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The Response of Blood Pressure in the Sitting Position to Humid Heat*

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The experimental study was designed to elucidate the response of blood pressure in the sitting position to humid heat for the purpose of determining the permissible limit of environmental heat. The upper permissible limit of humid heat seemed to be around 33°C wet bulb and yet around 95°F effective temperature.

In 1945 and 1946 EICHNA et al.⁵⁾ and AIZAWA¹⁾ respectively reported that men, exposed to such humid heat as 33°C wet bulb or more, might be subjected to heat stroke. But little work has been done to study this problem from the viewpoint of the response of blood pressure to humid heat, classified into the various levels of wet bulb temperature.

In the previous paper²⁾, the authors reported the response of blood pressure with the subjects in the supine position to humid heat. The present paper described the response of blood pressure with the subjects in the sitting position to humid heat.

METHODS

The subjects were 3 students in good physical condition, aged from 19 to 23 years. The experiments were conducted in August 1964. After 30 minutes' rest in the ordinary room temperature, the subjects were exposed to humid heat in the climatic room for 90 to 150 minutes. The levels of environmental heat were classified into the three groups of 30°-31°C, 33°-34°C and 36°-37°C wet bulb temperature. The details of

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the environmental heat for each exposure were shown in Figures 1-5 in which the experimental data were described.

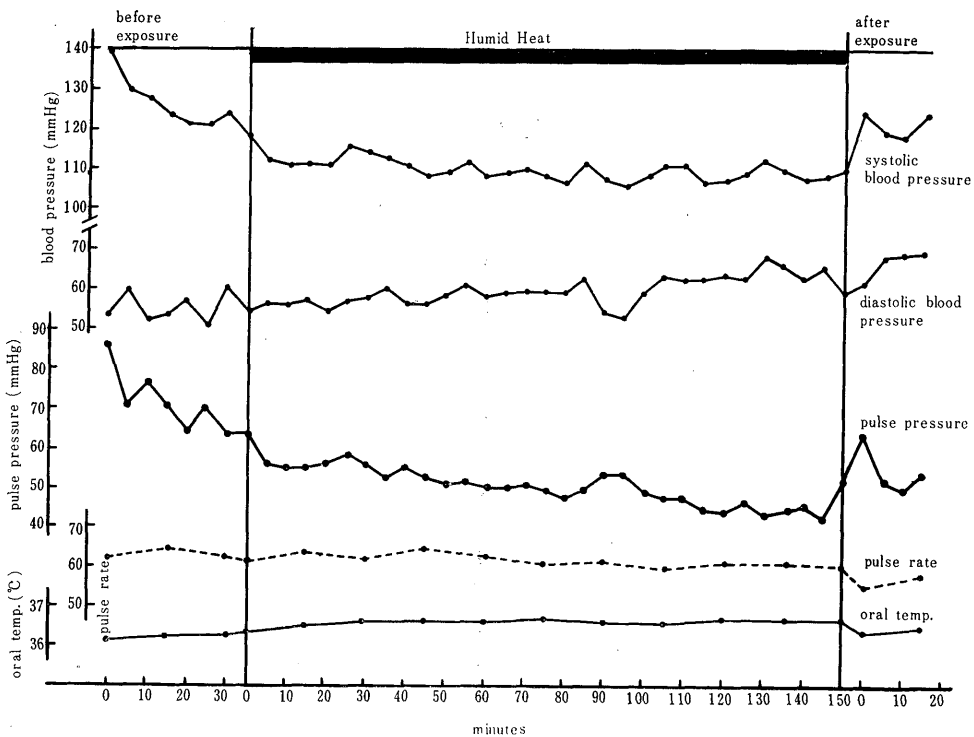
The blood pressure, oral temperature, pulse rate, rate of sweating (represented by the loss of body weight during the exposure to heat) and general clinical appearance were adopted as the measuring items. The details were described in the previous paper²⁾.

RESULTS

1) 30°-31°C wet bulb temperature (Fig. 1-2)

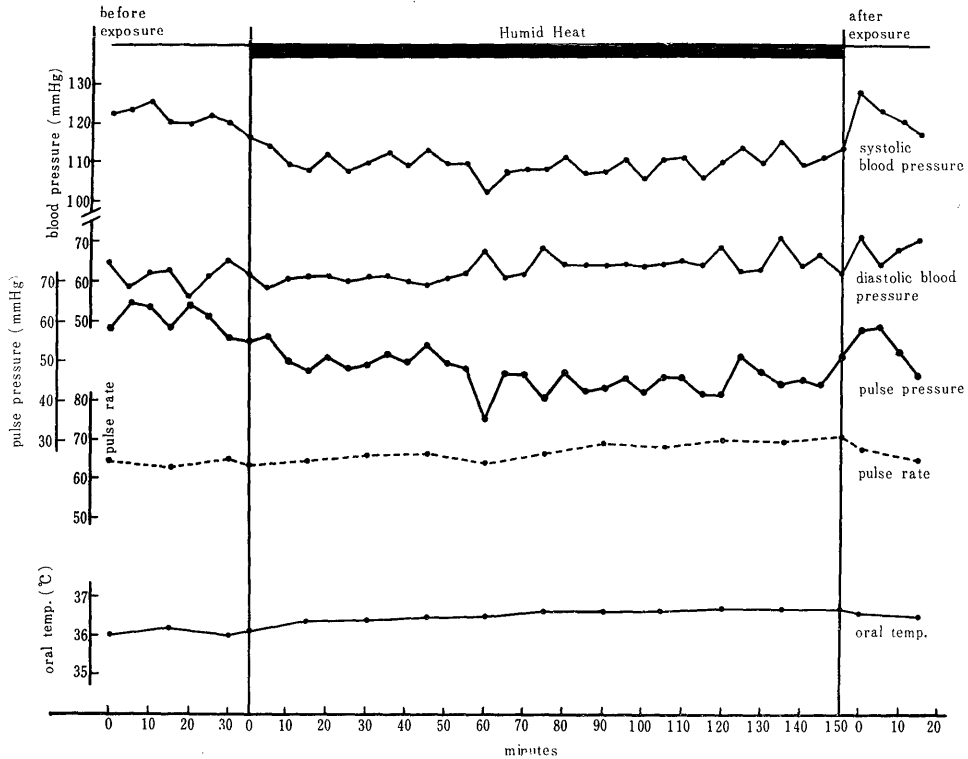
In the cases of 33° or 43°C dry bulb (respectively 88° or 93°F effective temp.), the physiological reactions remained almost unchanged, excepting the slight fall of systolic blood pressure with the slight fall of pulse pressure, slight increase of pulse rate and slight rise of oral temperature through 150 minutes' exposure to heat. The losses of body weight respectively were only 207 or 367 gm. per hr.

Fig. 1. Influence of Humid Heat (W. B. 30°-31°C) on Subjects



Note : (1) before exposure (D. B. 29.0°C, W. B. 26.0°C, E. T. 81°F)
 Humid Heat (D. B. 33.5°C, W. B. 30.1°C, E. T. 88°F)
 after exposure (D. B. 29.1°C, W. B. 26.0°C, E. T. 81°F)
 (2) Loss of Body Weight 517gm. (207gm. per hr.)

Fig. 2. Influence of Humid Heat (W.B. 30°–31°C) on Subjects



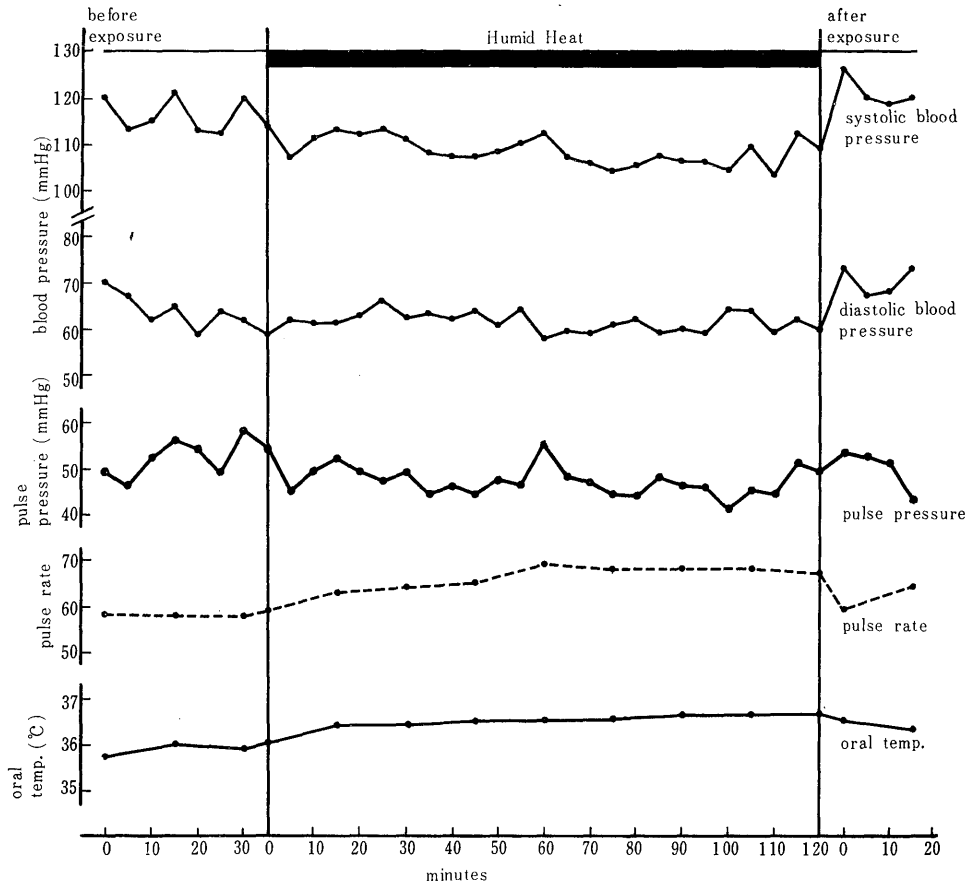
- Note : (1) before exposure (D.B. 28.9°C, W.B. 26.5°C, E.T. 81°F)
 Humid Heat (D.B. 43.0°C, W.B. 31.3°C, E.T. 93°F)
 after exposure (D.B. 29.2°C, W.B. 26.9°C, E.T. 82°F)
 (2) Loss of Body Weight 917gm. (367gm. per hr.)

2) 33°–34°C wet bulb temperature (Fig. 3–4)

In the case of 35°C dry bulb (93°F effective temp.), the blood pressure remained almost unchanged, and the loss of body weight was only 242 gm. per hr.

In the case of 43°C dry bulb (96°F effective temp.), the response of blood pressure to humid heat seemed to be fairly different from the above results. After the initial fall, the systolic and diastolic blood pressures remained almost unchanged for the some 100 minutes' exposure. But the systolic blood pressure began to rise gradually after 120 minutes' exposure. At the same time the diastolic blood pressure at a steady state rapidly turned to a fall, and the pulse pressure, maintaining a steady state, showed a rapid increase. And then, the subjects complained but of being very hot. The pulse rate steadily increased, the oral temperature remained at a steady state after 90 minutes' exposure. The loss of body weight amounted to 605 gm. per hr.

Fig. 3. Influence of Humid Heat (W.B. 33°-34°C) on Subjects

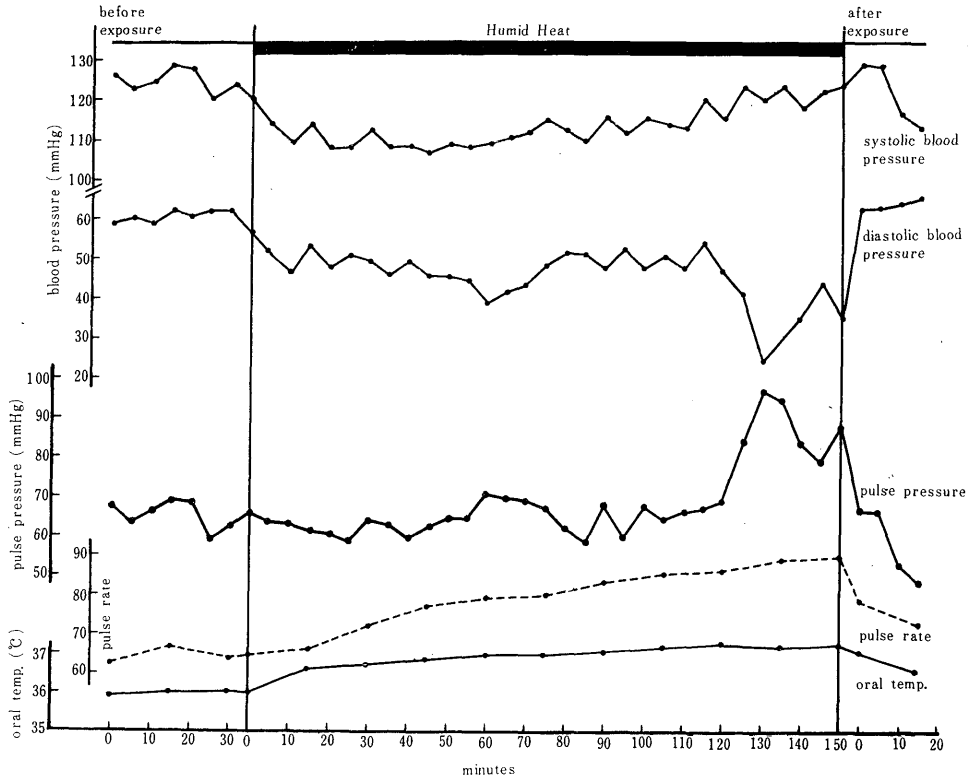


Note : (1) before exposure (D.B. 29.2°C, W.B. 26.8°C, E.T. 82°F)
 Humid Heat (D.B. 35.4°C, W.B. 33.4°C, E.T. 93°F)
 after exposure (D.B. 29.4°C, W.B. 26.4°C, E.T. 82°F)
 (2) Loss of Body Weight 483gm. (242gm. per hr.)

3) 36°-37°C wet bulb temperature (99°F effective temp.) (Fig. 5)

After the initial fall, the systolic blood pressure showed a slight fluctuation through the exposure. The diastolic blood pressure fell considerably after 30 minutes' exposure and, as recorded at the fifth phase of the KOROTKOFF sounds, frequently fell to zero. With continued exposure the pulse pressure developed into a marked increase. The oral temperature and pulse rate steadily rose or increased. As exposure continued, the subjects complained of being extremely hot, and the general clinical appearance seemed to develop. The loss of body weight amounted to 889 gm. per hr.

Fig. 4. Influence of Humid Heat (W.B. 33°–34°C) on Subjects



Note : (1) before exposure (D.B. 29.2°C, W.B. 26.5°C, E.T. 82°F)
 Humid Heat (D.B. 42.7°C, W.B. 32.8°C, E.T. 96°F)
 after exposure (D.B. 29.1°C, W.B. 26.8°C, E.T. 82°F)
 (2) Loss of Body Weight 1417 gm. (605gm. per hr.)

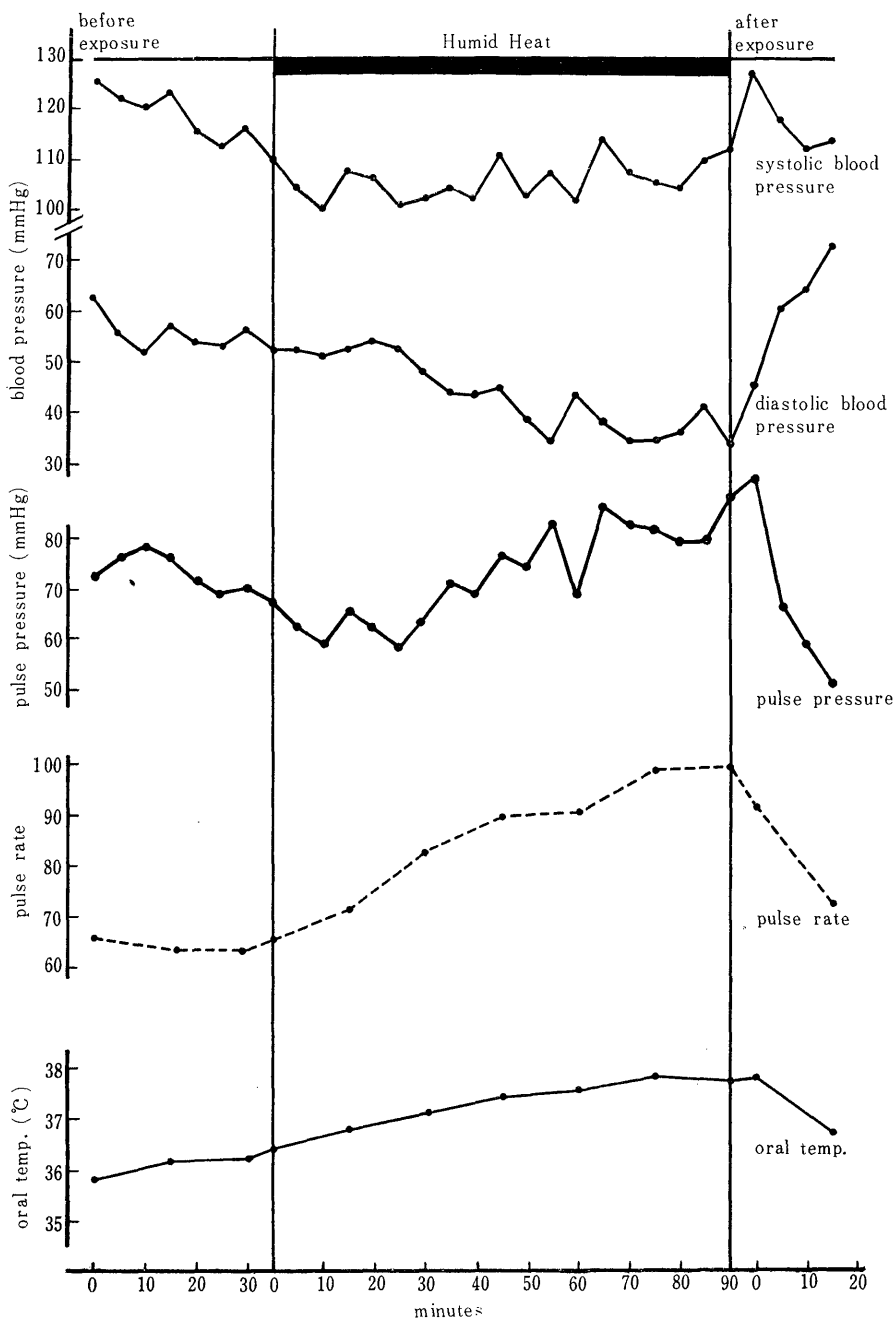
DISCUSSION

Numerous investigators³⁾¹¹⁾⁷⁾⁹⁾⁸⁾¹⁰⁾⁴⁾ have reported the response of blood pressure of men exposed to severe heat. But little work has been done to discuss the response of blood pressure to the various levels of humid heat for the purpose of determining the permissible limit of environmental heat.

In the cases of 30°–31°C wet bulb with 33° or 43°C dry bulb and 33°–34°C wet bulb with 35°C dry bulb (ranging from 88° to 93°F effective temp.) in our experiments, there was no physiological disequilibrium in the response [of blood pressure to heat, and the subjects seemed to adapt themselves to the environmental heat.

But in the case of 33°–34°C wet bulb with 43°C dry bulb (96°F effective temp.), the response of blood pressure was suggestive of the initial stage of physiological disequilibrium after 120 minutes' exposure.

Fig. 5. Influence of Humid Heat (W.B. 36°-37°C) on Subjects



Note : (1) before exposure (D.B. 29.1°C, W.B. 25.8°C, E.T. 80°F)
 Humid Heat (D.B. 39.9°C, W.B. 36.0°C, E.T. 99°F)
 after exposure (D.B. 29.1°C, W.B. 26.2°C, E.T. 81°F)
 (2) Loss of Body Weight 1333gm. (889gm. per hr.)

And then, in 1946 GERKING and ROBINSON⁶⁾ suggested that men, whose rate of sweating being over 600–800 gm. per hr., should be subjected to heat stroke. The loss of body weight in this experiment also reached this limit.

The response of blood pressure in the case of 36°–37°C wet bulb (99°F effective temp.) for 90 minutes' exposure showed a marked physiological disequilibrium.

In conclusion, the results of the present paper thoroughly coincided with those of our previous paper,²⁾ describing the response of blood pressure in the supine position to humid heat (the scheme of response of blood pressure to humid heat was illustrated in Fig. 8 in our previous paper²⁾).

SUMMARY

The authors conducted the experimental study on the response of blood pressure with the subjects in the sitting position, exposed to humid heat from 30° to 37°C wet bulb (ranging from 88° to 99°F effective temp.).

On the other hand, the subjective symptoms and other physiological reactions, such as oral temperature, pulse rate and loss of body weight, were observed.

From the viewpoint of the response of blood pressure to the various levels of humid heat, it was concluded that the upper permissible limit of environmental heat for the subjects in the sitting position seemed to be around 33°C wet bulb temperature and yet around 95°F effective temperature.

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