# DETERMINATION OF MOSQUITO ATTACK RATES BY INTERVIEW OF KERN COUNTY, CALIFORNIA RESIDENTS[1]

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Accurate data on the number of persons bitten by mosquitoes and the number of bites suffered by each are largely lacking. Although significant information on the public health importance of pest mosquitoes can be obtained by a house-to-house survey method (Hess and Quinby, 1956), most reports are descriptions of complications of bites requiring medical attention.

In Kern County, California, early in the summer of 1958, there was a high population of *Culex tarsalis* which was carrying western equine encephalitis virus. A survey was undertaken to learn the frequency of mosquito attack on the population of this area. The aims were to determine:

1. The frequency of mosquito attack on a representative sample of persons during the summer.
2. Whether the frequency of reported mosquito bites correlated with the mosquito population density shown in entomological surveys.
3. Whether mosquito bite histories would indicate the general pest level of mosquitoes, and differences in risk of mosquito bites of different parts of the population.
4. The possible values and limitations of this type of interview when conducted by a public health nursing staff.

The area surveyed was urban and suburban Bakersfield and the surrounding rural agricultural area. Peripheral mountainous and desert areas of the county were not included. In the survey area the distribution of the 200,000 residents by place of residence according to the 1950 census, was 51 percent urban and 49 percent rural.

METHODS. The public health nursing staff of the Kern County Health Department cooperated in the study. Nurses who were to work in Bakersfield and in rural areas were given a "mosquito bite history form" to be completed by them during home visits or child health conferences.

The mosquito bite history form included spaces for the following information to be filled in: name, age and sex of person interviewed, name of head of household, and relationship to person interviewed; statements on when and where person was bitten, and estimated number of bites in last 24 hours; statement of time of biting in relation to sundown, and whether indoors or out; whether or not repellants or aerosol bombs were used, and whether there was adequate screening.

Nursing notes included estimated number of bites seen, and their distribution on the body; and incidence of infected bites and other complications. The nurses obtained this information as a part of their routine home and clinic visits between June 20 and September 12, 1958.

RESULTS. Information was obtained for 242 households on a total of 502 persons —201 males and 301 females. Eighty-five percent of the interviews took place at home and 15 percent at child health conferences.

Three hundred sixteen persons (63 percent) said they were bitten. There was

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TABLE 1.—Age and sex distributions of 502 persons surveyed regarding history of mosquito bites during the summer, Kern County, 1958

| Age group | Males | | | Females | | | Both sexes | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. surveyed | No. bitten | Percent bitten | No. surveyed | No. bitten | Percent bitten | No. surveyed | No. bitten | Percent bitten |
| 0– 5 months | 8 | 3 | 38 | 10 | 8 | 80 | 18 | 11 | 61 |
| 6–11 months | 11 | 9 | 82 | 18 | 14 | 78 | 29 | 23 | 79 |
| 1– 4 years | 67 | 55 | 82 | 71 | 60 | 85 | 138 | 115 | 83 |
| Subtotal 0-4 years | 86 | 67 | 78 | 99 | 82 | 83 | 185 | 149 | 81 |
| 5– 9 years | 48 | 35 | 73 | 36 | 23 | 64 | 84 | 58 | 69 |
| 10–19 years | 15 | 6 | 40 | 43 | 22 | 51 | 58 | 28 | 48 |
| 20+ years | 50 | 20 | 40 | 120 | 59 | 49 | 170 | 79 | 46 |
| Age unknown | 2 | 1 | 50 | 3 | 1 | 33 | 5 | 2 | 40 |
| All ages | 201 | 129 | 64 | 301 | 187 | 62 | 502 | 316 | 63 |

TABLE 2.—Age distribution of 305 * persons bitten during the summer showing whether or not bitten during the last 24 hours, Kern County, 1958

| Age group | No. surveyed | No. bitten | Percent bitten |
|---|---|---|---|
| 0– 5 months | 11 | 9 | 82 |
| 6–11 months | 23 | 16 | 70 |
| 1– 4 years | 110 | 64 | 58 |
| Subtotal 0–4 years | 144 | 89 | 62 |
| 5– 9 years | 55 | 15 | 27 |
| 10–19 years | 27 | 7 | 26 |
| 20+ years | 77 | 26 | 34 |
| Age unknown | 2 | 0 | 0 |
| All ages | 305 * | 137 | 45 |

* Eleven persons whose history of bites within 24 hours was unknown have been deleted from the table.

a tendency for the percent of persons reporting being bitten to decrease with increasing age, from 81 percent in age groups below 5 years to 47 percent in persons over 20 years of age (Table 1). Males and females reported similar proportions with mosquito bites for each age group, and for all ages combined the proportion positive was 64 percent for males and 62 percent for females (Table 1). The age differential was also seen when the group of 316 persons who were bitten during the summer was subdivided on the basis of age and the history of bites during the last 24 hours or during the summer (Table 2). Of the 24-hour group, 65 percent were below the age of 5 years; this was higher than the age distribution of those bitten during the entire summer, in which the age group below 5 years constituted only 47 percent.

Significantly more rural residents than urban residents were bitten, and again more younger persons (Table 3).

The monthly distribution of interviews is presented in Table 4. Although fewer persons were interviewed in succeeding months, the percentage of persons bitten increased toward the end of the summer in both rural and urban residents. In the first months the percentage of rural persons bitten was higher and the percentage continued to increase throughout the summer. The attack rates reported for the 24 hours preceding the interview had an irregular pattern, being highest in urban residents in June and August and highest in August in rural residents (Table 5).

Of the 137 persons with a history of bites in the past 24 hours, 124 estimated the number of bites (Table 6). The range was from 1 to over 30 bites, most had less than 5 bites. There were no significant differences in the number of bites in different age groups.

Nurses checked validity of information by indicating whether or not they saw evidence of bites and the number of bites. Nurses examined 126 of the 137 persons with a history of bites in the past 24 hours and confirmed the report of 119. The number of bites of 108 persons was estimated by informants and nurses and a significant correlation was found between the two estimates. The group not bitten during the last 24 hours but bitten sometime during the summer was not asked to estimate the number of bites received. Nurses examined 149 persons in this group and saw evidence of bites in 62. The distribution by age and range in number of bites was almost identical to that in Table 6.

The bodily distribution of bites was reported for 172 persons. In most instances more than one area was involved—the head and one or more other areas most often (37 percent). In 65 persons only one body area was affected: legs 27 (41 percent); arms 20 (31 percent); head 11 (17 percent); body 7 (11 percent). Complications of bites, probably secondary infections, were reported for 26 out of the 316 persons bitten. It was not known if

TABLE 3.—Urban-rural differences by age * in the bitten and not bitten groups, Kern County, 1958

| | Urban | | | Rural | | |
|---|---|---|---|---|---|---|
| Age group | No. surveyed | No. bitten | Percent bitten | No. surveyed | No. bitten | Percent bitten |
| 0–4 years | 121 | 89 | 74 | 63 | 59 | 94 |
| 5+ years | 256 | 118 | 46 | 52 | 43 | 83 |
| All ages | 377 | 207 | 55 | 115 | 102 | 89 |

* 5 persons with age unknown and 5 persons with residence unknown are deleted from this table.

TABLE 4.—Distribution by month and place of residence * of 502 persons surveyed regarding history of mosquito bites during the summer, Kern County, 1958

| Month of Interview | Urban | | | Rural | | | All areas | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. surveyed | No. bitten | Percent bitten | No. surveyed | No. bitten | Percent bitten | No. surveyed | No. bitten | Percent bitten |
| June | 201 | 110 | 55 | 57 | 46 | 81 | 258 | 156 | 60 |
| July | 163 | 85 | 52 | 15 | 13 | 87 | 178 | 98 | 55 |
| August | 15 | 12 | 80 | 16 | 16 | 100 | 31 | 28 | 90 |
| September | 2 | 1 | 50 | 28 | 28 | 100 | 30 | 29 | 97 |
| All months | 381 | 208 | 55 | 116 | 103 | 89 | 497 * | 311 | 63 |

* Place of residence was undetermined for 2 in June and 3 in July.

TABLE 5.—History of mosquito bite during the last 24 hours for 486 persons distributed by month and place of residence,* Kern County, 1958

| Month of Interview | Urban | | | Rural | | | All areas | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. surveyed | No. bitten | Percent bitten | No. surveyed | No. bitten | Percent bitten | No. surveyed | No. bitten | Percent bitten |
| June | 199 | 47 | 24 | 55 | 26 | 47 | 254 | 73 | 29 |
| July | 160 | 26 | 16 | 15 | 7 | 47 | 175 | 33 | 19 |
| August | 15 | 5 | 33 | 15 | 13 | 87 | 30 | 18 | 60 |
| September | 2 | 0 | 0 | 25 | 10 | 40 | 27 | 10 | 37 |
| All months | 376 | 78 | 21 | 110 | 56 | 51 | 486 * | 134 | 28 |

* Sixteen persons for whom complete data were not available and not included in this table.

TABLE 6.—Age distribution and estimated number of mosquito bites as given by informants for 137 persons bitten during the last 24 hours, Kern County, 1958

| Age | Estimated number of bites | | | | | | | Estimate not stated | Total bitten last 24 hrs. |
|---|---|---|---|---|---|---|---|---|---|
| | 1–4 | 5–9 | 10–19 | 20–29 | 30+ | Some, number not stated | Total | | |
| 0– 5 months | 4 | 2 | 2 | | | 1 | 9 | | 9 |
| 6–11 months | 5 | 4 | 5 | 2 | | | 16 | | 16 |
| 1– 4 years | 35 | 14 | 5 | | 2 | | 56 | 8 | 64 |
| Subtotal 0– 4 years | 44 | 20 | 12 | 2 | 2 | 1 | 81 | 8 | 89 |
| 5– 9 years | 7 | 4 | | | 1 | | 12 | 3 | 15 |
| 10–19 years | 3 | 4 | | | | | 7 | | 7 |
| 20+ years | 12 | 5 | 2 | 3 | 1 | 1 | 24 | 2 | 26 |
| Total | 66 | 33 | 14 | 5 | 4 | 2 | 124 | 13 * | 137 |

* Of this group the nurse saw evidence of bites in 6 cases.

the complications required medical attention.

Another variable considered was the individual means of protection from attack. Of those who replied to the inquiry, 19 percent used repellents and aerosol sprays. Comparison of the use of repellents and aerosol sprays between the bitten and unbitten group revealed that more of the bitten group than the unbitten group used these measures. The same was found when the data were analyzed according to households instead of to persons. Persons probably used protective measures after they had been bitten rather than before.

In 54 percent of the homes screening was classified as adequate, but this judgment did not differentiate the groups reporting positive and negative histories of mosquito bites. For 105 persons who replied whether they were bitten indoors, outdoors, or both: 19 persons were bitten only indoors, 56 only outdoors, and 30 in both. Of those who were bitten only indoors, adequate screening was reported by 28 percent. For those bitten only outdoors, 80 percent reported adequate screening.

The time of day bitten was determined for only 98 of the 316 who were bitten. Eleven persons said they were bitten before sundown, 76 after sundown, and 11 both before and after.

The geographical location where bitten was: at or around home, 229 (72 percent); recreational areas, 27 (9 percent); visits away from home, 10 (3 percent); at work, 5 (1 percent); and not specified, 43 (14 percent). Most of the people were bitten at home outdoors in the evening.

DISCUSSION. Information on the frequency and extent of mosquito bites among residents of a given area may be obtained by the methods reported here. The method has certain limitations insofar as epidemiology is concerned. The number of interviews each month was unequal and the sample interviewed probably did not represent the total population of the area for it was assumed that nurses would see urban and rural population groups who had a higher risk of exposure to mosquitoes than the general population. Further, the bias introduced because of selection by the nurse, of who was to be interviewed, how many and when, could not be eliminated, largely because of limited staff and resources. As a usual thing, husbands were not at home at the time of the nurse's visits and the histories for them were not as reliable as those relating to the informants and children. This also resulted in a larger proportion of females than males in the study, with the interviews conducted in child health conferences further increasing this preponderance. Some effort was made in the questionnaire to provide verification by the nurse of the information given. There was close agreement between the informant's and the nurse's estimate of the number of bites.

Mosquito activity was measured during the summer by routine entomological means and the adult mosquito population decreased markedly in midsummer in the urban area because surface water decreased and control measures by the Kern Mosquito Abatement District were intensive. The mosquito population decreased less in the rural areas. These changes were reflected in the accounts of mosquito bites. The principal causes of urban-rural differences were the larger number of mosquitoes per person in the rural areas and factors such as occupation, housing, and self-protection affecting exposure.

The highest mosquito attack rates were in children under 5 years of age. Fewer infants below 6 months of age than the older children were bitten possibly because it would be easier for mothers to protect infants from attack.

It is open to question whether all the reported bites were mosquito bites. Trombiculid mites have been found in this area and could have inflicted some of the bites. Thirty-four percent of the 316 persons bitten during the summer and 43 percent of the bitten in the past 24-hour group said that they saw mosquitoes biting. The geographical location of the person when he was bitten, portion of the body, and the time of the day make it seem

probable that the bites were by mosquitoes rather than chigger mites or other blood-sucking arthropods. Finally, we may assume that both the informants and nurses had a fair degree of familiarity with the local arthropods and their characteristics. *Culex tarsalis* was the predominant mosquito in the area during most of the summer and readily bites man. The pattern of attack on the population clearly incriminates this mosquito as being involved in a high proportion of the cases recorded.

Of the 17 serologically confirmed cases of arthropod-borne encephalitis which were reported from Kern County during the summer, four were members of households included in the survey; two 3-month-old males and a 7-year-old male had western equine encephalitis, and a forty-three-year-old woman had St. Louis encephalitis. The households of the three western equine encephalitis patients were visited by the nurse after the onset of illness, for the completion of an epidemiologic history form. The mother of one of the 3-month-old children with western equine encephalitis told the nurse that both of her children (the diseased and a healthy sibling) had been bitten. The seven-year-old also was reported to have been bitten. The mother of the other infant patient said he had not been bitten. The visit to the home of the St. Louis encephalitis patient took place 11 days prior to the onset of the disease; although mosquitoes had been seen by the patient and she reported that her five children had been bitten, she denied having had any bites during the summer. Three of these four families reported using DDT spray and all reported having "adequate screening" on the windows and doors of their homes.

The value of future surveys would be increased by the including of more detailed questions in the questionnaire, obtaining more complete information, larger samples, and an equal sampling of rural and urban residents distributed evenly throughout the summer.

SUMMARY. During the summer of 1958 the nursing staff of the Kern County Health Department filled out questionnaires on the history of mosquito bites of residents of the area during their routine home and clinic visits. The answers provided data on the frequency and extent of mosquito bites experienced by 502 persons (242 households) under their ordinary living conditions.

Significantly more rural than urban residents were bitten. The percentage of persons bitten increased through the summer. The number of mosquito bites received during the 24 hours immediately preceding the interview was estimated by the informant and checked by the nurse and numbers given by these two were similar. More younger persons than adults were bitten and they had more bites each. Most persons were bitten outdoors in the evening. *Culex tarsalis,* known to be prevalent in the area, usually feeds in the evening.

*References Cited*

HESS, A. D. and QUINBY, G. E. 1956. A survey of the public health importance of pest mosquitoes in the Milk River Valley, Montana. Mosq. News 16(4):266–268.