}{12}$–5	2·4	3·2	2·7
6–10	11·1	16·7	13·7
11–20	17·8	17·0	17·3
21–30	24·3	26·0	25·2
31–40	39·6	30·2	36·7
41–50	44·4	35·1	41·3
51–60	39·5	40·4	39·8
61–70	37·9	36·6	37·4
> 70	44·2	34·7	39·6
Total	32·0	27·6	30·0

Table 2. *The number of patients with total antibody titres to* Toxoplasma gondii *of* $\geqslant 1/128$ *possessing* Toxoplasma *IgM at a titre* $\geqslant 1/32$, *according to age*

Age group (years)	Number (both sexes) with	
	IgG, A, M $\geqslant 1/128$	IgM $\geqslant 1/32$
$\frac{6}{12}$–5	2	2 (1 M, 1 F)
6–10	5	4 (1 M, 3 F)
11–20	4	0
21–30	16	3 (2 M, 1 F)
31–40	21	0
41–50	11	0
51–60	8	0
61–70	10	0
> 70	7	0
Total	84	9 (4 M, 5 F)

and in the 31–40 years age group (61/169) is statistically significant ($P < 0{\cdot}02$). These findings substantiate the presence of IgM positive sera in the 2 lower age groups and in the 21–30 years age group, and suggest that active toxoplasmosis is more common in these categories.

DISCUSSION

In the past, surveys for *Toxoplasma* antibody have been performed using either the Dye Test (DT) or the Indirect Haemagglutination Test (IHAT). The Indirect Fluorescent Antibody Test (IFAT) used to measure *Toxoplasma* antibody in this survey is as sensitive as the DT, is more reproducible, and is easier and quicker to perform (Walton, Benchoff & Brooks, 1966; Kagan *et al.* 1967). Unlike the DT it is not subject to the prozone phenomenon, an important consideration in screening large numbers of sera at low dilution (Frenkel, 1956; Walton *et al.* 1966).

The DT and IFAT measure an identical antibody produced against the parasite cell wall (Fleck, 1961; Karim & Ludlam, 1975). Although the IHAT measures

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Table 3. *Indirect immunofluorescent antibody titres to* Toxoplasma gondii *in the South Australian population, according to age and sex*

Age group (years)	Sex	Number tested	Titre								
			< 1/16	1/16	1/32	1/64	1/128	1/256	1/512	1/1024	1/2048
$\frac{6}{12}$–5	M	42	41	—	—	—	1	—	—	—	—
	F	31	30	—	—	—	1	—	—	—	—
	Total	73	71	—	—	—	2	—	—	—	—
6–10	M	27	24	—	1	—	—	2	—	—	—
	F	24	20	—	—	1	2	1	—	—	—
	Total	51	44	—	1	1	2	3	—	—	—
11–20	M	45	37	1	2	2	2	1	—	—	—
	F	53	44	1	4	3	1	—	—	—	—
	Total	98	81	2	6	5	3	1	—	—	—
21–30	M	115	87	1	10	9	6	2	—	—	—
	F	123	91	3	10	11	2	4	2	—	—
	Total	238	178	4	20	20	8	6	2	—	—
31–40	M	106	64	3	11	13	11	3	—	—	1
	F	63	44	—	2	12	1	3	1	—	—
	Total	169	108	3	13	25	12	6	1	—	1
41–50	M	72	40	3	13	9	4	2	1	—	—
	F	37	24	1	6	2	2	—	2	—	—
	Total	109	64	4	19	11	6	2	3	—	—
51–60	M	86	52	8	10	9	5	1	1	—	—
	F	47	28	7	7	4	—	1	—	—	—
	Total	133	80	15	17	13	5	2	1	—	—
61–70	M	58	36	2	6	8	2	2	—	2	—
	F	41	26	2	4	5	1	2	1	—	—
	Total	99	62	4	10	13	3	4	1	2	—
> 70	M	52	29	3	6	11	3	—	—	—	—
	F	49	32	2	3	8	4	—	—	—	—
	Total	101	61	5	9	19	7	—	—	—	—
Total	M	603	410	21	59	61	34	13	2	2	1
	F	468	339	16	36	46	14	11	6	—	—
	Total	1071	749	37	95	107	48	24	8	2	1

another antibody produced against the soluble components of the parasite (Fleck, 1961; Lunde & Jacobs, 1967) the IFAT and IHAT correlate well on a qualitative basis (DeSaram, Kelen & Labzoffsky, 1962; Kagan *et al.* 1967). Consequently, the results of population surveys for *Toxoplasma* antibody using any of these three tests should be comparable.

The results presented here are similar to those of Garven (1957) in that the percentage of antibody possessed by the population reaches a plateau at about 30 years of age. The greater percentage of positive reactors obtained by us (40% against 30%) may be due to the greater sensitivity of the IFAT or an increase in the percentage of *Toxoplasma* antibody in the general population since 1957.

Studies in England and Canada show a similar increase in *Toxoplasma* antibody with slight differences in the percentages and age at which the antibodies reach a plateau. The prevalence of parasite antibody possessed by the English population rises until it reaches a plateau of about 40% in the 41–50 years age group (Fleck, 1969). Recent studies in Ontario found that the prevalence of antibody in that population rises steadily until about 25 years of age when it stabilizes at around 50% (Tizard, Chauhan & Lai, 1977).

In this study we could not find any significant difference between the sexes in the possession of antibody but this may not reflect the true infection rates. Although the percentage of antibody possessed by the sexes in England is identical (Fleck, 1969) studies on the prevalence of toxoplasmic lymphadenopathy in England suggest that males are infected by *T. gondii* at a much earlier age than females. The infection rates in the 15–24 years age group of both sexes are identical, but after the age of 34 more females are infected than males (Beverley *et al.* 1976). The *Toxoplasma* IgM IFAT was included in this survey as an indicator of recently acquired infections, but the number of IgM positive sera are too small to allow valid statistical analysis between the sexes.

There is an obvious tendency for active toxoplasmosis to be more prevalent in the younger age groups, but the finding of an increased number of active infections in the 21–30 years age group is unexpected. It may be associated with the change in life-style that accompanies the transition from adolescent to adult.

The prevalence of *Toxoplasma* antibody found in this survey may be considered low by international standards, especially for a population that consumes such a large amount of meat. Good hygiene and effective cooking procedures probably keep toxoplasmosis at a low level in the South Australian population.

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