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Blood pressure measures among women in south India

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SUMMARY Blood pressures were measured using standard techniques on a random sample of 961 rural and 1073 urban women chosen from North Arcot District in Tamilnadu State of south India. The mean (SD) systolic blood pressures (mm Hg) were 101·4 (10·5) in the rural women and 105·3 (14·1) in the urban. The mean (SD) diastolic blood pressures were 65·9 (9·9) in the rural women and 68·0 (10·8) in the urban. For both systolic and diastolic blood pressures, the urban values were significantly higher than those in the rural. The correlations of blood pressures with selected socioeconomic, obstetric, and maternal factors were examined. For the rural women, blood pressures showed significant associations only with parity and weight. In the urban women significant associations were also noted for age and income. The implications of these findings are briefly discussed.

Hypertension is generally viewed as an "urban" phenomenon, with blood pressures tending to be low and not rising with age in underdeveloped societies.[1–4] Both genetic and environmental factors are put forward as an explanation.[4–11] Epidemiological approaches to test these hypotheses have been largely cross sectional studies contrasting rural and urban societies.[2 10 12] A few longitudinal follow up studies are reported in young populations to determine inter- and intraindividual variations over time.[8 9] In India some cross sectional studies have been attempted in which low blood pressures are noted in poorer sections and higher levels in urban areas.[13 15] No published report on women in south India is available. As part of a large scale community survey of human reproduction, rural and urban samples of women of childbearing age were followed up during their pregnancies. We report their blood pressure measurements when not pregnant.

Material and methods

The study was carried out in North Arcot District, one of the 14 districts in the State of Tamilnadu (formerly known as Madras State). The demographic characteristics of the district are fairly typical of that prevailing in other parts of the state. Agriculture, weaving, and tanning are some of the common occupations. Much of the agriculture depends on rain falling during the south west and north east monsoons. The climate is generally dry and warm throughout the year.

About 90% of the population are Hindus, who belong to more than 50 different castes and subcastes. Muslims and Christians constitute about 6% and 2% of the population respectively. Other religious groups (mostly Jains and Buddhists) make up the remaining 0·5–1·0% of the population. The overall literacy rate is only 35%. In general, the sanitation and living conditions are poor in the rural area and below satisfactory levels in the urban area. Most of the population in both areas lack minimal standards.

One rural community development block (K V Kuppam) was chosen and excluding those areas within 6–10 km of any town the remaining 50 000 population in this block constituted the rural sample. A random sample of a third of Vellore town, the headquarters of North Arcot District, provided the urban sample of about 40 000.

Stratified random subsamples of women in these areas constituted the material for the studies on blood pressures. An aneroid sphygmomanometer (ERKA, German made) that could be read accurately up to 2 mm Hg was used. The time of day was so chosen that the subject was relatively free and could spend time with the investigator in a relaxed manner. She was made to sit in a comfortable position, with the left arm adequately supported in semiflexion and abduction at about the level of the sternal angle. The cuff was applied firmly and evenly to the arm, which was adequately exposed. The lower edge of the cuff was kept about 2 cm above the antecubital space with the rubber bag centred over

the palpable course of the brachial artery. The uninflated cuff did not compress the underlying tissue. The cuff was then quickly inflated to 20–30 mm Hg above the pressure at which the radial pulse was no longer palpable. If there was visible venous congestion in the hand the recording was made with the arm raised. The stethoscope was applied to the area overlying the point at which the brachial pulse had been palpable, just below the edge of the cuff. Cuff pressure was permitted to fall at a rate of not more than 2–3 mm Hg per pulse beat, and the point at which the first audible pulse beat occurred was recorded as the systolic blood pressure (SBP); this is expressed as the next lower even number of mm Hg. The cuff pressure was allowed to go on falling, and the points at which the sound quite suddenly became muffled and dull (phase 4) and disappeared which was shortly afterwards (phase 5) were noted. Phase 5 was used to provide the diastolic blood pressure (DBP), rounding off to the lower even number of mm Hg.

The apparatus for measuring blood pressure was checked each week against a mercury sphygmomanometer. Five per cent of all women were reassessed by supervisory staff and thus the comparability and quality of data were maintained.

Results

DEMOGRAPHIC FACTORS

A total of 961 rural women and 1073 urban women aged 16 to 45 were included in these studies. All cooperated in the study. In both areas about 60% of women were under 30. The mean age (SD) was 28·7 (7·1) for rural women and 29·6 (7·5) for urban women. In rural areas 98·4% were Hindus, 0·8% Muslims, and the remaining 0·8% Christians. In the urban areas 87·7% were Hindus, 6·2% Muslims, 4·9% Christians, and the remaining 1·2% other religious groups.

Although 90% in rural and 86% in urban areas were non-vegetarians, for economic reasons animal protein foods and even eggs are sparsely and infrequently consumed.

In the rural areas 53·4% had a per capita annual income of Rs 300 or below as compared with 13·5% in the urban area. Mean per capita annual income (SD) was Rs 492 (392) in the rural and Rs 790 (606) in the urban areas, the difference being statistically highly significant ($p<0·001$).

Rural women tended to be taller than their urban counterparts (mean height (SD) 148·3 cm (7·1) *v* 143·0 cm (7·9)). The difference was statistically significant ($p<0·001$). On the other hand, rural women were lighter (mean weight (SD) 42·2 kg (5·3) *v* 43·3 kg (7·2)). The difference again was statistically significant ($p<0·001$).

BLOOD PRESSURE

The mean (SD) systolic blood pressure (SBP) in mm Hg was 101·4 (10·5) for the rural women and 105·3 (14·1) for the urban, the difference statistically significant ($p<0·001$). The mean (SD) diastolic blood pressure (DBP) in mm Hg was 65·9 (9·9) in the rural group and 68·0 (10·8) in the urban, the difference again reaching statistical significance ($p<0·001$).

Nevertheless, it should be pointed out that the variability among urban women was generally greater than that among the rural women, implying that the urban/rural median pressures are close. The higher urban mean pressures are due to a proportionately larger number of women with mild hypertension.

SOCIOECONOMIC FACTORS

The SBP of women in the three religious groups did not differ significantly in either area. The urban levels were higher than that of rural in all religions, but these differences attained statistical significance only among Hindus ($p<0·001$). For the DBP, only the difference between Muslims and Christians in the rural areas attained statistical significance ($p<0·05$). The urban DBP values were generally higher than that of the rural, but the differences were significant ($p<0·05$) among only Hindus and Muslims.

The difference between vegetarians and non-vegetarians was not statistically significant in either area, but the rural-urban differences among both vegetarians and non-vegetarians were highly significant ($p<0·001$).

Table 1 gives SBP and DBP levels by per capita annual income of women.

The differences between blood pressures among the rural women in the various income groups were not statistically significant. On the other hand, the urban women showed an increasing trend of blood pressures with rising income ($p<0·05$). The rural-urban differences attain statistical significance ($p<0·05$) in the higher income brackets only.

OBSTETRIC FACTORS

The blood pressure levels generally tended to show a lack of specific trend with parity (table 2) or with gravidity. Significant differences exist ($p<0·01$) in all parities between rural and urban areas.

Although women with reproductive losses in utero or in the neonatal period had higher blood pressure, the differences were not statistically significant. The rural urban differences in blood pressure were statistically significant ($p<0·001$) between women with fetal loss and the women without such losses.

Table 1 *Systolic and diastolic blood pressures by per capita annual income in rural and urban areas: mean (SD)*

Per capita annual income (Rs)	*No observed*		*SBP (mm Hg)*		*DBP (mm Hg)*	
	Rural	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*
≤300	504	144	101·3 (10·4)	102·9 (13·6)	66·5 (9·9)	67·7 (12·1)
301–600	296	429	101·4 (10·9)	104·0 (13·4)	65·2 (10·4)	67·5 (10·2)
601–1000	107	294	101·1 (10·9)	105·1 (12·9)	64·3 (9·8)	67·5 (10·8)
>1000	54	206	103·1 (10·2)	109·5 (15·4)	67·0 (9·2)	70·7 (11·4)

Table 2 *Systolic and diastolic blood pressures by parity in rural and urban areas: mean (SD)*

	No observed		*SBP (mm Hg)*		*DBP (mm Hg)*	
Parity	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*
0	129	123	103·9 (9·8)	106·4 (12·2)	67·5 (10·3)	67·2 (11·8)
1	165	135	100·1 (9·0)	105·4 (12·1)	65·1 (9·5)	66·3 (9·6)
2	161	170	101·9 (11·0)	103·8 (13·2)	66·6 (10·7)	67·8 (10·4)
3	132	169	100·6 (11·9)	104·3 (12·0)	64·5 (9·9)	67·8 (10·1)
4	94	137	97·9 (9·2)	106·2 (13·8)	64·3 (10·5)	69·0 (11·8)
≥5	280	339	102·2 (10·7)	106·0 (13·8)	66·3 (9·4)	68·7 (10·7)

AGE

Table 3 shows the SBP and DBP levels by maternal age. The SBP among rural women did not show significant associations with age, but it did so in the urban group ($p<0·01$). The rural urban differences in SBP attained statistical significance in most age groups. In the case of DBP no specific trends by maternal age were noticed. Rural urban differences were significant only in the age groups 26–30 and 36–40 ($p<0·01$).

HEIGHT AND WEIGHT

The blood pressures did not vary by height of women in either the rural or urban areas. Except at extremes (below 140 cm and above 160 cm) all the rural urban differences were statistically significant ($p<0·05$).

The SBP and DBP levels by weights of women are presented in table 4. The blood pressures showed a significant increase with body weight for both the rural and urban women ($p<0·01$). Rural urban differences were mostly not significant at the different weight subgroups.

The simple correlation coefficients (r) between each of the variables (age, height, weight, and income) and blood pressure as well as the multiple correlation taking all variables together (R) are shown in table 5.

In the rural group only the correlation of blood pressure with weight is statistically significant. In the urban group, however, in addition to weight, age and income are also correlated significantly with blood pressure.

Discussion

Within the ages of the childbearing period the findings among women in south India confirm that arterial pressures there are significantly lower than those found among Western or more developed societies. Such typically low blood pressures are generally attributed, among other factors, to the minimal exposure of women to urban stresses, a chronic state of malnutrition, and infectious diseases.[16] The populations of the present studies qualify for all these factors, earlier reports from these areas showing a high mortality among women, poor nutritional status, and a high degree of illiteracy.[17 18] The higher values and a much clearer trend with age among the urban dwellers underscores the role of modernisation in raising blood pressure levels.

Table 3 *Systolic and diastolic blood pressures by maternal age in rural and urban areas: mean (SD)*

Maternal age (years)	*No observed*		*SBP (mm Hg)*		*DBP (mm Hg)*	
	Rural	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*
≤20	128	101	102·2 (9·7)	102·8 (11·1)	66·1 (10·7)	67·0 (9·8)
21–25	216	226	100·9 (10·2)	104·0 (12·0)	65·3 (9·6)	66·5 (10·1)
26–30	261	267	100·8 (10·2)	106·7 (12·4)	65·7 (9·7)	68·8 (10·4)
31–35	176	252	100·8 (10·5)	104·8 (12·7)	66·4 (9·9)	67·8 (10·7)
36–40	105	169	102·8 (12·4)	106·8 (14·8)	65·7 (10·9)	69·3 (11·6)
>40	75	58	102·6 (10·9)	107·6 (17·8)	66·5 (9·4)	68·8 (12·7)

Table 4 *Systolic and diastolic blood pressures by weight of women in rural and urban areas: mean (SD)*

Weight (kg)	No observed		SBP (mm Hg)		DBP (mm Hg)	
	Rural	Urban	Rural	Urban	Rural	Urban
<35·0	49	70	97·9 (10·7)	100·4 (12·8)	62·5 (10·7)	63·2 (10·2)
35·0–39·9	299	300	99·0 (8·7)	101·5 (10·9)	64·2 (9·9)	65·0 (9·7)
40·0–44·9	306	189	101·5 (9·2)	103·3 (12·3)	66·1 (9·3)	66·0 (11·0)
45·0–49·9	209	192	102·2 (11·1)	104·6 (12·0)	67·0 (9·3)	67·7 (10·0)
50·0–54·9	68	115	104·8 (16·6)	107·7 (10·4)	68·1 (14·6)	70·3 (9·5)
≥55·0	30	207	109·4 (11·4)	109·5 (14·4)	71·2 (9·9)	71·7 (10·7)

Table 5 *Correlation coefficients(r) between systolic or diastolic blood pressures in rural and urban areas and age, height, weight, and income. Multiple correlation coefficient R for all those factors*

Correlation of blood pressure with	Rural		Urban	
	SBP	DBP	SBP	DBP
Age (r)	0·02	0·02	0·08*	0·07*
Height (r)	0·04	0·03	0·01	0·01
Weight (r)	0·21**	0·15**	0·23**	0·23**
Income (r)	0·03	0·05	0·15**	0·09*
All the above (R)	0·24**	0·17**	0·28**	0·28**

* Significant at 1% level.
** Significant at 0·1% level.

Nevertheless, the precise mechanisms through which the various socioeconomic and psychological factors operate to influence blood pressures are not clear. Studies among south African tribal and urban Xhosa people and among Samoan migrants in Hawaii did not always show the expected relations of urbanisation with arterial pressures, suggesting that the problem is not simple.[12] Furthermore, when there is a rise in blood pressure, the mechanisms are not always the same in different races.[11 12]

Apart from age, several other variables seem to have independent relationships to blood pressure. These have included weight, resting heart rate, plasma glucose, serum uric acid, serum cholesterol, and cigarette smoking.[5] It has been postulated that some of these factors which tend to have cumulative effect, such as ingestion of salt or tobacco smoke, might be important agents through which the relation between age and blood pressure would be shown.

The existence of a relation between hypertension and excess body weight has long been recognised. Longitudinal observations in Framingham have shown that adiposity predisposes and makes a significant contribution to the development of hypertension.[8] In a study of three Indonesian villages, systolic pressures (but not diastolic) were low in undernourished subjects, but the low calorie and protein intakes did not prevent systolic pressure rising with age.[1] On the other hand, studies in Solomon Island societies indicated that they were well nourished and had little or no hypertension.[19]

Much has been written on the role of salt intake increasing arterial pressures. Apparently, the consumption of sodium increases with modernisation; so do other features such as obesity, stress, and a more sedentary style of living. That the amount of sodium does not necessarily influence blood pressures is evident from several studies.[6] Perhaps there are again several regulatory and compensatory mechanisms that act to control arterial pressures.[2 3 16]

One or two other factors which could control blood pressures relate to the extent to which relaxation breaks are juxtaposed between strenuous activities as seen in pastoral communities.[7] Such frequent high rates of energy expenditure alternating with periods of rest would also use calories more efficiently despite low intakes.[3] Although life in rural areas is not necessarily peaceful or free from stresses,[12] the pace of life is more rhythmic and slower than that in urban societies, and could perhaps explain the low blood pressures seen in this study.

The data presented are expected to serve as a baseline to further longitudinal observations during pregnancy. It is hoped that such data will shed more light on the specific parts played by the various social and biological factors in controlling or increasing arterial pressures and in the emergence of hypertension. That living in urban areas generally leads to higher blood pressure is not in doubt based on the findings presented here and elsewhere. Nevertheless, since a multiplicity of factors seem to exist in this situation, each of which has been incriminated in hypertension, more studies are required to probe into the precise pathways in the epidemiology of hypertension. The people of Tamilnadu, as in other parts of India and developing areas, are part of a transitional society and provide valuable opportunities to carry out such studies to elucidate the aetiology of chronic disorders.

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