

Dengue Hemorrhagic Fever (DHF) in Bangkok :
Correlation of Monthly Incidence Rates
with Total Yearly Incidence Rates

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OBJECTIVE : To correlate monthly incidence rates of DHF with total yearly incidence rates.

BACKGROUND : The peak incidence of reported cases of DHF in Bangkok regularly occurs during the rainy season, usually during the months of July, August, or September. The peak number of reported cases during a severe epidemic season may reach over 1000 cases per month and over 5000 cases for the entire year. Case incidence rates typically decline late in the rainy season and continue to decline during the cool season to reach a nadir usually during the subsequent February or March.

Total reported cases during a severe DHF year may be as much as ten fold greater than during a mild year, yet factors governing yearly incidence rates of DHF remain poorly understood. Although the temporal association of peak DHF incidence rates with the rainy season is self-evident, to date there has been no quantitative evidence that the amount of rain during the rainy season influences peak case rates. Other factors which may govern the severity of a given DHF season remain totally obscure.

Since the late 1950's records have been maintained of the number of cases of DHF occurring per month in the Bangkok-Thonburi metropolitan area by the Thai Ministry of Public Health.

In the early 1960's clear diagnostic criteria for DHF were established, and in April 1962 a highly efficient system of surveillance was also introduced.

With over 16 years of reliable monthly DHF incidence reports available to us, we sought to examine the data for evidence of an association between monthly and yearly incidence rates.

METHODS : The raw data used in this analysis came from files maintained in the Ministry of Public Health and is presented in Table I. Ministry data was incomplete for the 16 months, September 1964 through December 1965; for these months graphic records kept by our laboratory were the source of the number of cases reported per month.

To evaluate the data for correlations between monthly and yearly incidence rates, the monthly incidence rate for a given month was defined as the independent variable and the yearly incidence rate for that year as the dependent variable. For example, for each of sixteen March incidence rates set as independent variables (X_n), there was a corresponding yearly incidence rate set as a dependent variable (Y_n) (Figure A). A linear regression analysis was then performed,

and the y intercept (b), slope (m) and correlation coefficient (r) were computed. The same analysis was done for 8 months of the precedent year, 12 months of the index year, and 8 months the subsequent "DHF year."

RESULTS : Mean monthly case incidence rates for the years 1963-1978 are presented in Figure 1A, and the average ranking of the number of DHF cases per month is presented in Figure 1B. From both of these curves it can be seen that case incidence rates of DHF have a nadir in February or March; this was the basis for defining the "DHF-year" as beginning in March and ending in February.

As expected, the total number of cases of DHF during a given year was strongly associated with the case incidence rate during the peak months of that year. For example, the number of cases during a DHF year is plotted against the number of cases reported during the September of that year for the years 1962-1978 in Figure 2B. A correlation coefficient (r) of .942 ($p < .001$) is obtained. Correlation coefficients obtained by analysis of monthly vs "DHF year" yearly incidence rates for 8 months of the preceding year, the 12 months of the index year and 8 months of the subsequent year, are plotted by month in Figure III. A smooth curve is obtained with a positive slope first clearly detectable between October and February of the preceding DHF year. By March, the first month of the "DHF-year", there is already a significant ($p < .01$) correlation between the monthly and yearly incidence rates. It should be noted that the incidence rates in February and March have a much stronger correlation with the total number of cases in the year immediately following than immediately preceding these month. Restated, the case rates at the nadir of disease activity show a much stronger correlation with future, rather than past, peak incidence rates. Indeed, as far back as December, 3 months before the nadir of disease activity, case rates are more closely correlated with future, rather than past peak incidence rates, although p values do not reach the .05 level. Also, it should be noted that by the onset of the rainy season in May, the severity of the dengue season is largely determined ($r = .858$ for May vs $r = .931, .919,$ and $.944$ for June, July, August, respectively). The quantitative linear regression relationships between monthly and yearly DHF incidence rates for several months are presented in Table 2.

The main conclusions from this analysis are that severe DHF seasons can probably be predicted with reasonable certainty 4 to 6 months in advance of peak disease activity, and that at least some of the factors which govern the extent of disease activity during the rainy season are already well established during the preceding dry season. These factors remain as yet undetermined.

REFERENCE :

1. Halstead, S.B., Scanlon, J.E., Umpaivit, P., Udomsakdi, S., Dengue and Chikungunya Infection in Man in Thailand, 1962-1964. IV. Epidemiologic Studies in the Bangkok Metropolitan Area. Amer. J. Trop. Med. Hyg. 18:997-1021, 1969.

Table 1. Cases of DHF Hospitalized per Month, April 1962-Dec 1978 February 1979

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Calendar Year Total	"DHF Year" Total*
1962	(57)	(23)	(27)	64	228	649	973 ^P	905	582	429	214	34	4185	4134**
63	21	8 ^N	14	27	108	166	306 ^P	284	288	206	115	114	1657	1857
64	103 ^N	126	210	298	417	926	1035 ^P	815	790	400	205	85	5410	5286
65	70	35	40	45	80	95	175	215	365 ^P	335	320	365	2140	2469
66	213	221	220	209	194 ^N	380	537 ^P	496	254	166	67	89	3046	2706
67	62	32	20 ^N	31	84	68	105	103	131 ^P	110	56	32	834	825
68	55	30	10 ^N	12	26	65	112	132	217 ^P	195	179	129	1661	1354
69	146	131	86 ^N	90	100	164	280	389	439 ^P	225	116	33	2199	1952
70	23	7 ^N	11	10	16	56	84	78	106	111 ^P	55	20	577	571
71	12	12	9 ^N	20	42	75	159	185	223 ^P	188	111	56	1092	1180
72	63	49	53	42 ^N	99	187	303	428 ^P	337	306	284	144	2295	2385
73	112	90 ^N	114	112	110	185 ^P	144	163	122	165	136	56	1509	1342
74	19	16 ^N	17	26	43	85	98	175	192 ^P	181	141	75	1068	1171
75	78	60 ^N	86	103	130	258	433 ^P	386	302	267	210	73	2386	2291
76	27	16	23	26	50	80	115	212	216	244	266 ^P	166	1441	1595
77	99	98	90 ^N	123	136	461	516	658	794 ^P	643	327	186	4231	4259
78	189	136	63 ^N	74	89	109	149	182 ^P	174	83	81	53	1382	1100**

P = Peak of reported cases for DHF year

N = Nadia of reported cases for DHF year

() = Monthly number of reported cases used to complete yearly total but not used in month by month analysis

* Sum of number of monthly reported cases March through February of next calendar year (see text)

** Approximately value based in part on inexact or estimated monthly totals

Table II. Relationship Between Number of Cases in Month vs Total Number of Cases During Index Year

Month analyzed		r	N
Dec of preceding-DHF year	$y = 4.69 x + 1535$	.321	16
Jan of preceding-DHF year	$y = 6.05 x + 1533$	.292	16
Feb of preceding-DHF year	$y = 9.42 x + 1393$	.464	16
Mar of Index-DHF year	$y = 12.98 x + 1157$	.696	16
Apr of Index-DHF year	$y = 12.27 x + 1198$	.718	17
May of Index-DHF year	$y = 11.78 x + 793$	.858	17
Jun of Index-DHF year	$y = 5.07 x + 950$	.931	17

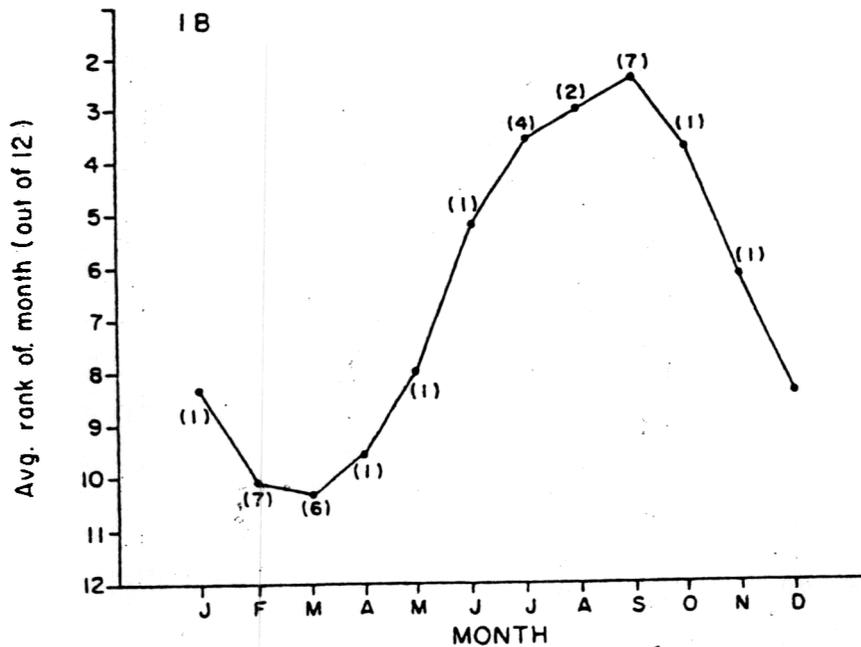
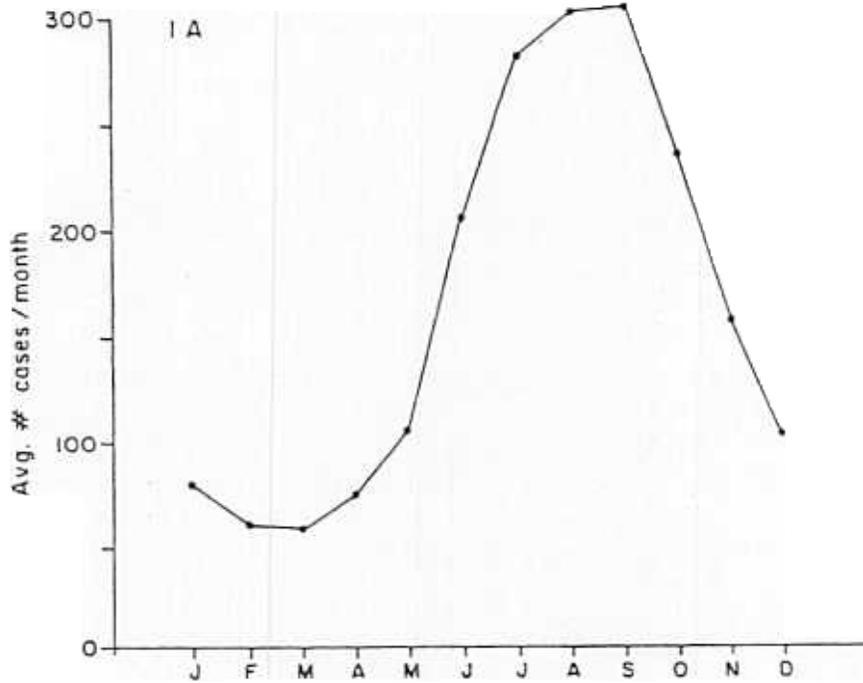


Figure 1. (A) Graph of mean number of hospitalized cases of DHF per month, 1963-1978. (B) Graph of mean rank per calendar year of each month. Numbers in parentheses below the line represent the number of years in which the specified month had the fewest number of cases of DHF; numbers in parentheses above the line represent the number of years in which the specified month had the greatest number of cases.

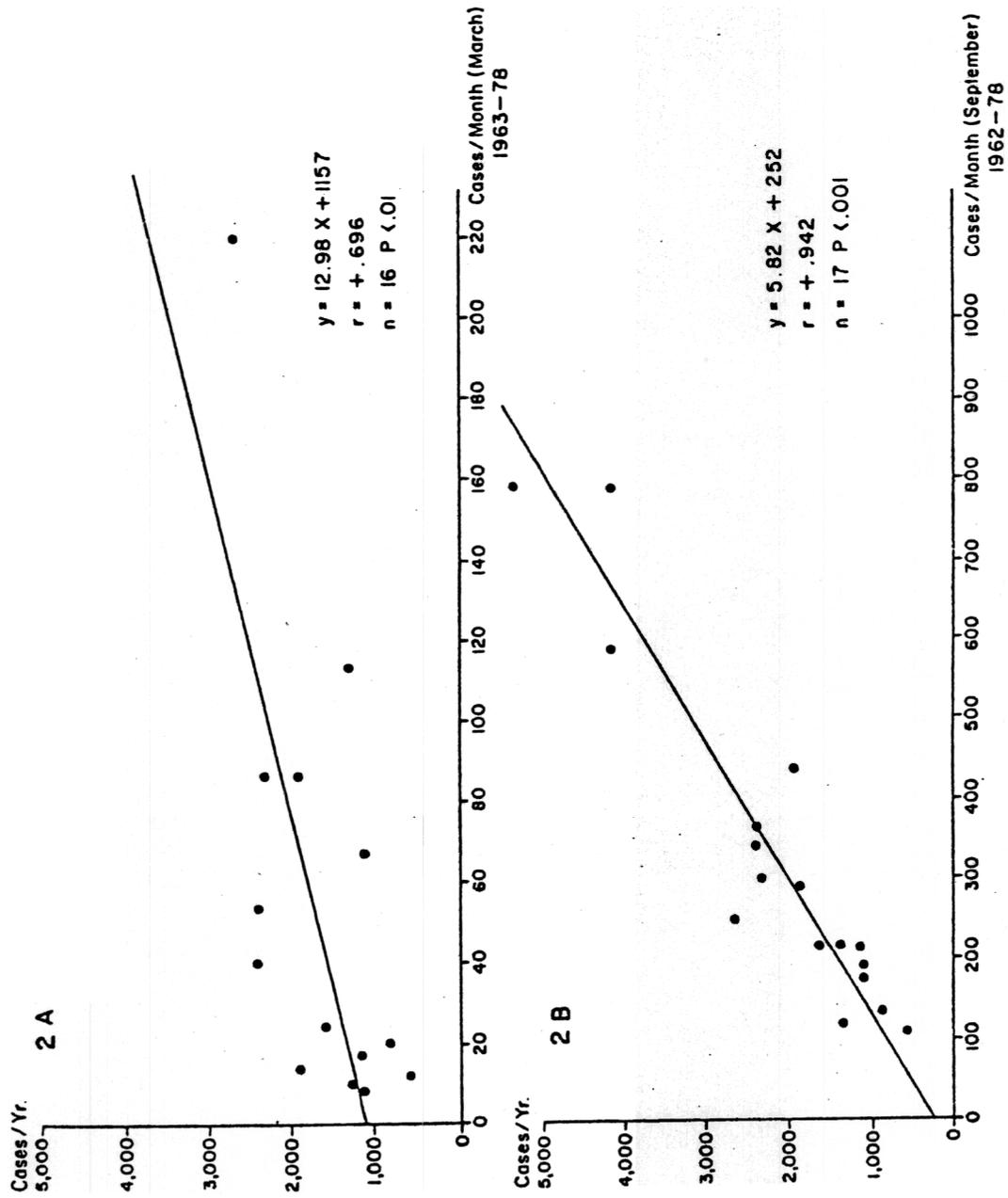


Figure 2. (A) Graph of number of cases of DHF reported each March, 1963-1978, versus the total number of cases reported that DHF year (B) Graph of number of cases of DHF reported each September, 1962-1978, versus the total number of cases reported that DHF year.

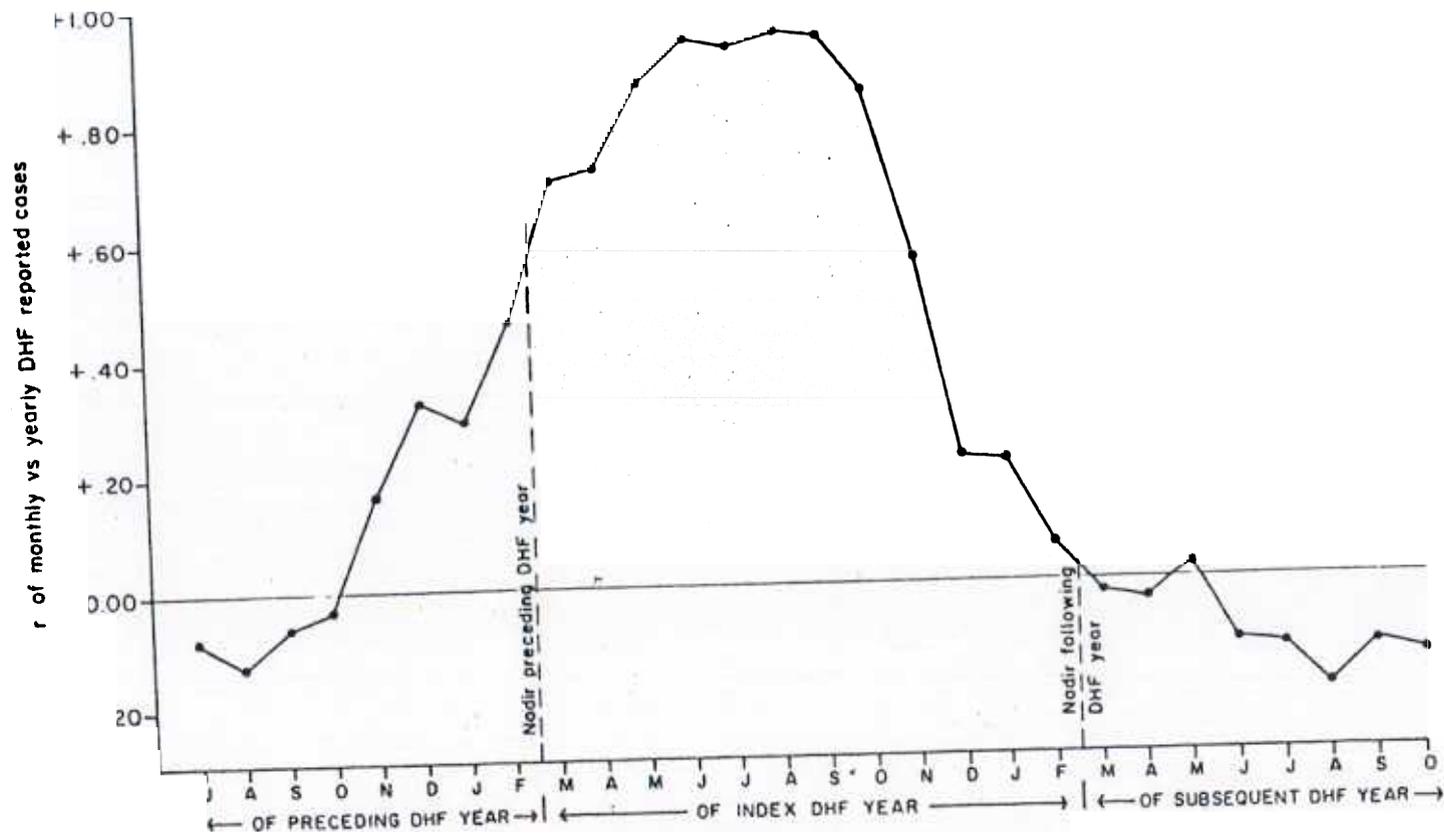


Figure 3. Graph of r (correlation coefficient) for the relationship of monthly reported DHF cases to annual total reported DHF cases.