NOTES ON CLIMATE AND MORBIDITY

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Opportunity was taken to study the morbidity of the more important groups of diseases affecting R.A.F. personnel with reference to the climatic conditions at Mingaladon, nr Rangoon, from February to July 1946. Temperature recordings (both wet and dry bulb), together with figures for humidity, were kindly provided by the Meteorological Forecast Centre at the station. The climatic conditions may be divided into two distinct periods: the pre-monsoon from mid-February to mid-May, and the monsoon itself which followed and continued throughout June and July.

Dry bulb. In the pre-monsoon period, the maximum dry-bulb temperature recorded was 103·5° F. with a mean of 96·5° F. and standard deviation 4·2° F. In the monsoon period the mean value of the maximum daily dry-bulb temperature was 10° lower and the degree of variation rather less than in the pre-monsoon.

Wet bulb. Daily temperature recordings (Fahrenheit scale) were taken at 23.59, 03.00, 06.00, 09.00, 12.00, 15.00 and 18.00 hr., and the mean of these seven figures was calculated for each day. In the pre-monsoon the mean of daily averages was 74·6° F. and standard deviation 3·01° F. In the monsoon the mean was 76·8° F., i.e. only 2·2° higher, but the degree of variation about the mean was considerably less. The mean wet-bulb temperature for each month rose slowly but steadily from 70 to 77° F. in the pre-monsoon; it remained almost constant throughout the monsoon.

Humidity. From the seven daily readings of wet and dry bulb, seven daily values were calculated for humidity. The average of the seven readings gives a measure of humidity for each day. This measure is considered more suitable, for the purposes of correlation with disease, than daily readings at a given time, because humidity varies widely within each 24 hr. In the pre-monsoon the mean of these daily averages was 68·6 % with wide variation (C.V. 13·4 %). In the monsoon the average humidity for each day remained persistently high (mean value 90·8 %) and the variation relatively small (C.V. 2·3 %).

Table 1. *Climatic conditions*

Dry bulb (maximum recorded daily)

Period	Range recorded lowest-highest	Mean S.E.	S.D.	C.V.
Pre-monsoon	82·0–103·5	96·54 ± 0·44	4·2	4·35 %
Monsoon	79·0– 93·0	86·45 ± 0·33	2·92	3·38 %

Wet bulb (average of seven daily readings)

Period	Range recorded lowest-highest	Mean S.E.	S.D.	C.V.
Pre-monsoon	65·4–78·6	74·65 ± 0·32	3·01	4·03 %
Monsoon	74·7–78·6	76·87 ± 0·11	0·95	1·24 %

Humidity (average of seven daily readings)

Period	Range recorded lowest-highest	Mean S.E.	S.D.	C.V.
Pre-monsoon	45–95·5	68·55 ± 0·97	9·22	13·44 %
Monsoon	78–97	90·87 ± 0·24	2·07	2·28 %

Pre-monsoon: 15 Feb.–14 May 1946; Monsoon: 15 May–31 July 1946.
S.E. standard error, S.D. standard deviation, C.V. coefficient of variation.

SUMMARY OF CLIMATIC CONDITIONS

In the pre-monsoon period the dry bulb was relatively high and humidity low at least for several hours each day; later, in the monsoon, humidity was high, approaching complete saturation for much longer periods each day, but the dry-bulb temperature averaged 10° less.

METHOD OF STUDY

It seemed worth while to plot the admission rates of important diseases against this background. In the case of skin diseases because only a small proportion

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Table 2. *Admissions compared in monsoon and pre-monsoon*

	Actual no.	Expected no. on pre-monsoon data	Difference	Difference / S.E.
Medical admissions	231	196	+35	2·50
Skin diseases	47	34	+13	2·23
Respiratory diseases	34	50	−16	2·26
Bacillary dysentery and acute enteritis	95	26	+69	13·53
Amoebic dysentery	29	36	− 7	1·17
Dengue and short-term P.U.O.	17	15	+ 2	0·52
Remainder	11	36	−25	4·17

S.E. standard error.

require admission, morbidity was also measured by the number of out-patient attendances. This has the disadvantage that it does not distinguish the number of new cases from the number of attendances required in the treatment of each case. Clearly no great significance should be attached to the records of but one season; nevertheless, the results hold some interest, and may suggest the extension of this method by those now in a position to do so.

The diseases were grouped as follows:

(1) Those of the skin directly exposed to the meteorological conditions measured.

(2) Those with direct access anatomically to the meteorological environment: (*a*) respiratory diseases (*b*) alimentary diseases.

(3) Others.

Results are given in Table 2, where the actual number of admissions caused by various diseases during the monsoon is compared with the number to be expected from the pre-monsoon. It will be seen that the most significant increase during the monsoon occurred in the group comprising bacillary dysentery and acute enteritis. The increase in admissions during the same period for skin disorder and the decrease for respiratory disorder are probably significant.

The total population at risk (based on weekly statements of ration strength) averaged 3582 during the pre-monsoon; during the monsoon the average population was 2038.

Skin diseases

In Table 3 the daily rates of out-patient attendance for skin disorder are compared during pre-monsoon and monsoon periods and the proportionate increase calculated.

(*a*) *Influence of temperature.* The total out-patient attendances for skin diseases was higher in the monsoon period than in the pre-monsoon. Pyogenic and fungoidal diseases were next grouped separately, and a two- to threefold rise in morbidity occurred in each. Taken separately tinea pedis, tinea cruris and fungus infections of other skin areas showed the same rate of increase. The rate for impetigo followed that of other infections. External otitis was the only exception; the increase was here less than double.

Since the increased morbidity rates occurred at a time when the dry-bulb temperature was falling, it is fair to disregard the effect of temperature *per se* on morbidity in the range of conditions under consideration. It appears that its effect is at least more than compensated for by some other factor.

Table 3. *Out-patient attendances for skin disorders*

Daily rate for 10,000 population

	Pre-monsoon (A)	Monsoon (B)	Ratio B/A × 100
Total attendances	20·39	40·23	197
Fungus diseases	6·19	14·69	237
Pyogenic diseases	6·31	14·97	237
Impetigo	1·52	3·71	244
External otitis	3·85	5·60	145

(*b*) *Influence of wet-bulb temperature and humidity* (see Table 4). From Table 4 it is interesting to note that during February, March and April (pre-monsoon months) the rate of skin out-patient attendances rose each month; the mean monthly wet-bulb temperature also rose, but the mean monthly humidity remained steady. In the monsoon months, June and July, however, skin morbidity continued to increase, in fact the rise was sharper, although climatic conditions were reversed in that the wet-bulb temperature remained constant and a striking change occurred in humidity, the atmosphere being more nearly saturated with water vapour for longer hours each day. It therefore appears that both wet-bulb temperature and persistent high humidity may separately influence morbidity, although there is no proof available from the data presented that either or both are the actual causes.

In the monsoon when humidity was persistently high it was observed that scabbing did not succeed the sticky exudate of serum that formed over a lesion, and that this was frequently brushed away allowing opportunity for renewed infection. Such an effect may cause increased morbidity while the

wet-bulb temperature remains constant, in this case at about 76° F. It is not, however, the whole story, because it is still necessary to account for the rise in skin morbidity in the pre-monsoon months when the mean monthly humidity remained constant at about 67° F. Further evidence is required to settle the relationship.

Locally applied dry heat, sufficient to cause capillary vasodilatation, was found to have a useful place in the treatment of septic infections of the extremities; in addition to the local capillary congestion which it produces, it may also be the means of allowing a protective scab to form. The incidence of otitis externa after bathing, which is usually followed by incomplete drying of the external auditory meatus, also lends some support to the view that persistent high humidity interferes with the normal skin process. *Prickly heat*, irritating as it could be, did not usually lead to attendance at sick parade unless complicated by sepsis. Out-patient figures are therefore not a measure of its incidence. It started most commonly during the 'sticky' pre-monsoon period, was experienced in some degree by most people, continued throughout the monsoon with a tendency to improve as the temperature fell and worsened in the 'sticky' weeks following the monsoon. It was relieved completely by transfer of the patients to a cooler zone. Transfer to a drier zone was successful provided that the temperature was not so high as to cause sweat to form in excess of evaporation and so to remain in contact with the skin. In very dry regions with a temperature in the shade as high as 105° F., direct exposure to sunlight seemed even beneficial.

Table 4. *Wet-bulb, humidity and monthly skin out-patient attendances*

Month	Feb.	Mar.	Apr.	May	June	July
Wet bulb ° F. Mean of daily averages for month	70·1	73·8	75·2	77·1	76·9	76·6
Humidity % Mean of daily averages for month	66·8	67·8	65·5	83·9	90·8	91·7
Skin out-patient attendances per 1000 population (Corrected to months of 30 days)	45	60	71	85	117	152

Respiratory diseases (see Table 3)

Respiratory infections were at a maximum in March. It has often been suggested that diminished resistance of the individual to bacterial invasion may occur during the monsoon period. The present data do not confirm this belief because the incidence of respiratory diseases was lowest during this particular period. Possibly the supposed relationship was nullified by the presence of other factors, and of these the allaying of dust may be an important one. Bronchial asthma was usually aggravated when humidity was high, and relieved by transfer of the patients to a rather drier zone. Here the dominant factor is more likely to be autonomic instability than infection.

Alimentary diseases

The highest daily admission rate (16 per 10,000 population) for all medical cases was recorded in July and was accounted for by an outbreak of dysenteric disorders. Bacillary dysentery and other forms of acute diarrhoea without a recognized bacillary exudate declined from a daily rate of 7 in June to 5 per 10,000 population in July, but an increase in amoebic dysentery offset this decline. The onset of the dysenteric outbreak was in May when a most pronounced rise in humidity took place, although the wet-bulb temperature altered little.

The daily admission rate of amoebic dysentery was highest in July, being 3 per 10,000 population, and the incidence in April and July was higher than in the intervening period. No immediate relationship to climate was apparent, but a delayed effect is a possibility 8 weeks after the outbreak of bacillary dysentery. Its importance as a cause of morbidity lies in the long hospitalization considered necessary in its treatment (at least 28 days followed by convalescence at a special depot.)

Other diseases

Malaria might have been expected to show a seasonal variation, but this did not happen. At Mingaladon primary malaria was certainly uncommon, if indeed it occurred. Of the small total of ten proven cases of malaria seen in the 6 months, all were benign tertian infections and the majority had a history of previous attacks.

Sprue which had been common in 1945 (e.g. thirteen cases were admitted in August 1945) died out steadily in the last 5 months of that year. In 1946 only two examples were seen, these in June and July.

Infective hepatitis showed a similar trend, although odd cases continued to appear from January to July 1946.

The decrease in morbidity of these two important diseases gave rise to much speculation. A close relation to climatic conditions seemed unlikely. More

probable explanations may be found in the natural end of an epidemic in both cases, or in the case of sprue possibly the early use of sulphaguanidine in the treatment of diarrhoea, a policy which became general in June 1945.

If the in-patient morbidity due to skin disorders and respiratory diseases, to the dysenteries and other forms of acute diarrhoea is subtracted from the total morbidity, the daily admission rate of the remainder to hospital was less than 2·0 per 10,000 population.

DISCUSSION AND CONCLUSIONS

In tropical zones where climatic conditions approach the limits of human tolerance, an understanding of the relation of morbidity to such factors as temperature and humidity is important. If, for example, humidity has in fact the importance suggested by these notes in hindering the process of skin repair, the treatment of skin lesions should aim, as soon as the original infection is controlled with such aids as saline baths and penicillin, at the early application of a dry aseptic absorbent-fixed dressing protected from the atmosphere, and secondly at leaving this dressing in place at least until a dry scab has formed. Dry heat applied locally by hot-water bottle or radiant-heat cradle to lesions of the extremities may help to achieve this. In humid surroundings, to produce a drying draught nothing less vigorous than an electric fan is likely to succeed—and it may be noted that punkahs, which are effective in a dry zone, were not seen in humid zones. Ointments prevent the formation of a dry scab and powders (including talcum powder) are hygroscopic, soon becoming saturated, after which more harm than good is likely to result from their application. Both are likely to be less satisfactory than spirit, cleansing or astringent lotions, and in practice this was the impression gained. If efficient laundries are provided they may justify themselves on grounds of cleanliness when compared with cold-water dhobie, but the more complete destruction of fungi will not be followed by a prompt decrease in morbidity, if the chief cause of morbidity lies in the effect of a saturated humid atmosphere on skin repair. The establishment of a skin out-patient department linked to the skin ward and under the care of the same medical officer and nursing sister, enables continuity in principle and treatment to be obtained. This appeared to be the most successful single measure undertaken to reduce the morbidity of skin disease.

The results obtained by this preliminary study of morbidity in relation to climatic conditions suggest that it might be repeated with profit for the purpose of confirmation. If the deleterious effect of persistent high humidity on skin repair should be established, extension of this method of study might be contemplated to other tropical zones, and also to investigation of morbidity in certain industrial populations, particularly those exposed to high humid and dry temperatures. In temperate zones seasonal atmospheric changes may be quite considerable, yet published studies of their influence on morbidity are uncommon. Their bearing on accident rates, suitability of clothing, bath facilities, the best forms of air conditioning and methods of treatment to be prescribed, adds an interest to such findings which reaches beyond the limits of topographical knowledge.

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