

THE AGE LEVEL FOR THE PEAK OF ACQUIRED IMMUNITY TO MALARIA AS REFLECTED BY LABOR FORCES¹

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Malariologists are inclined to some range of opinion as to when the peak of immunity is gained by people who spend their lives in regions where malaria has high endemicity. Perhaps this is partly due to the fact that it is always more convenient and time saving to survey the children who are more apt to be present at home or in the schools. For many years I have personally been interested in the *labor index* of malaria and I think enough evidence has been assembled in some regions where I have had service to present it for analysis. It might be well to refer to a few of the records from well recognized authors from 1922 to 1942 before presenting this experience.

(1) *Byam and Archibald (1922)*. Immunity to malaria, when it is present, is almost always a partial immunity acquired by frequent infection and reinfection repeated continuously over a number of years. Children who survive to the age of three or four years will be found to have acquired a considerable degree of *tolerance* but parasites will continue to be found in their blood.

(2) *Manson-Bahr (1929)*. It has been shown that the natives of malarious districts acquire their immunity from repeated and persistent infection in childhood. In such places the blood of practically every child up to 3 or 4 years of age contains malaria parasites. The proportion of infected children gradually becomes smaller with each additional year until adolescence is approached, when the blood becomes practically parasite-free and immunity is established.

(3) *Boyd, Mark F. (1930)*. Absolute immunity in malaria appears to be rare. There is abundant evidence to indicate that a relative immunity may be acquired. The resistance shown by natives or old residents of a highly endemic area was first shown by Koch to be the result of infection, and associated with it. The acute infestation which

lasts through childhood to adolescence might be called the stage of *immune infestation*.

(4) *Hackett, L. W. (1937)*. Quotes Barber as having found 100 per cent of the children infected after their first year of life in Lagos and that young adults in their twenties complained from time to time of illness while those over 30 years showed little evidence of malaria.

(5) Djapardze made a study of immunity in malaria based on mass observation conducted in the course of two years (1927-8) in the Black Sea Coast of Caucasus where the three main species of parasites occur. In one district (Gal) no anti-malarial measures were in effect and the disease was hyperendemic. Its course could be observed in the true form. This district was compared with the Gudaut district where malaria was characterized by epidemic outbreaks with a low general incidence. He found that the population of the hyperendemic region, having been repeatedly exposed to seasonal infections in the course of 4 to 5 months from year to year, had developed a relative immunity which was strictly strain-specific. The parasite rate reached its maximum at the age of 5, after which it gradually decreased until by the age of 40 it was halved. When both benign and malignant tertian malaria were present, the population acquired a more stable immunity against the former. The immune state of the adult population in the hyperendemic region was reflected (1) in the absence of severe clinical forms of malaria and (2) in the presence of infected persons showing no symptoms at all.

In 1922 I was advised to use the following age groups in malaria surveys of labor camps and rural communities: 0-4 years, home or domestic life; 5-14 years, school period; 15-49 years, active business period of life; 50 years and over, inactive life.

It was believed that serious malaria control would only be necessary in the first two groups since acquired immunity would protect the others.

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This made it appear that those of *labor age* would be easy to control in labor camps on the basis of making malaria a dispensary disease.

We all know that at about the age of puberty, if the child has lived in an endemic area, a respectable degree of tolerance has been gained but this is not very stable. As soon as these young

TABLE I

The consolidated annual records for ten years of persons with malaria by age groups

Chagres River villages. Permanent and Migratory inhabitants (6)

AGE GROUPS	DRUG CONTROL		
	Number examined	Number positive	Per cent positive
0-5	1300	352	27.1
5-10	785	350	44.6
10-20	1330	567	42.6
20-40	1666	452	27.1
40-60	788	206	26.1
Over 60	262	61	23.6
Totals.....	6,131	1,988	32.4

TABLE II

Río Pescado control towns. Chagres river-lake shore

AGE GROUPS	ORIGINAL SURVEY			VOLUNTARY USE OF QUININE, 12 CUMULATIVE MONTHLY SURVEYS		
	Number examined	Positive for malaria	Per cent positive	Number examined	Positive for malaria	Per cent Positive
0-5	34	21	61.7	50	28	56.0
5-10	30	26	86.6	62	34	54.8
10-20	22	16	77.2	59	27	45.7
20-40	25	14	56.2	49	15	30.6
40-60	15	6	40.2	29	4	13.8
Over 60	2	1	50.2	3	1	33.3
Totals....	128	84	65.2	252	109	43.2

people enter an active life the fatigue, strain and exposure upset their relatively low degree of immunity. The actual peak of relative immunity would appear to be more accurately measured by what happens to the adolescent after entrance into active business life. I will attempt to demonstrate this by our experience over many years with the Chagres River villages and with a negro labor force from Haiti. These people are strongly negroid in race and have spent their lives

in uncontrolled endemic areas. The former group has been under antimalarial drug control following frequent blood film surveys for the last several years. These groups by race and life-long exposure represent people of high tolerance.

Table I shows in the annual cumulative records that there is a significant incidence of malaria in all age groups, even those above 60 years of age. The peak, however, is shown in the groups of 5 to 20 years.

There is no evidence in Table II of a stable degree of immunity until somewhere between the 20 and 30 years period. Some people never gain a sufficient degree to become parasite-free or symptom-free.

TABLE III

Men and children in Haiti, 1927 (7)

	NUMBER EXAMINED	NUMBER POSITIVE	PER CENT POSITIVE
Adults.....	11,000	2585	23.5
Children (2-12 yrs.).....	1,102	462	41.9

TABLE IV

Degrees of infestation

	ADULTS	CHILDREN
Heavy infestations.....	25.2	11.9
Medium infestations.....	34.0	44.4
Light infestations.....	40.8	43.7

In 1927 I had an opportunity to make a medical selection of laborers (7) in Haiti for use in the sugar plantations of northeastern Cuba. We were supplied with good technical assistance to do, among other things, a thick blood film survey for malaria. These negroes are as pure descendants of the African negro as can be found in the Caribbean region and therefore could be expected to possess a significant degree of immunity. These men came from all of the civil districts of Haiti. They worked 6 months in the sugar cane harvest of Cuba and then returned to Haiti. No women or children were in the labor camps. However, in order to compare the children's incidence of malaria with the young male labor force a representative number of children from all the civil districts were examined. Tables III and IV show the results of these blood film results.

One year prior to these surveys I was in Cuba at the end of crop which means that the Haitian labor force had been actively employed for 6 months in the field and living in camps. No antimalarial measures were then in force other than hospital and dispensary attention. A similar blood film survey made near the end of crop revealed a parasite index of 66 per cent. A second survey was conducted on men found in camp during working hours and a similar number of men busy cutting cane. The first group gave a rate of 88 per cent and the second 12 per cent. This highly tolerant negro labor force did show a sufficient reaction to malaria, after a lifelong exposure to it, to decrease their labor efficiency. The hospitals received many of them and there were some deaths. However, they need but little help in addition to their relative degree of immunity to remain on duty. For 8 years these men never exceeded 0.9 to 0.93 tons of cut cane per day, per man, per crop. Labor selection and a field program of malaria control during the next three years brought their efficiency up to 1.5 tons. A labor force that has grown up in a rural endemic region without medical or sanitary care is in no position to realize what good health means. The so called "camp loafers" in the sugar cane fields no longer existed in a significant number after malaria control was well established.

A few years after we started antimalarial drug control in the selected Chagres villages, the inhabitants were nearly always able to tell us whether we would find parasites in their blood films.

The peak of relative immunity, 12 to 15 years, that is usually recorded is probably correct for inactive people who have spent their lives in an endemic region but from the viewpoint of an efficient labor force the period from 15 to 30 years requires almost as much attention as the period under 15 years. There is no such thing as absolute

immunity to malaria for the general run of people regardless of race and a long life in malarious regions. Fatigue, exposure, underfed people, introduction of new strains, etc. can break any degree of tolerance and the level of labor efficiency will drop to an important degree.

Non-immunes who enter and remain in such endemic regions will, in most instances, require a very long period of time to acquire a respectable degree of immunity. This will become better recognized by us when our young men return after the war.

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