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Age Regression Of Blood Pressure In An Urban Population Of Age 15-59 Years

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Systolic and diastolic blood pressures of 975 adults of Allahabad city, recorded by door to door visit, have been utilized to obtain blood pressure levels as regression function of the age. In males, mean systolic level was quantified at approximately 113 plus two-fifth of age, while mean diastolic at approximately 71 plus three-tenth of age. Blood pressures in the females, however, were third degree functions and revealed relatively steep rise after the age of 45 years. Some possible hypotheses for such rise in the females have been discussed.

Introduction

Investigation on blood pressure correlates risks redundancy in view of already numerous publications on the subject. Nevertheless, review of the literature immediately reveals conspicuous scanty availability of information on blood pressure distribution in general Indian population. Since race and nationality have been demonstrated as factors affecting blood pressure (Lovell 1963, Boyle **et al** 1967), perhaps new hypothesis can be forwarded for Indian population. An investigation, in domiciliary conditions, therefore, was undertaken with the objective of studying blood pressure and some of its possible correlates. The present report is limited to two factors only, namely age and sex, which have widely been reported as influential factors. Miall (1967) opined age, sex and race as the main variables to which blood pressure is largely related. Increase in systolic as well as diastolic pressure with advancing age has been reported by Boe **et al** (1957), Aleksandrow (1967) and Miall and Lovell (1967). Padmavati and Gupta (1959) and Celine and Mathur (1970) found it true for some strata of Indian population also. However, wide variation in blood pressure for a specific age makes relative contribution of age debatable. What is high for a particular age in a particular set of environments is still a matter of discussion. The determination of quantum of increase in blood pressure, if any, per unit increase in age, may, thus, be of considerable predictive value. Pickering (1967) emphasized identification of those factors in the environment that affect the rate of rise of blood pressure with age and to assign them a quantity. A necessary prelude

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to this is quantitative determination of age effect itself. An attempt, therefore, has been made in the present paper to obtain systolic as well as diastolic pressure as a regression function of age which could enable reasonable quantitative expression of blood pressure in terms of age. A relatively higher rise in blood pressure of the females in the later age-groups, observed in the present study, served as a pointer to investigate polynomial regression instead of confining to linearity only.

Material and Methods

The frame of the study was constituted by residents of railway colonies in the city of Allahabad. The sample studied included 975 individuals of age 15-59 (completed) years from these urban colonies. Nearly two-thirds of them belonged to Social Class IV or below at norms suggested by Prasad (1968). The average per capita income was nearly Rs. 900 per annum.

The survey was conducted in the months of April to June, 1970, between 7 A.M. and 10 A.M. Readings were taken with mercury sphygmomanometer and the subjects in sitting posture in their own houses applying the auscultatory method (American Heart Assoc 1951). Three consecutive readings of both systolic and diastolic pressures were taken for each individual and all subsequent computation was based on average of these 3 readings. In spite of limitation of casual blood pressure, such pressure only could be recorded due to obvious reasons, pointed out by Davies and Lewist (1966) also.

The regressions were obtained by the technique suggested by Fisher (1963a) which provided an additional advantage of giving due weight to the varying number of individuals measured in different age-groups. The equations so obtained would also remove any confusion between irregularity and multimodality discussed by Pickering (1963) since these would fit a trend to the data. Wilson (1958) gave similar quadratic and cubic equations relating blood pressure of Assam plantation workers with their age, though without mentioning the method of their fitting. Pickering (1961) has frequently used such regression curves to illustrate his stand point.

Results

Mean and standard deviation of observed blood pressures, systolic as well as diastolic, for each 5-year age-group and for each sex, are shown in Table I. The means are plotted in the Graph which indicates that, on the whole, the blood pressures were rising with age. In the females, observed measurements of both systolic and diastolic pressures showed steep rise in later age-groups after some depression in age 40-49 years. Males did not show any such pattern. This necessitated separate study of the two sexes.

Blood pressure in the females showed steady rise in initial age-groups, a depression in subsequent age-groups and then a steep elevation in the last age-groups. This suggested a third degree polynomial. In the absence of any such phenomenon in

males, no attempt for fitting a polynomial was necessary in their case and the regression was limited to linearity only. This linear regression for males worked out as

$$Y_{sm} = 112{\cdot}78 + 0{\cdot}38\ X$$

for systolic, and

$$Y_{dm} = 70{\cdot}84 + 0{\cdot}29\ X$$

for diastolic blood pressure, where X is age in completed years.

Table I. Systolic and diastolic blood pressure by age and sex

Age-group (years)	Males			Females		
	Frequency	Mean blood pressure ± SD (mm Hg)		Frequency	Mean blood pressure ± SD (mm Hg)	
		Systolic	Diastolic		Systolic	Diastolic
15—19	124	119·7 ± 6·5	75·1 ± 4·4	80	118·4 ± 6·6	75.8 ± 4·8
20—24	47	118·7 ± 6·7	77·0 ± 5·1	48	119·6 ± 6·1	77·4 ± 5·0
25—29	66	123·2 ± 5·8	80·3 ± 4·6	83	120·9 ± 6·4	77·8 ± 5·1
30—34	69	124·2 ± 6·2	80·9 ± 5·8	65	122·2 ± 6·4	79·5 ± 6·1
35—39	77	128·8 ± 6·7	81·6 ± 5·2	66	129·8 ± 6·7	82·6 ± 5·4
40—44	66	127·6 ± 6·6	83·2 ± 4·8	40	127·5 ± 7·0	80·1 ± 5·6
45—49	51	129·6 ± 7·3	85·3 ± 5·6	23	123·4 ± 7·6	79·1 ± 6·2
50—54	35	134·0 ± 7·8	86·0 ± 6·0	14	136·9 ± 7·9	81·9 ± 6·2
55—59	13	132·2 ± 7·6	83·4 ± 6·1	8	139·9 ± 8·0	91·1 ± 7·1

The third degree equation obtained for systolic blood pressure in the females was

$$Y_{sf} = 118{\cdot}1384 + 1{\cdot}7352\ x + 0{\cdot}0524\ \frac{x\ (x-1)}{2} + 0{\cdot}0705\ \frac{x\ (x-1)\ (x-2)}{3{\cdot}2},$$

and for diastolic blood pressure the equation was

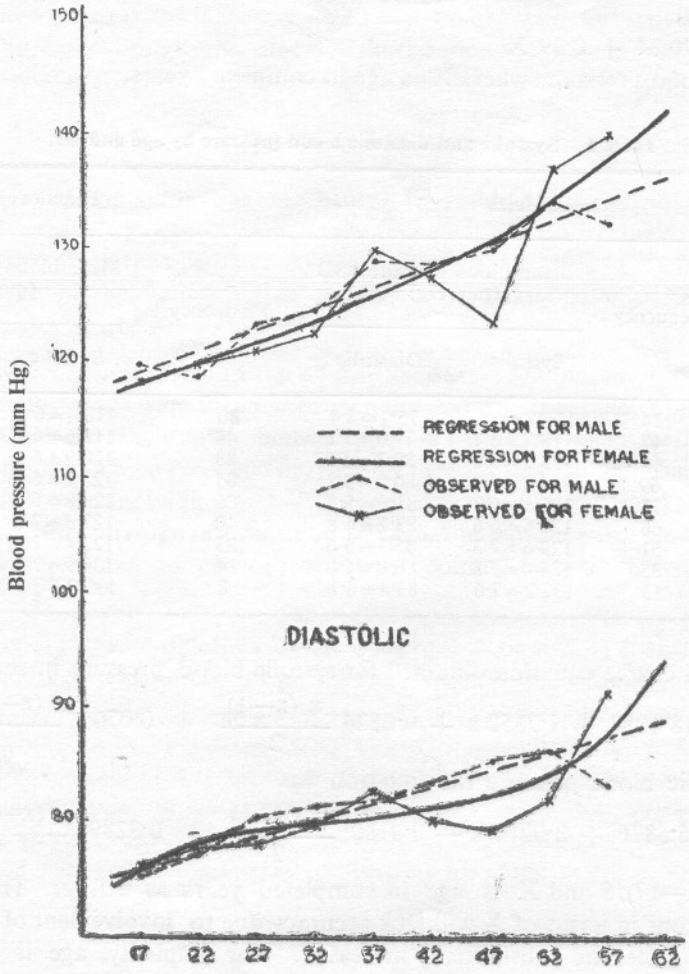
$$Y_{df} = 75{\cdot}5826 + 2{\cdot}0214\ x - 0{\cdot}8180\ \frac{x\ (x-1)}{2} + 0{\cdot}3289\ \frac{x\ (x-1)\ (x-2)}{3{\cdot}2},$$

where $x = (X-17)/5$ and X is age in completed years as before. Transformation of these equations in terms of X will lack accuracy due to involvement of third powers unless decimal places are substantially increased. For simplicity, age is expressed in terms of different origin and scale. The curves, plotted in the Graph, show a relatively steep rise in blood pressure of the females after the age 45 years.

Goodness of fit of these curves was tested by the technique of analysis of variance suggested by Fisher (1963**b**) for such regressions. The technique consists of calculation of sum of squares contributed by deviations from regression and those contributed by within age variations. For fit to be good, sum of squares due to deviations from fitted regression should not exceed significantly to sum of squares due to within age variations. He used statistic 'z' for testing such significance. Table II shows that, in none of the cases, sum of squares due to deviations from regression was significant. This indicates that the curves fitted were **good**.

Graph

Systolic



Mid point of the age-interval (years)

Discussion

Discussion by McKeown (1964) on effect of age on blood pressure is indicative of uncertainty in respect of relative contribution of age. Norman-Taylor and Rees (1963) concluded that the average systolic and diastolic pressures did not increase markedly with age in any of the three areas studied by them. The same was reported by Malhotra (1971) for North and South Indian subjects. The present results in respect of males confirm the general result of Boe **et al** (1957), Aleksandrow (1967)

and Miall and Lovell (1967) as well as of Padmavati and Gupta (1959) and Celine and Mathur (1970) since both systolic and diastolic blood pressure in males showed an increasing trend with advancing age. The regression equations show that mean systolic pressure in males was approximately 113 plus nearly two-fifth of age, while mean diastolic pressure was approximately 71 plus nearly three-tenth of age. Epstein and Eckoff (1967) have given some slopes for classifying systolic blood pressure of a population. Within the age-group studied by us, the closest of these slopes to regression line for male systolic blood pressure is slope 1.

Table II. Values of statistic 'z' as test of significance of sum of squares due to deviations from fitted regression

Sex	Degress of freedom	Value of statistic 'z'	
		Systolic	Diastolic
Male	(7,539)	negative* not significant	negative* not significant
Female	(5,418)	0·2772 (P>0·10) not significant	0·3729 (P>0·05) not significant

*negative values of 'z' show a very good fit

Blood pressures in the females were obtained as third degree functions and were not so directly expressible in terms of age. Of considerable interest is relatively steep rise after the age of 45 years. The females of Rhondda Fach and Vale of Glamorgan (Miall and Oldhan 1958) as well as of Assam (Wilson 1958) showed such rise, though much more steep in systolic than in diastolic blood pressure. Since body built is known to effect blood pressure levels, the built of the individuals studied was categorized as ectomorph, mesomorph or endomorph at the time of recording of blood pressure. Built-wise position of the total sample, of all the females and of the females of age 45 years and above, is shown in Table III. There was no preponderance of endomorphs in the females of age 45 years and above and so built was not likely to be a contributory factor to relatively higher blood pressure level in this age-group.

Table III. Distribution of the subjects by built

Built	Total sample	All females	Females of age 45 years and above
Ectomorph	263 (27%)	125 (29%)	11 (24%)
Mesomorph	630 (65%)	259 (61%)	30 (67%)
Endomorph	82 (8%)	43 (10%)	4 (9%)
Total	975	427	45

One is tempted to link the steep rise of both systolic and diastolic blood pressure after the age of 45 years with the changes in the females—mainly endocrinal—that are well known to occur with the onset of menopause. Simpson (1959), Lloyd (1962), Martin (1964), all have mentioned of such a possibility of rise in blood pressure. The other factor may be larger size of families in the population surveyed. Miall (1967) has made a related observation in discussing age and blood pressure of females : rate of increase of pressure following the end of the child bearing period tends to be greater in those with large families than in subjects with no children.

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