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Serum immunoglobulin concentration in Nigerian infants

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Summary

Serum immunoglobulin (Ig) G, M and A were determined at 3-monthly intervals during the first year of life in 35 healthy Nigerian infants. The neonatal IgG values were high, but dropped rapidly by 3 months to about 37% of the neonatal value, and thereafter rose steadily. The neonatal IgM values dropped slightly (10%) by 3 months and then rose steadily to reach a level above the neonatal value after 1 year. IgA was not detected in most of the children during the neonatal period, but where it was detected and was measurable, the values were very low and then rose steadily until the age of 1 year. There was a suggestion that the pattern of immunoglobulin in infancy might be influenced by the level of maternal education.

Résumé

Les immunoglobulines (Ig) G, M et A du sérum ont été estimées chaque 3 mois pendant la première année chez 35 enfants nigérians en bonne santé. Les valeurs néonatales d'IgG ont été élevé et cela baissaient rapidement jusqu'à 37% a l'âge de 3 mois, et puis augmentaient progressivement. Les valeurs d'IgM néonatales baissaient légèrement (10%) à l'âge de 3 mois et puis augmentaient progressivement jusqu' à la valeur néonatale à l'âge d'un an. L'IgA n'a pas été discernable chez la plupart des enfants pendant la période néonatale. D'où on l'a trouvé et mesurable les valeurs sont très basses et augmentaient graduellement jusqú à l'âge d'un an. Les résultats suggèrent que les valeurs des immunoglobulines dans la première année peuvent être influencées par le niveau d'éducation maternelle.

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Introduction

It is known that during infancy and childhood, immunoglobulin levels are unsteady. Measurements of serum concentration of immunoglobulin in normal children, in infancy and childhood, would be of great value in the evaluation of immunological deficiency, especially in this environment where infections often dominate the clinical profile. Although the 'normal' values of immunoglobulins have been defined in some normal children in Nigeria, the numbers studied have understandably been small [1,2]. The results obtained by us should therefore help in establishing further the 'normal' values of immunoglobulins in infancy in this environment.

Subjects and methods

One hundred normal full-term infants, weighing at least 2.5 kg at birth, were recruited consecutively at their first attendance for routine immunization at the Infant Welfare Clinic of the Institute of Child Health, Ibadan.

Blood samples were collected from them at their first visit (i.e. < 1 month) at 3 months, 6 months, 9 months and 12 months. The first sample of blood obtained during the neonatal period was by heel prick, while later samples were by femoral venepuncture. Serum was separated from the collected blood samples and stored at −20°C until they were analysed, in batches, for immunoglobulins (Ig) G, M and A by the modified immunodiffusion technique [3].

Results

A considerable number of mothers withdrew their children as they were reluctant to subject them to repetitive venepunctures. Blood samples for the immunoglobulin estimations were therefore obtained from a maximum of 35 infants from the 100 initially recruited. The mean levels of serum immunoglobulins obtained at < 1 month, 3 months, 6 months and 1 year are shown in Table 1.

Immunoglobulin G

The IgG levels varied from 448 to 2158 mg/100 ml in the first month, dropped to 147–903 mg/100 ml by the third month, followed by a steady rise to 356–1176 mg/100 ml after 6 months, and a further rise to 416–1852 mg/100 ml by 1 year. The mean value of 1180 mg/100 ml obtained during the neonatal period was not repeated within the first year (when the mean value was 75 mg/100 ml).

The mean variation within the group was statistically significant (Table 2). The fall in the mean IgG after 3 months was quite significant, and although there was a steady rise after this period, the value obtained at 1 year was still significantly lower than the value during the neonatal period.

Immunoglobulin M

The neonatal IgM values ranged from 30 to 195 mg/100 ml with a mean of 85.2 mg/100 ml. There was an initial fall at 3 months to a mean value of 76.7 mg/100 ml, followed by a steady rise to 122.1 mg/100 ml after 1 year. The mean value at 1 year was significantly higher than the mean value during the neonatal period (Table 2).

Immunoglobulin A

In contrast to IgG and IgM, IgA was detected, at the specified intervals, in only 12 children. The values obtained ranged between 14 mg/100 ml and 32 mg/100 ml with a mean of 26.3 mg/100 ml during the neonatal period, rising steadily to a mean of 69.3 mg/100 ml at 1 year. This rise during the first year of life was statistically significant. The rise between 3 months and 1 year was also significant, but there was no statistically significant difference in the value obtained during the first 6 months of life (Table 2).

The mean IgG, IgM and IgA values were higher in males than in females throughout infancy. However, the differences were not statistically significant except for the IgG neonatal value which was significantly higher in males than females (Table 3).

As maternal education has been shown to be the most important factor in improved antenatal and child care [4], an attempt was made to see if this had any influence on the immunoglobulin patterns of these infants. Table 4 gives the details of the analysis.

The mean IgG values during the neonatal period and at 1 year were highest in children of uneducated mothers and lowest in children of mothers with post-primary education, but the differences were not statistically significant at any period. However, at 3 months the highest mean values were in children of mothers who had had post-primary education, and lowest in children of illiterate mothers. The mean IgM values showed very little variation in all three groups. The values were initially highest in children of mothers with post-primary education, but by 1 year the children of illiterate mothers had the highest values. A similar pattern was obtained for IgA, and the difference in this case was statistically significant by the age of 1 year (Table 4).

There were significant changes in IgG, IgM and IgA values during the first year of life in the groups of children of mothers with either primary or no education. Although the pattern of changes of IgG, IgM and IgA during the first year of life was similar in the children of mothers with post-primary education, the differences were not statistically significant.

Discussion

The pattern of changes of immunoglobulins during infancy obtained in this study is similar to that described in previous studies undertaken both in southern and northern parts of Nigeria [1,5]. Similar patterns have also been found in other West African paediatric communities and in biracial American studies [6–9]. Very high neonatal IgG levels were obtained in all the groups, followed by a rapid fall to about 30% of the neonatal values after 3 months. However, by 6 months there was an appreciable rise, which then continued steadily until 1 year of

Table 1. Immunoglobulin levels in Nigerian infants

Age (months)	IgG				IgM				IgA			
	Mean (mg/100 ml)	Standard deviation	Range	*n**	Mean (mg/100 ml)	Standard deviation	Range	*n**	Mean (mg/100 ml)	Standard deviation	Range	*n**
< 1	1182.46	451.5	448–2158	35	85.17	42.6	30–195	29	26.25	5.4	14–32	12
3	442.89	198.8	147–903	35	76.72	26.9	29–129	29	29.92	22.6	10–36	12
6	656.22	200.0	356–1116	22	99.10	36.9	55–158	29	46.58	25.1	19–106	12
12	751.86	309.1	416–1852	35	122.14	54.6	49–313	29	69.25	34.7	31–125	12

**n* is the number of children.

Table 2. Statistical variation in immunoglobulin levels during infancy

Statistical comparison	IgG†	IgG†	IgA†
< 1 month vs 3 months (d.f. = 68)	9.66***	0.74	−0.35
< 1 month vs 6 months (d.f. = 60)	6.41**	−1.23	−1.93
< 1 month vs 12 months (d.f. = 68)	5.54***	−3.26**	−4.09***
3 months vs 6 months (d.f. = 69)	−2.60**	−1.97	−1.58
3 months vs 12 months (d.f. = 68)	−4.11***	−4.00***	−3.74***
6 months vs 12 months (d.f. = 68)	−1.24	−2.03*	−2.15

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.
†t values for each comparison.

Table 3. Differences in immunoglobulin levels due to sex of Nigerian infants

	IgG			IgM			IgA		
	Male	Female	t value†	Male	Female	t value†	Male	Female	t value†
< 1 month									
Mean (mg/100 ml)	1438.4	1065.2	2.423*	93.9	82.7	0.672	25.00	27.22	0
Standard deviation	447.9	411.7	(d.f. = 33)	43.5	41.4	(d.f. = 26)	0.00	6.20	(d.f. = 13)
n‡	11	24		10	18		6	9	
3 months									
Mean (mg/100 ml)	507.1	413.5	1.320	78.3	76.3	0.182	37.33	27.30	0.665
Standard deviation	135.2	215.7	(d.f. = 33)	21.6	30.0	(d.f. = 26)	29.60	27.20	(d.f. = 10)
n‡	11	24		10	18		6	6	
6 months									
Mean (mg/100 ml)	609.1	621.3	−0.129	102.8	98.3	0.306	53.60	41.57	0.844
Standard deviation	149.7	245.7	(d.f. = 24)	26.5	42.2	(d.f. = 26)	27.80	21.80	(d.f. = 10)
n‡	8	18		10	18		6	6	
12 months									
Mean (mg/100 ml)	818.1	718.2	1.093	136.1	116.8	0.849	81.33	66.33	0.910
Standard deviation	283.7	235.4	(d.f. = 33)	49.3	61.4	(d.f. = 26)	32.60	30.50	(d.f. = 10)
n‡	11	24		10	18		6	6	

*$P < 0.05$.
†Value for comparison between male and female for each age group.
‡n is the number of children.

age. The fall in IgG during the first 3 months of life has been attributed to the catabolism of the maternal IgG which would have passed transplacentally into the foetal circulation. The subsequent rise is due to increased synthesis by the child's immune system [10,11]. The mean values of IgG obtained in this study were similar to those obtained by Adeniyi and Ayeni [1], but slightly higher than values obtained in European populations [9,12].

The mean values of IgM were higher than those obtained by Adeniyi and Ayeni [1] at every stage. Unlike most other studies, our values dropped during the first 3 months and then rose steadily. As IgM does not pass transplacentally to the foetus [13,14] the slightly

Table 4. Mean immunoglobulin values during infancy according to maternal educational level

	IgG				IgM				IgA			
	< 1 month	3 months	12 months	*F*†	< 1 month	3 months	12 months	*F*†	< 1 month	3 months	12 months	*F*†
No education												
Mean (mg/100 ml)	1266.60	405.00	859.40	13.39***	62.29	79.29	107.37	3.78*	22.80	35.80	96.20	9.58***
Standard deviation	394.28	157.11	440.99		15.77	27.57	36.51		4.40	33.49	27.95	
Primary education												
Mean (mg/100 ml)	1214.81	416.44	698.88	23.53***	92.50	71.88	138.93	5.96**	28.17	41.25	75.00	5.10***
Standard deviation	480.98	213.84	190.74		49.19	25.22	68.27		3.24	35.19	25.00	
Post-primary education												
Mean (mg/100 ml)	842.50	638.75	687.25	0.33	102.40	87.20	95.00	0.20	29.00	30.33	39.33	1.11
Standard deviation	481.45	217.54	173.47		39.66	29.80	33.06		5.66	4.03	11.09	
F‡	1.20	2.07	0.90		1.55	0.57	1.29		2.23	0.90	4.14*	

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.
†Values for comparison between groups of different ages.
‡Values for comparison between groups of different educational backgrounds.

high mean neonatal value may be attributed to the presence of perinatal bacterial, viral or parasitic infections in some of the babies [7,15,16] (six babies had IgM values > 100 mg/100 ml during this period and these values dropped to < 100 mg/100 ml in four of them by the third month).

The pattern of change of concentration of IgA in these children was also similar to that obtained by most of the other workers described previously. IgA was rarely detected in the very young, but again the level rose steadily during infancy as the development of this immunoglobulin is stimulated by the presence of infections.

In this study, mean immunoglobulin levels were found to be higher in males than in females, the only significant difference was in the mean IgG levels of neonates. Most other studies have also shown no significant sex difference in immunoglobulin levels in infants except in IgM levels, but the values have usually been higher in females than males [6,9]. However, statistically significant differences between the sexes, in IgM levels, has been well documented in adults, and has been shown to be related to the number of X chromosomes present [17,18]. It is possible that the effect of this chromosome is less pronounced in infants.

The slightly higher IgG, IgM and IgA values generally obtained in children of illiterate mothers (Table 4) may be due to the higher frequency of infection in this group of children leading to greater stimulation of immunoglobulin production. The lower levels of IgG in infants of illiterate mothers at 3 months, compared to infants of mothers with secondary education at the same period, could be due to a slower rate of immunoglobulin production resulting from deficiency in nutrition, as even at this stage as some of the mothers may be malnourished, or may not be feeding their babies properly.

The overall pattern of immunoglobulin changes in children of mothers in the three educational levels (Table 4) suggests that the changes in immunoglobulin levels in children of mothers with post-primary education were far less than the changes in children of mothers with no education or with primary education. It is believed that the first group of children not only live in a cleaner environment and are therefore subjected to less bacterial and parasitic infections, but that they also have the benefit of easier access to medical attention and thus early treatment of infections.

This striking difference in immunological changes among the defined educational groups confirms the belief that maternal education enhances, to a certain degree, the level of child care.

The overall occurrence of higher immunoglobulin levels, especially IgA, in children of illiterate mothers in later months compared with children of mothers with post-primary education are similar to findings in studies between black and white populations, where immunoglobulin values in the black population were found to be higher than in the white population [19,20]. Although this difference has been explained on the basis of genetic constituents and environmental factors such as recurrent exposure to infections (bacterial and parasitic), we believe that the environmental factors may be more important in this study, as all the children studied were Nigerians. As the number studied is too small to arrive at any meaningful statistical conclusion, we suggest that further work is required to define the influence of socio-economic factors in immunoglobulin levels of children.

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