10. Cuoco L, Cammarota G, Jorizzo RA, *et al*. Link between *Helicobacter pylori* infection and iron deficiency anaemia in patients with coeliac disease. Scand J Gastroenterol 2001;36:1284–8.
11. Sarker SA, Davidsson L, Mahmud H, *et al*. *Helicobacter pylori* infection, iron absorption, and gastric acid secretion in Bangladeshi children. Am J Clin Nutr 2004;80:149–53.
12. Collett JA, Burt MJ, Frampton CM, *et al*. Seroprevalence of *Helicobacter pylori* in the adult population of Christchurch: risk factors and relationship to dyspeptic symptoms and iron studies. NZ Med J 1999;112:292–5.
13. Choi JW. Does *Helicobacter pylori* infection relate to iron deficiency anaemia in prepubescent children under 12 years of age? Acta Paediatr 2003;92:970–2.
14. Pilot A, Fabrello R, Franceschi M, *et al*. *Helicobacter pylori* infection in asymptomatic elderly subjects living at home or in a nursing home: effects on gastric function and nutritional status. Age Ageing 1996;25:245–9.
15. Gilman RH, Partanen R, Brown KH, *et al*. Decreased gastric acid secretion and bacterial colonization of the stomach in severely malnourished Bangladeshi children. Gastroenterology 1988;94:1308–14.
16. Ozden A, Bozdayi G, Ozkan M, *et al*. Changes in the seroepidemiological pattern of *Helicobacter pylori* infection over the last 10 years. Turk J Gastroenterol 2004;15:156–8.
17. Altuglu I, Sayiner AA, Ozacar T, *et al*. Seroprevalence of *Helicobacter pylori* in a pediatric population. Turk J Pediatr 2001;43:125–7.
18. Buyukgebiz A, Dundar B, Bober E, *et al*. *Helicobacter pylori* infection in children with constitutional delay of growth and puberty. J Pediatr Endocrinol Metab 2001;14:549–51.
19. Arslan D, Kendirci M, Kurtoglu S, *et al*. *Helicobacter pylori* infection in children with insulin dependent diabetes mellitus. J Pediatr Endocrinol Metab 2000; 13:553–6.
20. Us D, Hascelik G. Seroprevalence of *Helicobacter pylori* infection in an asymptomatic Turkish population. J Infect 1998;37:148–50.
21. Yilmaz E, Dogan Y, Gürgöze MK, *et al*. Seroprevalence of *Helicobacter pylori* infection among children and their parents in eastern Turkey. J Paediatr Child Health 2002;38:183–6.
22. Doğanci T, Kansu A, Doğanci L, *et al*. 6 ay-5 yaş arasi çocuklarda *Helicobacter pylori* seroprevalansi. Turk J Gastroenterol 1998;9:138–45 (in Turkish).
23. Altindiş M. Afyon bölgesinde *Helicobacter pylori* enfeksiyon sikliği. Genel Tip Derg 2001;11:109–113 (in Turkish).
24. Selimoglu MA, Ertekin V, Inandi T. Seroepidemiology of *Helicobacter pylori* infection in children living in eastern Turkey. Pediatr Int 2002;44:666–9.
25. Yegane TS, Kasirga E, Ertan P, *et al*. Evidence against the fecal-oral route of transmission for *Helicobacter pylori* infection in childhood. Med Sci Monit 2003;9:CR489–92.

Correspondence: Ayse Demet Kaya.
E-mail <ademetkaya@superonline.com>.

Antibody Responses and Resistance against Ascaris lumbricoides Infection among Venezuelan Rural Children: The Influence of Ethnicity

Summary

We studied the production of anti parasite antibodies and the resistance against *A. lumbricoides* infection among the school population of three different Venezuelan ethnic groups: Warao Amerindians, Afro- Americans and white *'Creole'* descendents. The prevalence and intensity of *A. lumbricoides* were determined before and after 1 year of anthelminthic treatment. Parasitic loads were associated to pre-treatment serum levels of anti *A. lumbricoides* IgE and IgG4 antibodies. The intensity of the infection and the proportion of re-infected children were significantly lower ($p < 0.0001$) among the Warao Amerindians, exhibiting higher levels of IgE ($p < 0.0001$) and lower levels of IgG4 ($p < 0.0001$) compared to their non-Amerindian counterparts. IgE levels correlated inversely with the proportion of re-infected children, whereas the levels of IgG4 were positively associated. These results suggest that ethnicity may influence the balance of IgE/IgG4 levels, modulating the intensity of *A. lumbricoides* and the resistance to the infection.

Introduction

An atopic condition may favor the production of elevated levels of anti *A. lumbricoides* IgE, conferring protection against this parasite in rural children [1], whereas elevated anti- parasite IgG4 levels have been associated to high parasitic loads and persistence of the infection [2]. We studied whether differences in ethnicity among distinct groups of rural children would affect the production of these antibodies and their effectiveness on protection against this infection.

Material and Methods

We evaluated 401 school children belonging to three well-defined ethnic groups [3]: Warao Amerindians from the Delta of the Orinoco River, Afro–Americans from the Central coast and white *'Creole'* from the Venezuelan Andes. The groups shared similar socio-economic conditions and comparable prevalence of *A. lumbricoides* (Table 1). Stool examinations were performed by the Kato–Katz technique before and 6 months after 1 year of bi-monthly treatment with Albendazole (400 mg in single dose). Parasitic loads were associated to pre-treatment levels of IgE and IgG4 against *A. lumbricoides* antigens determined by an ELISA

TABLE 1
Socioeconomic conditions A. lumbricoides *infection and antibody levels in different groups of Venezuelan rural children*

	Creole (145)	Afro-American (170)	Statistical significance (95% CI)	Warao Amerindian (115)	Statistical significance[a] (95% CI)
Percentage of children without sanitary facilities and access to tap water	65	72	$\rho = 0.2946$ (0.875–1.655)	68	$\rho = 0.505$ (0.599–1.275)
Prevalence of *A. lumbricoides*	69	70	$\rho = 0.4046$ (0.636–1.188)	68	$\rho = 0.697$ (0.532–0.673)
Geometric mean No. eggs/gr faeces (geometric mean + 1SD)	6750 (13 600)	8700 (16 500)	Welch *t*-test: 2.11 $p = 0.036$ (0.005–0.16)	2120 (4380)	Welch *t*-test: 4.93 $p < 0.0001$ (−0.26 to −0.11)
Percentage of *A. lumbricoides* re-infected children after ant-helminthic treatment	45	48	$p = 0.572$ (0.729–1.182)	21	$p < 0.0001$ (1.273–1.914)
Median anti *A. lumbricoides* IgE Levels (ODU) (25th percentile–75th percentile)	0.305 (0.200–0.532)	0.273 (0.221–0.358)	Mann Whitney U: 13 729 $p = 0.6671$	0.705 (0.546–1.125)	Mann Whitney U: 997.5 $p < 0.0001$
Median anti *A. lumbricoides* IgG4Levels (ODU) (25th percentile–75th percentile)	0.768 (0.423–1.98)	0.592 (0.305–1.092)	Mann Whitney U: 13 118 $p = 0.6671$	0.23 (0.085–0.632)	Mann Whitney U: 9633.0 $p < 0.0001$

[a]Statistical significance between the Warao Children and the non-Amerindian groups.

assay [4]. Statistical analysis was done by Graph-pad Instat 3 Software.

Results

The intensity of the infection and the proportion of re-infected children were significantly lower ($p < 0.0001$) among the Warao Amerindians, exhibiting higher levels of IgE ($p < 0.0001$) and lower levels of IgG4 ($p < 0.0001$) compared to their non-Amerindian counterparts (Table 1). IgE levels correlated inversely with the intensity of the infection (Spearman r: −0.673: $p < 0.0001$) and the proportion of re-infected children (Spearman r: −0.563; $p < 0.0001$), whereas the levels of IgG4 were positively associated to the increase in these parameters (r: 0.691; $p < 0.0001$ and r: 0.582: $p < 0.0001$, respectively).

Discussion

A genetic background in the stimulation of high IgE levels has been reported among different populations of tropical ancestry including Amerindians [5] and African descendants [6]. This situation may represent an efficient strategy to fight helminthic infections. However, differences in life style among distinct ethnic groups may modulate the development of such immune responses. For example, the Warao people constitute small nomad fishing communities living in wood houses built at the border of the Orinoco River, placing the children in less contact with soil transmitted parasites thus leading to a mild or seasonal pattern of infection. This condition may favor their capacity to produce IgE [7], protecting them against re-infection. In contrast, children living in tropical mainland farms are subject to different environmental conditions favoring chronic exposure to these parasites, which may promote a more tolerant profile characterized by high levels of blocking IgG4 antibodies, limiting immunopathology driven by IgE dependent mechanisms [8] but allowing continuous re-infection. Nevertheless, the link between different genetic components and the resistance to this infection has not been elucidated and would be an important subject of following investigations.

ISABEL HAGEL[a], MAIRA CABRERA[a], ERIKA BUVAT[a], LOANA GUTIÉRREZ[a], CARLOS SANTAELLA[a], RAFAEL BORGES[a], BENITO INFANTE[b], MARIA CAROLINA SALAS[c], *and* YELITZA BARRIOS[c]

[a]*Instituto de Biomedicina* [b]*Laboratorio de Ciencias Básicas, Escuela de Nutrición, Facultad de Medicina, Universidad Central de Venezuela and* [c]*Laboratorio de Parasitologia, Dirección de Epidemiología Ambiental, Ministerio de Salud, Venezuela*

doi:10.1093/tropej/fmn032
Advance Access Published on 3 May 2008

References

1. Lynch NR, Hagel I, Palenque ME, *et al*. Relationship between helminthic infection and IgE response in atopic and non-atopic children in a tropical environment. J Allergy Clin Immunol 1998;101:217–21.
2. Turner JD, Faulkner H, Kamgno J, *et al*. Allergen-specific IgE and IgG4 are markers of resistance and susceptibility in a human intestinal nematode infection. Microbes Infect 2005;7:990–96.
3. Rodríguez Sarralde A, Castro de Guerra D, González Coira M. Frecuencia génica y porcentaje de mezcla en diferentes áreas geográficas de Venezuela de acuerdo a los grupos RH y ABO. Interciencia 2001;26:8–12.
4. Hagel I, Rodríguez O, Sánchez P, *et al*. Factores inmunológicos protectores frente a la infección por *Ascaris lumbricoides* en niños indígenas y criollos de comunidades rurales del país. Boletín de Malariología y Salud Ambiental 2005;45:37–46.
5. Salzano F. Molecular variability in Amerindians: widespread but uneven information. Anais da Academia Brasileira de Ciencias 2002;74:223–63.
6. Ness RB, Haggerty CL, Harger G, *et al*. Differential distribution of allelic variant in cytokine genes among African Americans and White Americans. Am J Epidemiol 2004;160:1033–38.
7. Cooper PJ. Can intestinal helminthic infections (geohelminths) affect the development and expression of asthma and allergic disease? Clin Exp Immunol 2002;128:398–04.
8. Yazdanbakhsh M, Kremmsner PG, Van Ree R. Allergy, parasite and the hygiene hypothesis. Science 2002;296:490–94.

Acknowledgement

We are grateful to Prof. Maria Eugenia Pinardi for revising our manuscript. This work was financed by FONACIT: Project: G-2005000371 and by Central University of Venezuela: Project, CDCH: 0966012006.

Correspondence: Isabel Hagel, Sección de Inmunoquímica, Instituto de Biomedicina. San Nicolás a Providencia, Parroquia Altagracia, Distrito Capital. Apartado Postal: 4043, Caracas 1010A, Venezuela. Tel/Fax: (58212) 8615530; E-mail <isabelhagel@yahoo.com>.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.