Epidem. Inf. (1987), 99, 85–89
Printed in Great Britain

Measles antibody levels in children of rural and urban areas of Nigeria following vaccination campaign

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(*Accepted 8 September 1986*)

SUMMARY

This study compares the presence and level of measles haemagglutination inhibiting antibody in the sera of primary school children in selected rural and urban areas of Kaduna State, Nigeria following a vaccination campaign. The results, analysed by Mann–Whitney statistical test at $\alpha = 0{\cdot}05$, showed significantly higher levels of haemagglutination inhibiting antibody in all the age groups in urban areas when compared with rural areas. The implications of these findings on measles vaccination campaigns are discussed.

INTRODUCTION

In developed countries, clinical measles infection has declined greatly during the past 20 years due to vaccination (Krugman, 1977). Despite intense anti-measles campaigns, regular epidemics with their complications which measles infection present in all parts of Nigeria are often worse than malaria; and measles now causes the highest percentage of childhood mortality. This has been shown by investigators who have studied the incidence and the problems associated with measles infection in Nigerian children (Gans *et al.* 1961; Katz, Morley & Krugman, 1962; Morley, Woodland & Martin, 1963).

These epidemics which continue to expand despite the government's efforts at control prompted this investigation, which compares the levels of haemagglutination inhibiting (HAI) antibody in Nigerian primary school children in rural and urban areas following vaccination campaigns.

MATERIALS AND METHODS

Collection of serum specimens

Specimens of blood were collected from 1006 children aged 6–15 years in selected primary schools from seven local government areas of Kaduna State, considered as urban or rural on the basis of population and social amenities. Each of these areas had a measles vaccination programme within the previous 5 years (infor-

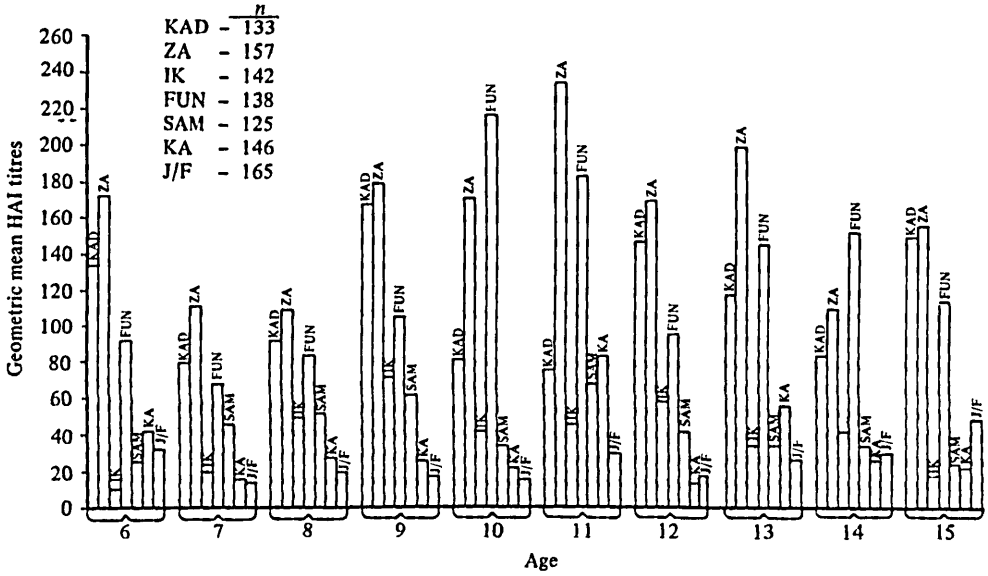

Fig. 1. Diagramatic representation of geometric mean HAI titres of various age groups in urban and rural areas of Kaduna State, Nigeria following measles vaccination campaign.

mation obtained from the Epidemiology Unit, Kaduna State Ministry of Health). Areas of the state with no record of an anti-measles campaign during the 5 years prior to collection were excluded from the study.

In each local government area, two schools were selected for specimen collection, and 14 schools in all were visited. Blood samples were collected from not less than 60 pupils in each school taken from classes 1–6.

Reagents

The reagents used for the assay were: (*a*) Measles haemagglutinin (HA) (Catalogue no. VH03) prepared by Tween–ether treatment of a strain of measles virus grown in monkey kidney cells. (*b*) Measles HA negative control antigen (Catalogue no. VE03) prepared in a similar way from uninfected control cells. (*c*) Measles HAI positive control serum (Catalogue no. HG03) prepared from a pool of measles immune sera. (*d*) Measles HAI negative control serum (Catalogue no. VJ03) prepared from a pool of sera from measles-susceptible children. All were purchased from Wellcome Diagnostics, Dartford, UK. (*e*) 0·85% sodium chloride as diluent. (*f*) 25% kaolin (Sigma Co.) used for absorbing the sera. (*g*) Grivet monkey erythrocytes as 50 and 1% suspensions. They were used for absorption and as test indicator respectively. They were prepared locally.

Haemagglutination inhibition (HAI) test

The haemagglutination inhibition test was performed in Linbro/Titertek microtitration V-bottom multi-well plates (Catalogue no. 76-221-05). It was carried out as described by Rosen (1961). Non-specific inhibitors were removed from the sera by absorption with 25% kaolin and 50% grivet monkey erythrocytes as described in our previous paper (Odama *et al.* 1980).

https://doi.org/10.1017/S0950268800066887 Published online by Cambridge University Press

Table 1. *Proportion of children in each local government area (LGA) with and without protective levels of measles HAI antibody*

LGA	No. of children's sera examined	Urban (U) or rural (R)	No. with protective levels of antibody ($\geqslant 32$) (%)	No. without protective levels of antibody ($\leqslant 16$) (%)
Kaduna	133	U	114 (86)	19 (14)
Zaria	157	U	143 (91)	14 (9)
Funtua	138	U	107 (78)	31 (22)
Ikara	142	R	53 (37)	89 (63)
Saminaka	125	R	49 (39)	76 (61)
Kachia	146	R	54 (37)	92 (63)
Jema'a Federation	165	R	51 (31)	114 (69)

RESULTS

This investigation covered seven local government areas. The urban areas were Kaduna, Zaria and Funtua, while the rural areas visited were Ikara, Saminaka, Kachia and Jema'a Federation. The geometric mean antibody titres in each group in the local government areas investigated are shown in the Fig. 1. The level of antibody titres obtained in the different age groups of children varied from community to community. The highest levels of circulating HAI antibody were found in the Zaria local government area in almost all the age groups. This was followed by Kaduna and Funtua.

In the rural areas, low HAI antibody levels were found in all age groups. The data analysed by the Mann–Whitney test at $\alpha = 0{\cdot}05$ also confirmed that the difference between the two broad areas under investigation was significant.

The numbers and proportion of children with HAI titres of $\leqslant 16$ and $\geqslant 32$ respectively in each area studied are given in Table 1.

DISCUSSION

Serological studies have suggested that mean titres of antibody to measles virus decline somewhat over the years especially in the absence of endemic or epidemic measles that can stimulate antibody production by subclinical infection (Black & Rosen, 1962; Bass *et al.* 1976; Yeager, 1976). Repeated reinfection with clinical measles is common in the Nigerian community, although the extent of the problem has yet to be documented.

The problem of measles epidemics causing a high mortality in malnourished populations, particularly those with protein deficiency has been reported (Morley, 1962). In such populations Morley *et al.* (1963) found that the clinical and epidemiological characteristics of measles in West Africa today are quite unlike the patterns of the disease in England. They reported that the pattern of the disease in West Africa closely resembled measles as seen in England before the 20th century. From the information now available in the literature and pattern and intensity of the disease in Nigeria highlight the need for a concerted research effort in this country.

https://doi.org/10.1017/S0950268800066887 Published online by Cambridge University Press

In Zaria, Kaduna and Funtua (urban areas) a high antibody level was found in all the age groups studied, suggesting that this aspect of health care was adequate in these areas. An alternative interpretation of these data might be that they received frequent boosters due to exposure to natural measles in the urban areas as a result of high population densities. In the Jema'a Federation, Kachia, Ikara and Saminaka local governent areas, very low levels of antibody were observed in all age groups, which could have been the result of inadequate health care. However, the low levels in these rural areas may have been due to other contributory factors. Most notably, the children will probably have received vaccine of low potency. The low potency of the vaccines used in most communities in Nigeria have been well documented (Eghafona *et al.* 1979).

The conversion rate from susceptible to immune status is measured by antibody response, with the circulating antibody titre related to the degree of immunity (Karelitz & Markam, 1962). The effect of low levels of HAI antibodies on measles virus replication was also demonstrated *in vitro* in our earlier study (Odama, Eghafona & Emejuaiwe, 1985). The results of this study suggested that an HAI titre greater than 16 could inhibit measles virus replication until an anamnestic response was initiated. This usually led to a rise in antibody levels and subsequent neutralization of the virus. Hence any subject with a level of measles antibody less than 16 should be re-vaccinated as part of a serious immunization campaign. Similarly, Stokes *et al.* (1961) found evidence of reinfection with measles virus in those who had antibody titres of < 8.

The children in rural areas may also be unable to seroconvert adequately as a result of malnutrition or the existence of other debilitating diseases which can inhibit an effective immune reponse even to a potent vaccine. Such unhelpful conditions are known to be very common in our rural areas. Variations in the frequency of contact with active measles infections between rural and urban areas are also likely to occur.

This investigation shows the need for improved public health measures in our rural areas, where the present conditions make it difficult to achieve a high degree of protection following measles vaccination. However, a sustained effort must be made to spread successful vaccination to our rural areas, where 80% of the population lives, if the anti-measles campaign is to succeed. Measles can be controlled almost completely by 90–95% herd immunity. However, if the proportion of susceptibles rises to 20% the virus can be maintained at endemic levels while 25% is said to be sufficient to initiate seasonal epidemics (Babbot & Gordon, 1954).

We are grateful to the following: Gimba Braimoh and Obioha Achor for excellent technical assistance, Mrs S. A. Ajekigbe for secretarial work, Mr J. O. Emokpaire (Centre for Educational Technology, A.B.U., Zaria Nigeria) for the Figure and Dr Kessiena Agori-Iwe, IAR, A.B.U., Zaria for statistical analysis.

This work was financed by Ahmadu Bello University Senate Research Grant No. 52073 of 1979.

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