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Another Approach, and Analysis, to Evaluate the Risk of Malaria Transmission in Angola According to Vector Control Method and Duration of Stage: The Birley's Formula

N. Carnevale [1], G. Carnevale [2], B. Monbeig [3], P. Carnevale [4]

1 First help Instructor, Meyre street; Soussans; France

2 Vector Control in Emergency Situation, Jalan Raya Sakah 22xx, Batuan, Sukawati, Gianyar, Bali, Indonesia-80582

3 Teacher in Risks Protection, 19 Reclus Street, 64300, Orthez, France

4 Director of Research ELII, A. Sakharov Street, Georges Residency, Buiding A, Castelnau-le-Lez, 34170; France

Corresponding email: pjcarnevale2001@yahoo.fr

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Abstract

Background:

Three indicators are used to evaluate the entomological intensity of malaria transmission: the "entomological inoculation rate" of Ross; the "reproduction rate" of Macdonald and the "vectorial capacity" of Garrett-Jones. They were successfully used to evaluate the impact of vector control. But they do not consider the duration of stay in malarious area. Therefore, Birley introduced the parameter "t" (in days) in the new formula of the inoculation rate which became $h= 1-(1-s)^{ma.t}$, where ma= biting rate; s= infectivity and t the time of exposure.

Objective:

We used the Birley's formula in the framework of the long-term malaria vector control program implemented in eight villages around Balombo (Angola) to compare the efficacy of four methods.

Method:

The method of vector control were: the long-lasting insecticide (deltamethrin) treated nets ("LINs") PermaNet® 2.0 (P2.0) alone, in two villages; LLINs P2.0 in combination with insecticide (deltamethrin) treated plastic sheeting ("ITPS") model ZeroFly®, in two villages; ITPS model ZeroVector® (deltamethrin treated) alone, in two villages; and two rounds of lambdacyhalothrin inside residual spraying ("IRS") followed by installation of ITPS, in two villages. In the first five years both entomological and parasitological field surveys were done every two months, two years before vector control and three years after. Entomological evaluation was based CDC Light Trap inside houses; the "density per trap" was used as a proxy of the "biting rate" inside the house to get the "risks in the house" before and after vector control. Mosquito were identified and analyzed to get species identification and infectivity.

Results:

Main vectors (MV) were *Anopheles funestus* and *An. gambiae* which were gathered and used as "ma", in the Birley' formula. The risks of being inoculated increased sharply as a logarithmic function of the length of exposure. Without vector control, with an average density of 0.6 "main vectors per trap", and an infectivity of 4.53% the risks of infections were 2.7% in one day; 17.2% in one week; 55.5% in one week and 99.5% in one year. After vector control, with a density becoming 0.17 main vectors per trap, and an infectivity of 2.59%, the risks were 0.15% in one day; 3.1% in one week; 12.7% in one month and 80.5% in one year; meaning a protection of 94.4% in one day; 82% in one week; 77% in one month and 19% for one year. The trends in the reduction of risks were similar with the four methods of vector control but the level of reduction was different with methods. In the condition of the trial, the best method, in term of efficacy, and long-lasting effect, was the ITPS ZeroVector® alone.