METEOROLOGICAL FACTORS AND PRE-ECLAMPSIA

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SYNOPSIS

The incidence of pre-eclampsia for the different months in 1983 was calculated taking into account the number of antenatal clinic attendances for each month.

A total of 389 cases were studied, giving a crude incidence of 5.5 per cent for 1983. The incidence for each month was correlated with various weather factors and statistical tests applied.

The onset of pre-eclampsia seemed more common on hot, dry sunny months prior to a major change in weather.

A selected review of the literature over 140 years showed considerable disagreement as to the relation between weather factors and the onset of eclampsia.

A hypothesis using current concepts in the etiology of the disease was forwarded to explain the findings.

The results obtained may be of value in fertility counselling.

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INTRODUCTION

Pre-eclampsia is a major contributor to maternal morbidity in Singapore. In 1983, in the B unit a crude incidence rate of 5.5 per cent for all pregnant women established pre-eclampsia as the commonest medical disorder in pregnancy.

Furthermore, in 1982, 40 per cent of the maternal mortality was attributable to eclampsia which is a possible sequelae of a poorly-controlled pre-eclamptic state.

AIM

Since the eighteenth century, there has been a general impression that there is an association between pre-eclampsia and the weather. A review of the literature showed a good deal of disagreement as to the specific climatic factors involved.

In the B unit of the Kandang Kerbau Hospital for Women in Singapore, we have noted a distinct periodicity of the disease throughout the 12 months of the year. Hence this study was undertaken to see if a correlation between the incidence of pre-eclampsia and climatic factors could be found.

PATIENTS AND METHODS

For the purpose of this study, pre-eclampsia is defined as a blood pressure of 130 millimetres of mercury systolic or 90 millimetres of mercury diastolic or greater; or a rise of 30 millimetres of mercury systolic and 15 millimetres of mercury diastolic above the patient's pre-pregnancy blood pressure, in a pregnant woman after the 20th week of gestation with proteinuria and/or oedema.

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All patients with a previous history of renal disease or hypertension on medication were excluded from the study.

From the period 1 January 1983 to 31 December 1983, the 389 cases of pre-eclampsia were identified from the labour records and ward admission books and each case sheet analysed so that only confirmed cases of pre-eclampsia were included in the study.

Patients with pre-eclampsia who were referred by general practitioners for management of the disease were excluded from the analysis as the study population was the antenatal clinic patients.

For each patient with pre-eclampsia, the date during the antenatal course at which the diagnosis of pre-eclampsia was first made was recorded.

The incidence of pre-eclampsia for each month was then calculated by dividing the total number of cases of pre-eclampsia diagnosed during the month by the total number of antenatal clinic attendances for the month.

Data on the mean barometric pressure, maximum, mean and minimum temperature, mean dew-point, mean relative humidity, mean amount of cloud, total sunshine, total rainfall and mean wind velocities for the various months of 1983 were obtained per kind permission of the Director of Meteorological Services, Singapore Changi Airport.

The incidence rate for each month was then correlated with the monthly values for the climatic factors mentioned above and the Coefficient of Correlation calculated.

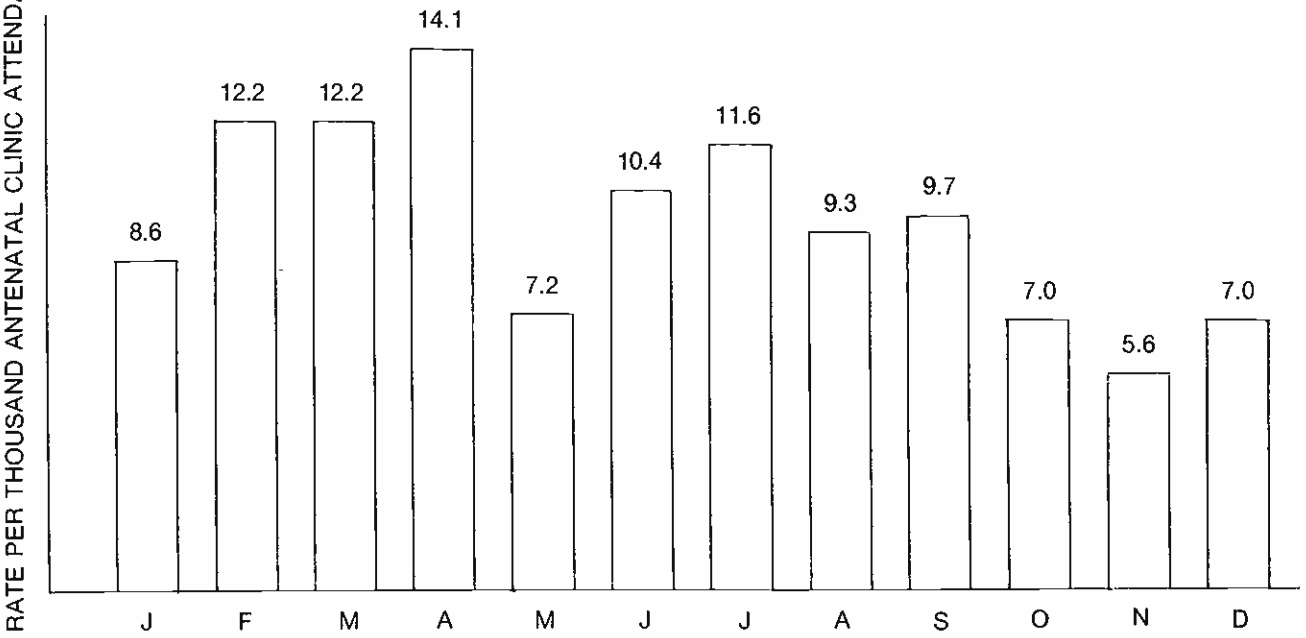
The influence of parity or period of gestation on the monthly incidence of pre-eclampsia was considered and found to be insignificant.

RESULTS

The highest incidences of pre-eclampsia occurred in February, March and April (12.2, 12.2 and 14.1 per thousand antenatal clinic attendances respectively) (See Figure 1).

The lowest incidences were in the months October, November and December (6.9, 5.2 and 6.9 per thousand antenatal clinic attendances respectively) (See Figure 1).

Fig. 1 Incidence of pre-eclampsia in 1983



CLIMATIC FACTORS (See Table 1)

Maximum Temperature (Degree Centigrade)

February, March and April were the hottest months of 1983 with the highest maximum temperatures.

Mean Temperature (Degree Centigrade)

The mean monthly temperatures for 1983 ran parallel to the maximum temperatures for the year. February, March and April were the hottest months and November, December and January the coolest.

There was a distinct correlation between the incidence of pre-eclampsia and high temperatures.

The coefficient of correlation calculated for maximum and mean monthly temperatures were both 0.717 which was statistically significant ($t = 3.25$, $0.01 p 0.001$).

Barometric Pressure

The mean barometric pressure fluctuated slightly throughout 1983 with a range of 3.6 millimetres of mercury.

January, February and March had the highest pressures and May, June and July the lowest pressures.

Mean Dew Point, Mean Amount of Cloud

April, May and June had the highest mean dew points and January, February and March the lowest mean dew points.

November, December and January were the cloud-

TABLE 1
WEATHER DATA FOR 1983

	Mean Pressure mbs	Mean Temp C	Mean Dew Point C	Mean Rel Humid %	Mean Amt of Cloud %	Total Sunshine hrs	Total Rainfall mm
1983							
Jan	1012.1	26.4	23.7	85.5	85.5	4.26	246.0
Feb	1011.9	28.3	23.6	78.0	64.4	9.32	5.6
Mar	1011.3	28.9	23.9	76.0	65.0	8.85	18.6
Apr	1009.7	29.4	24.7	77.3	82.9	6.62	33.6
May	1008.5	28.3	25.0	83.2	80.7	5.92	160.8
Jun	1008.7	28.3	24.9	82.4	80.1	5.94	94.0
Jul	1008.9	27.6	24.5	83.7	82.5	5.41	190.0
Aug	1009.3	28.1	24.5	81.3	79.9	6.26	262.2
Sep	1009.9	27.2	24.2	84.4	85.8	3.85	170.8
Oct	1009.2	27.6	24.2	82.5	82.7	5.17	212.7
Nov	1010.0	26.6	23.8	85.2	88.4	3.19	228.8
Dec	1010.7	26.2	23.9	87.7	86.5	3.33	494.1

iest months and February, March and August the months with the least cloud cover.

There was no statistically significant correlation between the incidence of pre-eclampsia and the mean pressure, mean dew-points and mean amount of cloud for the months of 1983.

Total Sunshine, Wind Velocity

The sunniest months of the year were February, March and April with September November and December as the months with the least sunshine.

January, February and March were the windiest months of the year and May, October and November the months that were most still.

There was a significant correlation between the incidence of pre-eclampsia and sunshine and wind velocity (t = 3.15, p 0.05 and t = 2.5 p 0.05 respectively).

Mean Realtive Humidity

February, March and April were the driest months of the year and November, December and January the most humid.

There was a very significant inverse correlation between the incidence of mild pre-eclampsia and the mean relative humidity for 1983 (t = 3.71 0.01 p 0.001).

Total Rainfall

The wettest months of 1983 were January, August and December and February, March and April as the months with the least rainfall.

The Coefficient of Correlation showed an inverse relationship between the incidence of pre-eclampsia and the amount of rainfall (t = 3.07 p 0.05).

TABLE 2

Correlation of incidence of pre-eclampsia and:		
— maximum temperature	= 0.717	t = 3.25**
— mean temperature	= 0.717	t = 3.25**
— minimum temperature	= 0.699	t = 3.09*
— total sunshine	= 0.706	t = 3.15*
— wind velocity	= 0.622	t = 2.5 *
— mean pressure	= 0.037	t = 0.117 ns
— mean dew point	= 0.153	t = 0.49 ns
— mean amount of cloud	= −0.564	t = 2.16 ns
— mean relative humidity	= 0.761	= 3.71**
— total rainfall	= −0.696	t = 3.07*

**0.001 p 0.01 *0.01 p 0.05

DISCUSSION

In the study, the incidence of pre-eclampsia was high in February, March and April. These were the months with the highest temperatures, the lowest humidity and the most sunshine and they followed the period of the North East Monsoon in November, December and January. A low incidence of mild pre-eclampsia was noted for the months of October, November and December which were the cooler months with higher humidity and less sunshine.

A review of the literature revealed that although many authors noticed a seasonable variation in the incidence of eclampsia, there is no unified belief as to the effect of the different meteorological factors on the incidence of the disease.

A summary is presented below.

We have found that the incidence of pre-eclampsia was higher in the hot, dry, sunny months.

In support of our findings, Quillan et al(1) in their study on the incidence of pre-eclampsia among Kampuchean refugees in Thailand found a raised incidence of the disease in the months of November through March which is the dry season prior to the wet months of June to September.

Oppenheimer of Germany using daily weather data found an association between the incidence of eclampsia and warm months.

Also, Tottenham(8) of Hongkong, an island like Singapore, using monthly weather data, likewise found an association with hot weather.

Dieckmann(3) of the United States of America using yearly weather data, found a weak association with warm yearly temperatures.

Mitra of Calcutta found a raised incidence of eclampsia following cool humid weather three months prior.

This is similar to the local pattern where a raised incidence of the disease was present in the hot, dry sunny months in February, March and April, three months after the North East monsoons which resulted in the months of November, December and January being cool and wet.

A unified hypothesis to explain our findings using currents concepts in the aetiology of pre-eclampsia is given below.

On hot dry sunny days, increased sweating and insensitive water loss would lead to a decrease in the plasma volume. Gallery(9) and Maclean(10) have found that a reduction in plasma volume is associated with pre-eclampsia.

The decrease in plasma volume could in turn lead to a decrease in the uteroplacental circulation, causing placental damage. Studd(11) and Scanlon(12) found a considerable reduction in blood flow through the uterine spiral arteries into the intervillous space in cases of pre-eclampsia, which resulted in obliterative fibrinoid necrosis and acute arteritis with intravascular thrombosis in the spiral arteries.

Placental damage in turn leads to the release of thromboplastins and a low grade of disseminated intravascular coagulation. Mac Gillivray(13) found that disseminated intravascular coagulation, increased fibrin deposition and fibrinolysis played an important role in the pathogenesis of pre-eclampsia.

The sequel to disseminated intravascular coagulation and fibrin deposition is glomerular endothelial lesions, resulting in glomerular hypoperfusion. Gatzek (14) and Gallery(15) found that glomerular hypoperfusion causes the juxta-glomerular apparatus to secrete more renin which leads to increased levels of angiotensin II, vasoconstriction and hypertension.

Furthermore, Symonds(16) proposed that a reduced glomerular filtration rate would lead to sodium retention and an intracellular sodium shift which in turn results in a further reduction in plasma volume.

TABLE 3
CHARACTERISTICS OF PREVIOUS STUDIES

	Authors	Place	Number of cases	Conclusions about type of weather associated with eclampsia
1.	Arnell	New Orleans	142	Cool, humid (2)
2.	Bowles	Honolulu	44	Concludes no association with "Kona" hot spells, data suggest protective effect
3.	Brezowsky and Dietel	Germany	668+	Sunny and cold fronts
4.	Das	Calcutta	101	None, Data suggest cool, dry weather
5.	Dieckmann	U.S.A.	City rates	Found weak association between reported eclampsia rates and warm, average yearly temperature (3)
6.	Eufinger and Weikersheimer	Germany	38	Frontal change
7.	Frazer	Madras	None	Monsoon rains
8.	Fuerstner and Sargent	Chicago	46	Cold fronts (4)
9.	Griswold and Cavanagh	Miami	40	Low barometric pressure (5)
10.	Hoenhorst	Germany	340	Fluctuations in temperature and pressure
11.	Hoffstrom	Sweden	240	No relation
12.	Jacobs	Middle Europe	668	Cold fronts
13.	Konrad	Germany	13	Cold — damp
14.	Lever	London	14	None
15.	Louros and Panagiotou	Greece	32	Any weather change
16.	Mitra	Calcutta Madras Bombay	1041	Cool, humid three months before
17.	Mitra and Ghosh	Calcutta	541	Cool — damp
18.	Oppenheimer	Germany	169	Warm months
19.	Sapeika	South Africa	68	No relation (6)
20.	Schlichting	Germany	262	Cold moist, summer weather
21.	Setzer	Germany	129	Cold fronts and humidity
22.	Su Y. S. and Chiu S. J.	Taiwan	168	Change in weather (7)
23.	Tottenham	Hongkong	97	Hot weather (8)
24.	Von Heuss	Germany	1700	Cold fronts
25.	Von Latzka	Hungary	173	Cold fronts

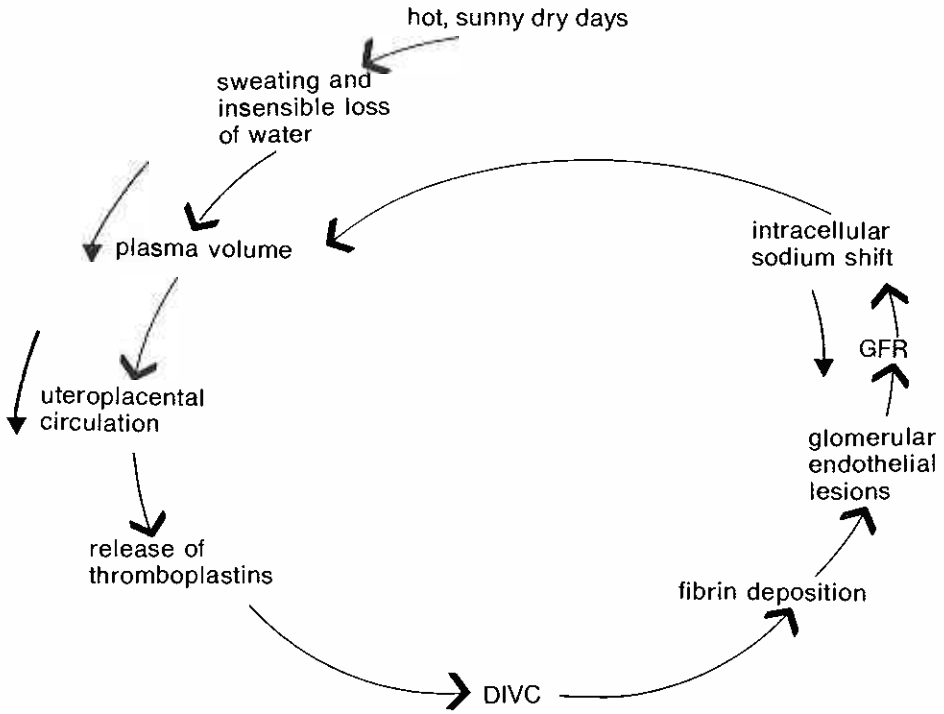


Fig. 2 Pathophysiology

The pathophysiology of pre-eclampsia precipitated by hot day, sunny weather is summarized in Figure 2.

The contrary view is held by some investigators who found an association between the incidence of eclampsia and cool wet weather. Arnell(2) reported an association between the disease and cool, humid days and Setzer that of cold fronts and high humidity. Their findings were supported by Mitra and Ghosh who found a correlation between the incidence of eclampsia and cool, damp weather.

Su(7) forwarded the theory that high humidity and low temperatures reduce perspiration from the skin, cause slow evaporation of waste products in perspiration and increases water retention. Agobe(17) believed that cool wet weather decreases transpirational water loss from the lungs, again causing water retention. Both these authors believe that the resultant change in fluid and electrolyte balance, in particular sodium, may cause eclampsia in a susceptible woman.

All being said and done, it is obvious that the last word has not been said about the aetiology of this disease.

SUMMARY

The incidence of pre-eclampsia is higher in the hot, dry sunny months prior to a major change in weather.

Haemodynamic and renal factors may play an important role in the aetiology of the disease.

The findings may be useful in fertility counselling. Perhaps we can advise would-be mothers to conceive in the wetter, cooler months of the year?

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