ARTERIAL BLOOD PRESSURE IN PLANTATION WORKERS IN NORTH-EAST INDIA

BY
J. M. G. WILSON
London

The arterial blood pressure in Asiatic and African peoples is usually reported as being lower than that in the western world, (Cadbury, 1922; Kilborn, 1926; Tung, 1930; Chopra, Chopra, and Chopra, 1942; Munro, 1949; Bibile, Cullumbine, Kirtisinghe, Watson, and Wirkramanyake, 1949; Williams, 1941; Alam and Smirk, 1943), and also as being lower in Caucasians living in Asia than when at home (Foster, 1927; Tung, 1927). The rise of blood pressure with age, particularly in the female, found in Britain

(Hamilton, Pickering, Roberts, and Sowry, 1954) and the U.S.A. (Master, Dublin, and Marks, 1950) appears not to have been noted, except by Chopra and others (1942) in India, and by Ordman (1948), who observed a moderate rise with age in men in South Africa. Other age-specific records show either no rise at all, or only a very slight one, with advancing years. These East-West differences are variously ascribed to inherent racial distinctions, or to such environmental factors as diet, climate,

TABLE I
MEAN ARTERIAL BLOOD PRESSURES OF ASSAM LABOUR FORCE, WINTER (JANUARY-FEBRUARY, 1956) (3,377 SUBJECTS)

Age (yrs)	Females						Males					
	Systolic			Diastolic			Systolic			Diastolic		
	No.	Mean	SD	No.	Mean	SD	No.	Mean	SD	No.	Mean	SD
10-14	33	110.0	10.9	32	62.8	8.0	30	103.5	9.5	30	59.6	6.0
15-19	218	114.8	11.9	214	67.3	9.0	160	113.2	9.6	160	65.4	7.3
20-24	289	116.3	10.4	287	69.7	9.7	182	116.3	11.3	181	68.1	9.2
25-29	275	117.2	14.1	273	72.1	10.0	279	117.8	10.7	273	70.8	8.1
30-34	215	118.5	16.0	215	72.9	9.7	254	119.0	11.9	256	72.7	8.9
35-39	199	124.2	10.1	199	76.5	9.8	248	121.0	13.6	249	74.2	9.2
40-44	151	127.6	21.7	150	79.6	12.2	197	125.0	17.1	194	76.0	9.2
45-49	95	136.3	25.2	92	83.5	12.8	161	127.0	17.7	160	78.3	10.0
50-54	47	139.8	20.8	47	85.4	11.7	121	132.0	23.6	118	81.4	11.7
55-59	43	147.0	23.8	44	88.5	14.1	74	144.3	27.4	75	83.0	11.3
60-64	24	155.2	22.5	23	92.9	12.5	43	144.3	26.2	43	83.7	14.3
65-69	13	151.7	29.5	13	90.5	12.2	18	161.1	25.3	20	88.1	8.8
70-74	2	174.5	56.0	2	88.5	9.9	6	162.5	18.8	6	91.2	9.9
Total Subjects ..	1,604*			1,591*			1,773*			1,765*		

* In some cases the systolic and diastolic pressures could not be satisfactorily recorded.

TABLE II
MEAN ARTERIAL BLOOD PRESSURES OF ASSAM LABOUR FORCE, MONSOON (JULY-SEPTEMBER, 1956) (1,711 SUBJECTS)

Age (yrs)	Females						Males					
	Systolic			Diastolic			Systolic			Diastolic		
	No.	Mean	SD	No.	Mean	SD	No.	Mean	SD	No.	Mean	SD
10-14	10	112.9	11.3	10	66.9	9.7	2	94.5	—	2	54.5	4.0
15-19	155	113.5	10.6	156	67.4	8.8	107	110.0	9.3	106	63.5	8.6
20-24	108	115.9	10.1	107	68.0	9.2	98	114.8	10.4	98	66.8	7.9
25-29	115	119.1	14.2	116	72.2	9.5	97	116.2	10.6	96	67.1	9.4
30-34	129	121.4	13.9	128	74.1	9.0	152	119.8	16.4	152	71.4	9.5
35-39	67	123.3	21.7	66	74.5	10.6	106	119.9	15.5	103	72.6	9.5
40-44	88	129.0	22.2	88	78.5	11.0	97	120.0	15.0	97	71.8	9.6
45-49	64	136.5	24.5	64	83.3	12.6	88	125.4	17.7	88	76.5	11.1
50-54	33	139.1	26.2	32	80.5	12.6	61	128.6	11.8	61	79.1	12.1
55-59	23	157.5	30.7	23	89.5	10.2	46	137.5	25.0	48	81.5	11.4
60-64	16	144.5	24.1	16	83.5	11.8	32	144.3	33.1	31	84.3	14.8
65-69	3	182.5	23.5	3	99.8	15.2	9	146.0	24.0	9	89.2	14.4
70-74	1	110.5	—	1	67.5	—	4	156.5	30.2	4	92.5	11.7
Total Subjects ..	812			810			899			895		

physical activity, and health, and to variations in the degree of mental strain encountered in daily life. The operation of such factors is hard to prove and the various methods of recording and reporting results make comparisons difficult.

It is of interest, therefore, to set on record the age- and sex-specific arterial blood pressures found in an Indian population of Upper Assam tea-garden labourers. The blood pressures were recorded with clinical mercury sphygmomanometers, with a cuff width of 13 cm., at the end of a short routine physical examination at which the subject was recumbent. No people known to be ill were included. Examinations were carried out by the Indian doctors in charge at twelve hospitals within the group of

gardens served by the writer. The technique and the manometers used were personally checked and there was reasonable agreement between random readings taken in collaboration with the doctor directly responsible for the examinations. The diastolic blood pressure was taken as the point of disappearance of the Korotkoff sounds. The first sample of the population was examined in the winter season, (Table I, Fig. 1). The second and similar sample (a continuation of the same series of physical examinations; selection was made by place of residence on the garden and was considered unlikely to have any bearing on the results) was examined in the monsoon season (Table II, Fig. 2).

The equations on which the curves in Figs 1 and 2

FIGS 1 and 2.—Mean systolic and diastolic arterial blood pressure of men and women tea-garden labourers in Assam, showing growth of pressure with age. Females—Continuous line and open circles. Males—Broken line and squares.

Note: In this and other figures the size of each square or circle has been varied to correspond with the number of observations in each age group. All curves are fitted quadratics (see text).

TABLE III
QUADRATIC EQUATIONS FOR FITTED CURVES BY AGE AND SEX OF ARTERIAL BLOOD PRESSURE IN ASSAM TEA GARDEN LABOURERS—WINTER AND MONSOON

Season	Sex	Blood Pressure	Equation
Winter (January–February, 1956)	Male	Systolic Diastolic	$y = 119.4900 - 0.5632x + 0.01619x^2$ $y = 57.0032 + 0.49992x + 0.000928x^2$
	Female	Systolic Diastolic	$y = 116.59 - 0.43408x + 0.016768x^2$ $y = 59.5883 + 0.3916x + 0.001776x^2$
Monsoon (July–September, 1956)	Male	Systolic Diastolic	$y = 111.9922 - 0.16368x + 0.010016x^2$ $y = 58.9823 + 0.25584x + 0.00232x^2$
	Female	Systolic Diastolic	$y = 111.1508 - 0.06752x + 0.011968x^2$ $y = 58.8377 + 0.46816x - 0.00008x^2$

Where y = arterial blood pressure in mm. Hg; x = age in completed years

Records of birth are not available for the older people and an estimate of age has been based on a combination consisting of the doctor's personal knowledge of the subject and of the result of his physical examination.

are based are shown in Table III.

The mean monthly temperatures and rainfall are shown in Table IV.

TABLE IV

Season 1956	Mean Monthly Rainfall (in.)	Mean Monthly Atmospheric Temperature (°F.)	
		Maximum	Minimum
Winter	1.82	74.0	49.6
Monsoon	9.76	88.9	74.5

DISCUSSION

The first point of interest is that systolic and diastolic blood pressures rise with age, more so in females than in men, in much the same fashion as that followed by the sample examined by Hamilton and others (1954), using similar criteria in London (Figs 3 and 4 opposite).

The curves for the London series are based on the equations in Table V.

Secondly, there is very little difference between the blood pressure levels, at comparable ages, of the Indian and the Londoner, despite a marked difference in bodily habitus (Table VI), diet, and physical and mental environment. When allowance

is made for differences in mean arm size* (Pickering, Roberts, and Sowry, 1954). (Table VI), and in the criterion for measurement of the diastolic blood pressure (muffling rather than disappearance of the Korotkoff sounds), such variation as there is between the two sets of curves is further minimized.

TABLE VI
MEAN WEIGHT AND ARM SIZE (ALL AGES) OF A SERIES OF INDIAN SUBJECTS

Sex	Mean Body Weight*		Mean Mid-Biceps Arm Circumference	
	No. of Subjects	Weight (kg.)	No. of Subjects	Circumference (cm.)
Male	42	45.6 (100 lb.)	566	22.8
Female	72	37.7 (83 lb.)	531	21.2

* These weights are the mean of a small series selected for admission to hospital for investigation of renal function, in part a random sample of the entire sample and in part patients with high blood pressure.

The mean weight of 1,977 males of the blood pressure sample population was 44.3 kg. S.D. 4.9 (97.5 lb. S.D. 10.7).

Thirdly, when the mean blood pressure in a similar sample under nearly identical conditions, except climatic, is compared, there appears to be very little variation between the curves for the cold and hot season (Figs 5 and 6, overleaf).

* See Appendix.

TABLE V
EQUATIONS FOR CURVES OF ARTERIAL BLOOD PRESSURE BY AGE FOR ST. MARY'S HOSPITAL OUT-PATIENTS (FIGS 3 AND 4)
Hamilton, Pickering, Roberts, and Sowry (1954)

Blood Pressure	Sex	Equation
Systolic	Female	$y = 126.22 - 1.139x + 0.037977x^2 - 0.00017339x^3$
	Male	$y = 115.20 + 0.084048x + 0.0035098x^2 + 0.000057291x^3$
Diastolic	Female	$y = 66.74 + 0.033445x + 0.011264x^2 - 0.000087369x^3$
	Male	$y = 62.67 + 0.32862x + 0.0030821x^2 - 0.000038879x^3$

Where y = arterial pressure in mm. Hg; x = age in completed years

FIGS 3 and 4.—Mean systolic and diastolic arterial blood pressure of men and women tea-garden labourers in Assam, showing rise in pressure with age, compared with similar curves obtained at St. Mary's Hospital, London by Hamilton, Pickering, and Sowry (1954). Assam—Continuous line and open circles. London.—Broken line and squares.

Note: the London curves are fitted from cubic equations.

No comparable clinical observations are known to the writer; the blood pressure is usually regarded as being lower in tropical countries, as already noted. After periods of experimental exposure to heat the systolic and diastolic blood pressure in human subjects at rest falls (Hellon and Lind, 1958). It may well be that the Indian workman is particularly well adapted to his environment; or some other variable, such as diet, may account for the lack of climatic variation.

Thus it appears that this Indian population, despite wide variations from Western standards of diet, climate, physique, and general environment, shows the same blood pressure trends as the population of London. It has also been demonstrated (to

be published) that the frequency distribution of blood pressure in each age group follows the characteristics of a continuous variable, as reported by Hamilton and others (1954), without any line of demarcation between the normotensive and the hypertensive state.

SUMMARY

Observations on the arterial blood pressure in tea plantation workers in North East India have shown that, despite the difference from Western standards of diet, climate, physique, and general environment, the findings show similar trends to those represented for the population of London.

FIGS 5 and 6.—Rise in arterial blood pressure with age in men and women tea-garden labourers in Assam, compared for cold weather winter season and monsoon rainy season.

Winter—Broken line and solid circles. Monsoon—Continuous line and open circles.

APPENDIX

Correction of Arterial Pressure for Arm Circumferences

From Ragan and Bordley's data, Pickering and others (1954) have calculated equations relating arm size to indirect sphygmomanometric blood pressure recording and direct intra-arterial measurement. They do not give actual arm measurements but, applying their equations, the mid-arm measurement at mean age 45 years would be approximately 25.4 cm. for women and 25.6 cm. for men. The

corresponding Indian measurements are 21.4 cm. and 23.4 cm. respectively. Applying these workers' correction factor (Table I in the above paper), the intra-arterial pressure would be 10 mm. Hg higher than the indirect systolic Blood Pressure reading in the Assam series, but only 5 mm. Hg higher in the London measurements. This would tend to minimize the difference between the two systolic curves.

For the diastolic measurement the same correction of 5 mm. Hg is applicable in both series. However, these deductions must be accepted with some reserve: in the first place, Pickering's arm measurements were taken half-way along the length of the arm, with forearm extended; whilst the Assam measurements were simply recorded as mid-biceps: and secondly, the calculation of Pickering's 45-year-old subjects' arm circumference is based on mean blood pressures at that age. It would be more satisfactory to compare age specific blood pressures corrected for arm circumference.

It is a pleasure to acknowledge the help given me in this by Dr. D. C. Majumdar, and also by Drs. N. L. Pal, A. C. Biswas, S. M. Chaudhury, A. Chaudhuri, T. C. Das,

N. Das, B. C. Das Gupta, M. A. Rahman, G. Sarma, B. L. Sen, A. Sen Gupta, T. Sonowal, and K. Bhattacharjee.

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