Blood Pressure Profile of Lepchas of the Sikkim Himalayas: Epidemiological Study

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Abstract We evaluate the blood pressure profile in relation to selected biological, behavioral, and socioeconomic factors among the Lepchas, a tribal population of Asian origin inhabiting the Dzongu area of northern Sikkim. The results show that mean systolic and diastolic blood pressures of Lepcha adults (aged 19 years and older), engaged primarily in agricultural practices, are conspicuously high and that the prevalence of essential hypertension (defined in terms of WHO criteria) is remarkably high as well, irrespective of sex. Significant effects of age on blood pressure were found. None of the anthropometric variables considered was a significant correlate of blood pressure in males, whereas triceps skinfold thickness was the only significant correlate of blood pressure in females. Systolic blood pressure among males was significantly affected by alcohol intake. Mean systolic and diastolic blood pressures consistently increase with increasing intake of alcohol in both sexes.

Several studies have revealed that the blood pressure level of a population is influenced by a variety of biological, behavioral, and sociocultural factors (Lowenstein 1961; Hanna and Baker 1979; McGarvey and Baker 1979; Katz et al. 1980; Rao 1980; McGarvey 1984; McGarvey and Schendel 1986; Dressler et al. 1987, 1992; Fleming-Moran et al. 1991). Epidemiological studies of blood pressure can provide important insights into the role of environmental factors in the determination of essential hypertension, which is a major public health problem for developed countries and for many developing countries. Etiological factors determining blood pressure levels of traditional and of modernized or Westernized populations differ (Epstein and Eckhoff 1967; Ward 1983; McGarvey and Schendel 1986). Available evidence also suggests that even among traditional populations the major factors affecting blood pressure levels may not be similar (Ward 1983), and exceptions occur to the

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general finding that hypertension is rarely experienced in traditional societies (Neilson and Williams 1978; Marmot 1979). It has also been shown that, although some factors that contribute to the increase in blood pressure levels cut across sociocultural characteristics and geographic regions, other factors are population specific (Marmot 1979; Ward 1983).

Recently, some studies have been conducted in India on epidemiological profiles of blood pressure among some socioculturally distinguishable rural and urban populations inhabiting plains areas [e.g., Mukherjee et al. (1988) and Majumder et al. (1990, 1994)], but such studies among Indian populations living in mountainous areas are absent.

In view of this, the present study is aimed at evaluating the blood pressure profile in relation to some selected factors among the Lepchas, who inhabit a rural setting in the Sikkim Himalayas. The factors are divided into biological (age, sex, body morphology, disease status), behavioral (tobacco use, alcohol intake, oral contraceptive use), and socioeconomic (education) categories.

Materials and Methods

The Lepchas are a tribal population of Asian origin, with Mongoloid morphological features, believed to be indigenous to the Sikkim Himalayas (Gorer 1938). They call themselves *Rongkup,* meaning "son of snowy peak" (Tamsang 1983). In the past the Lepchas were hunter-gatherers and shifting hill cultivators; at present they are predominantly settled agriculturists. According to some researchers [e.g., Das (1978)], settled agriculture probably began to be practiced by the Lepchas of the Sikkim-Darjeeling area during the mid nineteenth century. However, Gorer (1938, p. 111) states: "In the reserve of Zongu the introduction this century of cardamum and terraced fields bound them more securely to the land." Furthermore, with changing times and the spread of education, the Lepchas are also now engaged in nonagricultural occupations.

The Lepchas' language is known as Rong, which is included in the Tibeto-Burman family of languages (Grierson 1927). In Sikkim the Lepchas generally profess the Tibetan form of Lamaist Buddhism. Monogamy is practiced by most of the Lepchas, although polygynous marriages are not rare; the Lepchas do not practice polyandry. Consanguinity is absent.

The Lepchas are distributed throughout the mountainous state of Sikkim, although their major concentration is in its North District. The Dzongu area, which lies in the lower range of Kanchenjunga, about 75 km north of Gangtok, the state capital, has 13 revenue blocks (clusters of villages) out of 45 revenue blocks in the North District and has been treated as a Lepcha reserve for a long time. In those 13 revenue blocks Lepchas are the permanent inhabitants and owners of land; no other communities are allowed to settle there permanently and to own land.

The Lepchas of Dzongu cultivate cardamom as a cash crop; cardamom was introduced at the beginning of the twentieth century. They also grow maize, paddy, millet, buckwheat, wheat, pulses, and vegetables on their own land for their own consumption. Animal husbandry is an important economic activity. The diet of Dzongu Lepchas includes cereals (e.g., rice, maize) and millets, roots and tubers, green leafy vegetables and other vegetables, meat (e.g., beef, pork, and chicken), and occasionally fish.

Consumption of alcoholic beverages is extremely common among the Lepchas, and they generally but not exclusively consume indigenous millet beer (called *chi*). Consumption of alcoholic beverages among the Lepchas is a traditional practice, and especially preparation (or procurement) of *chi* in the household, irrespective of economic status, is a culturally preferred norm. Apart from the daily consumption by most adults, *chi* is consumed in larger quantities during all social and religious ceremonies. The Lepchas "believe that *chi* has medicinal qualities" (Gorer 1938, p. 98). Millet is normally grown by all the households in the dry lands owned by them, and a sizable portion of the annual yield is used for the preparation of *chi.*

The level of consumption of common salt is fairly high in Lepchas. Salt is consumed almost regularly with tea, besides being used freely and in cooked food. It is estimated that the average salt consumption per person per day in the North District of Sikkim, where most of the residents are Lepchas and Bhutias, is 27 g (All India Institute of Hygiene and Public Health and Government of Sikkim 1994). Animal fat is often used as a cooking medium, although vegetable fats and oils are used in smaller quantities.

For the present investigation Lepcha adults of both sexes (aged 19 years and older) inhabiting three contiguous revenue blocks (Barfok, Lingdong, and Lingthem of the Dzongu area) constitute the study group. The Lepcha households from which the participants were drawn are located 3000 ft to 6000 ft above sea level. Figure 1 shows the map of the study area.

Age was estimated with the help of the Lepcha traditional calendar, which follows a twelve-year cycle with one-year periods. From the three revenue blocks 242 Lepcha adults (see Table 1 for age groups and sex breakdown), engaged primarily in agricultural practices, participated in the study.

Using a mercury sphygmomanometer, S. Mukhopadhyay took two consecutive blood pressure (systolic and diastolic) readings on the left arm of each seated subject after a 10-min rest. She also took one pulse rate measurement from each subject.

Data on body dimensions included anthropometric measurements such as height, weight, chest girths (inhaled and exhaled), upper arm girth, calf girth, and skinfold thicknesses (triceps and subscapular). Anthropometric measurements of males were taken by one observer (B. Mukhopadhyay) and those of females were taken by another observer (S. Mukhopadhyay). Height was measured using a GPM Swiss-made anthropometer. Weight was recorded on a platform spring scale, and girth measurements were taken using a mea-

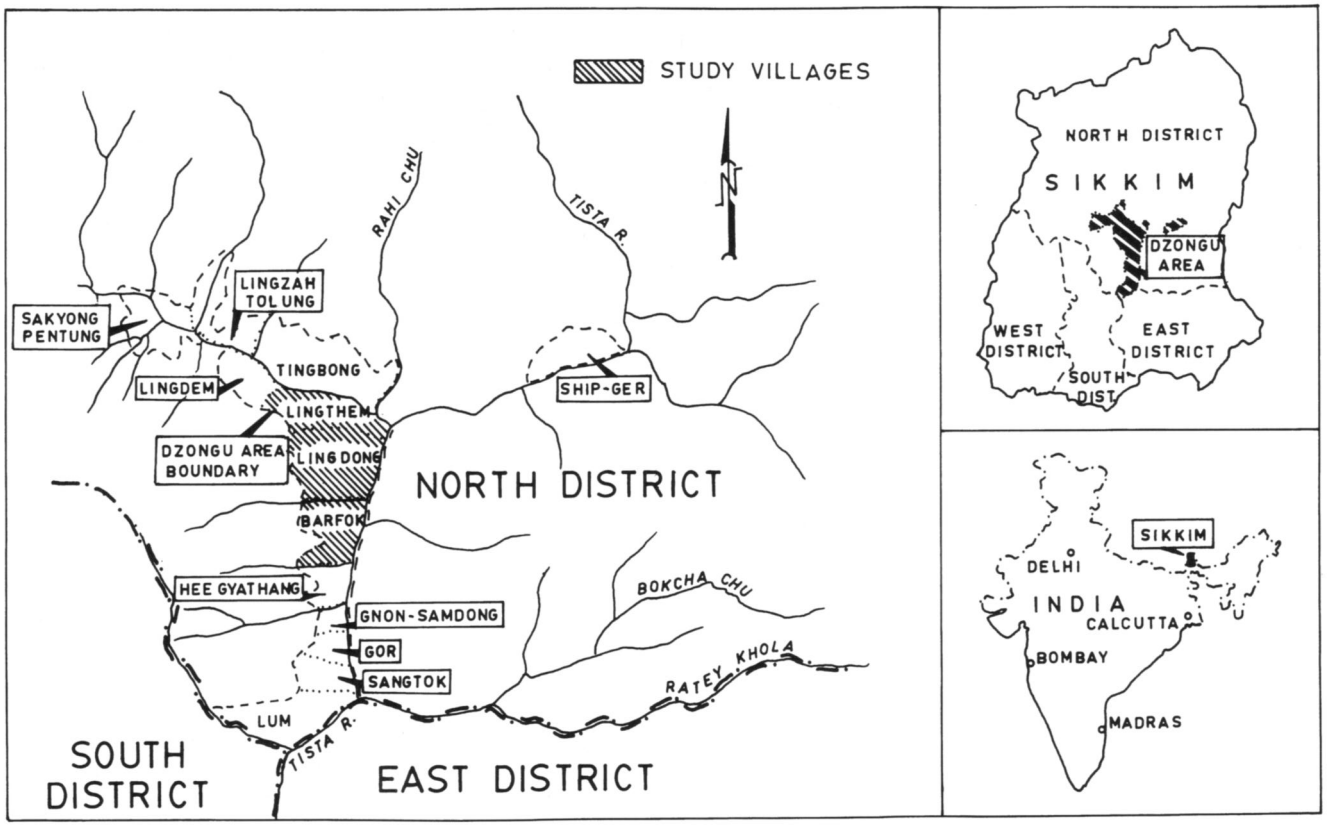

Figure 1. The study area.

Table 1. Sample Sizes by Sex and Age Group

Age Group (Years)	*Male*	*Female*
≤29	41	39
30–39	43	43
40–49	17	16
50–59	13	9
≥60	16	5
Total	130	112

suring tape. A Harpenden skinfold caliper was used to measure skinfold thicknesses, following standard techniques (Weiner and Lourie 1981).

The following data were also gathered for each subject: age, sex, level of education, tobacco use (smoking and tobacco chewing), alcohol intake, use of oral contraceptives (from married nonmenopausal females), self-reported disease status, and current use of antihypertensive drugs. The frequency distribution of sample subjects, by sex with respect to categorical variables, is shown in Table 2.

Because two readings for blood pressures were available on each subject, for the purpose of analysis the averages of the two systolic and two diastolic readings were used. However, before averaging the pressures, we adopted the following strategy. For each subject the difference between the values of the first and the second readings was computed for both systolic blood pressure (SBP) and diastolic blood pressure (DBP). If the difference between the first and the second readings exceeded 9, then the corresponding blood pressure reading was declared to be missing. (The cutoff point of 9, albeit arbitrary, corresponds approximately to the 98th percentile of the distribution of differences between readings.) From this procedure the numbers of imputed missing readings were 15 and 17 for SBP and DBP, respectively. Although the original blood pressure values showed significant skewness and kurtosis, substantial reduction in skewness and kurtosis values were obtained by log-transformation of SBP and DBP values. Hence log-transformed values of SBP and DBP have been used for the analyses.

To examine the effects of the categorical secondary variables—education, tobacco use (smoking and tobacco chewing), alcohol consumption, oral contraceptive use, and disease status—on the primary variables, that is, SBP and DBP, we regressed the quantitative secondary variables (age, pulse rate, and anthropometric variables) that showed significant effects on the primary variables. Significance of the quantitative secondary variables was assessed by treating the set of quantitative variables as a set of predictor variables for predicting either SBP or DBP. A stepwise multiple regression algorithm was used to identify a subset of significant variables from the set of predictor

Table 2. Frequency Distribution of Categorical Variables by Sex

	Male		*Female*		*Total*	
Variable	*N*	*%*	*N*	*%*	*N*	*%*
Education[a]						
Illiterate	38	29.69	75	66.96	113	47.08
Primary	57	44.53	24	21.43	81	33.75
Middle and above	33	25.78	13	11.61	46	19.17
Smoking[b]						
Low	5	3.91	2	1.79	7	2.91
Medium	0	0.00	1	0.89	1	0.42
Heavy	1	0.78	0	0.00	1	0.42
None	122	95.31	109	97.32	231	96.25
Tobacco chewing[c]						
Heavy	13	10.16	13	11.71	26	10.88
Light	26	20.31	10	9.01	36	15.06
None	89	69.53	88	79.28	177	74.06
Alcohol intake[d]						
Heavy	35	27.34	18	16.07	53	22.08
Light	71	55.47	70	62.50	141	58.75
None	22	17.19	24	21.43	46	19.17
Oral contraceptive use						
Yes	–	–	22	19.64	22	19.64
No	–	–	90	80.36	90	80.36
Disease status[e]						
Hypertension/chest pain	8	6.25	7	6.25	15	6.25
Well	120	93.75	105	93.75	225	93.75

a. Illiterate: unable to read and write. Primary: 1–5 years of schooling. Middle and above: 6 or more years of schooling.

b. Low: 10 or fewer cigarettes/day. Medium: 11–20 cigarettes/day. Heavy: More than 20 cigarettes/day.

c. Light: 5 or fewer times/day. Heavy: More than 5 times/day.

d. Light: 2 or fewer drinks/day. Heavy: More than 2 drinks/day.

e. Hypertension/chest pain: Reportedly suffering from hypertension and/or have experienced chest pain within 15 days of the survey. Well: Not reported to have suffered or suffering from vascular, circulatory, or renal disorders or diabetes.

variables. To study the effects of categorical variables, we performed analyses of covariance.

The World Health Organization's (1962) definition of hypertension (SBP $\geq$ 160 mm Hg and/or DBP $\geq$ 95 mm Hg) was used to identify hypertensive subjects, and those who showed SBP values between 141 and 159 mm Hg and/or DBP values between 91 and 94 mm Hg were identified as borderline cases.

Results

Descriptive statistics pertaining to age, SBP and DBP, pulse rate, and anthropometric variables are presented in Table 3. This table shows that with

Table 3. Descriptive Statistics Pertaining to Age, Blood Pressures, Pulse Rate, and Anthropometric Measurements by Sex

	Male (n = 115)			*Female* (n = 90)			*Total* (n = 205)		
Variable	$\bar{X}$	*SD*	*Range*	$\bar{X}$	*SD*	*Range*	$\bar{X}$	*SD*	*Range*
Age (years)	38.33	14.86	19–82	35.21	10.99	20–65	36.96	13.36	19–82
Systolic blood pressure (mm Hg)	131.62	20.06	99–230	127.65	18.35	98–188	129.88	19.38	98–230
Diastolic blood pressure (mm Hg)	88.90	14.69	59–141	84.97	13.08	60–119	87.18	14.11	59–141
Pulse rate	78.94	9.92	58–104	83.69	9.32	64–108	81.02	9.92	58–108
Weight (kg)	60.50	8.51	40.0–86.0	51.32	7.85	35.5–95.5	56.47	9.39	35.5–95.5
Stature (cm)	161.12	5.52	146.5–175.6	148.16	4.96	135.6–159.1	155.43	8.32	135.6–175.6
Chest girth (inhale) (cm)	91.20	5.90	76.4–105.3	85.13	6.47	70.0–113.0	88.53	6.84	70.0–113.0
Chest girth (exhale) (cm)	85.14	5.67	70.9–101.8	82.02	6.46	66.5–109.0	83.77	6.21	66.5–109.0
Upper arm girth (cm)	25.97	2.43	20.5–32.3	24.22	2.29	18.0–35.5	25.20	2.52	18.0–35.5
Calf girth (cm)	34.09	2.76	23.1–41.0	30.68	2.29	25.8–42.0	32.59	3.07	23.1–42.0
Triceps skinfold thickness (mm)	7.61	3.61	3.4–32.4	11.14	3.22	3.6–18.6	9.16	3.86	3.4–32.4
Subscapular skinfold thickness (mm)	12.91	7.63	4.8–38.4	13.06	4.52	5.4–40.8	12.97	6.43	4.8–40.8

Table 4. Results of Stepwise Multiple Regression Analysis Using Only Anthropometric Variables As Predictors

Dependent Variable	*Data Set*	*Sample Size*	*Significant Quantitative Predictors*	R^2
ln SBP	Male	115	Age	0.20
	Female	90	Age^2, triceps skinfold thickness	0.41
ln DBP	Male	115	Age, age^2	0.27
	Female	90	Age, triceps skinfold thickness	0.31

All R^2 values are significant at the 5% level.

respect to both SBP and DBP males have higher mean values compared with females, whereas the reverse trend is found for pulse rate. However, the sex differences are not significant at the 5% level. With respect to anthropometric variables, as expected, males have higher mean values compared with females, except for triceps and subscapular skinfold thicknesses.

Table 4 provides the results of the stepwise multiple regression analysis using age and anthropometric variables as predictors of log-transformed SBP and DBP. It is evident from the table that a significant effect of age exists on both SBP and DBP for both sexes. Furthermore, nonlinear (quadratic) age trends were noticed for SBP in females and for DBP in males. The scatter diagrams of SBP and DBP, with lines of best fit and 95% confidence intervals, are presented in Figure 2 for males and females. Of the eight anthropometric variables considered, none was found to affect SBP and DBP significantly among males, although a significant effect for triceps skinfold thickness was found among females.

To investigate the effects of qualitative categorical variables on the primary variables, we performed an analysis of covariance separately for each sex. Covariates used for each primary variable and for each sex were those identified as significant predictors, as given in Table 4. Only alcohol intake was found to have a statistically significant effect on SBP among males (F ratio = 3.93; d.f. = 2, 115, p = 0.022). Mean adjusted SBP was found to increase with increasing intake of alcohol (Table 5).

Table 6 shows the frequency distribution of hypertensive subjects, borderline cases, and normotensive subjects by sex. The percentage of hypertensive subjects in the study population is remarkably high irrespective of sex. However, higher percentages of hypertensive subjects and borderline cases were found among the males compared with females.

Discussion

The present study demonstrates that the blood pressure level among the adult Lepchas inhabiting a rural setting in the Sikkim Himalayas is conspic-

uously high compared with other ethnoculturally distinct rural populations living in the plains areas of the adjacent Indian state of West Bengal [e.g., Mukherjee et al. (1988) and Majumder et al. (1990)]. There are indications that some migrant populations, for instance, Oraons, Tamangs, and Sherpas of the Terai and foothills (Kalimpong) of the eastern Himalayas also show rather high blood pressure levels (Bhattacharya et al. 1988; Basu et al. 1982). It can be argued that differences in the physical and social environments and possibly genetic factors contribute to blood pressure variations among populations living in contrasting ecological zones.

Some researchers have observed that in many nonurbanized rural populations blood pressure does not increase significantly with age and that hypertension is practically absent (Lowenstein 1961; Sinnet and Whyte 1973). The present study does not support these earlier observations because a significant age effect on blood pressure and a high prevalence of hypertension have been found in the present rural study population, members of which are primarily engaged in orthodox agrihorticultural pursuits.

A sex effect on blood pressure has not been found to be significant, although females have a slightly lower mean blood pressure compared with males (see Table 3). This trend has generally been observed in many earlier studies.

Interestingly, although none of the anthropometric variables considered was found to be a significant predictor of blood pressure among males, triceps skinfold thickness was a significant predictor of blood pressure among females. (We have verified that this effect is not artifactual by the presence of a few obese females. In the present data, 7% of females had a triceps skinfold thickness greater than or equal to 15 mm.)

Although several studies have suggested that education is either inversely [e.g., Dyer et al. (1976) and McGarvey and Schendel (1986)] or sometimes directly [e.g., Hutchinson (1986) and Mukherjee et al. (1988)] related to blood pressure, the level of education was not a significant correlate of blood pressure in the present population. Possibly, behavioral changes in terms of dietary practices, health awareness, etc., which are generally expected to occur with an increase in the level of education, have not been marked in this population.

Behavioral and health traits such as smoking, tobacco chewing, oral contraceptive use, and disease status do not affect blood pressure significantly in the study population. Explanations for such a finding cannot be readily offered. Smoking has been amply demonstrated to be one of the important factors influencing blood pressure level. In the present study, however, a relationship between smoking and blood pressure is not discernible, perhaps primarily because of the extremely low percentage (3.46%) of smokers.

Alcohol intake is the only behavioral trait that was found to have a significant effect on SBP among males. Mean SBP level consistently increases from nondrinkers to heavy drinkers (see Table 5). We also note that

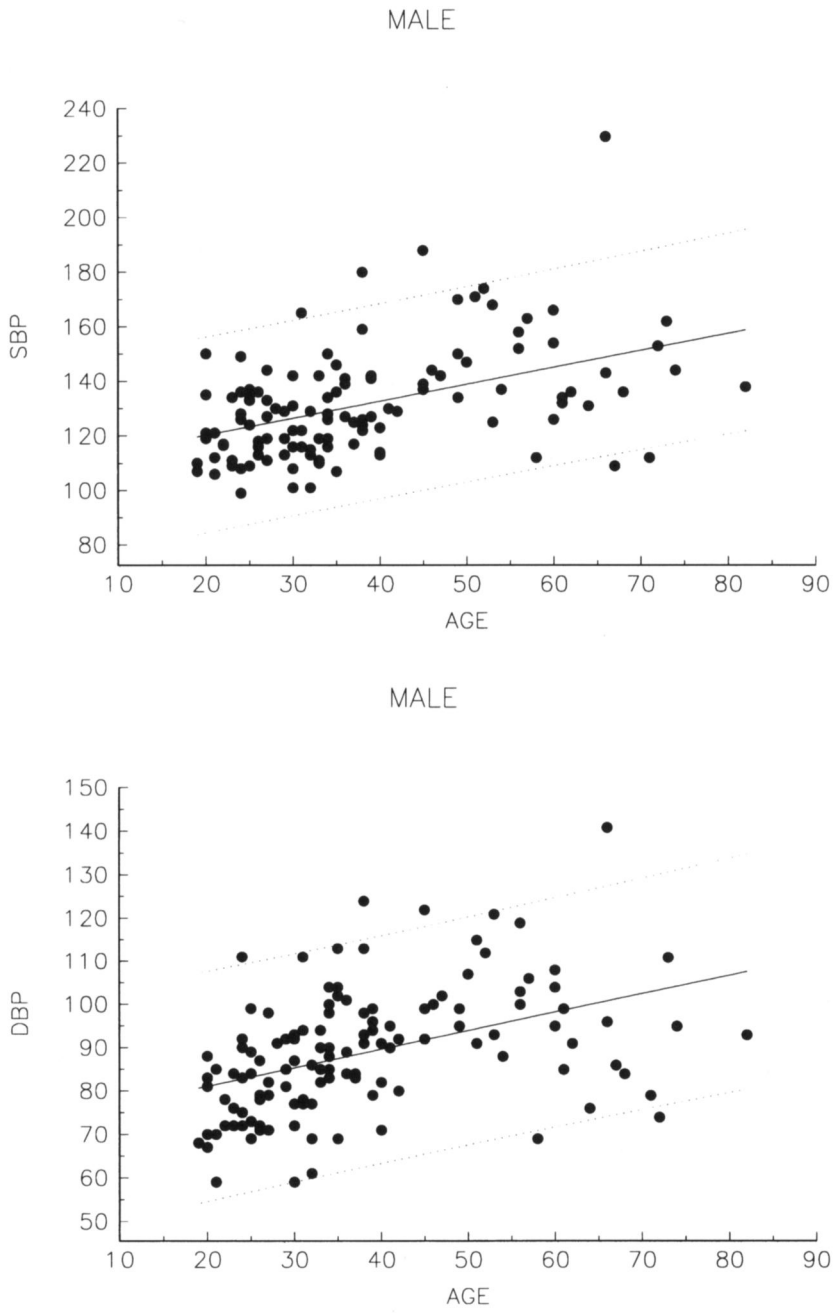

Figure 2. Systolic and diastolic blood pressures, lines of best fit, and 95% confidence intervals among Lepcha males and females.

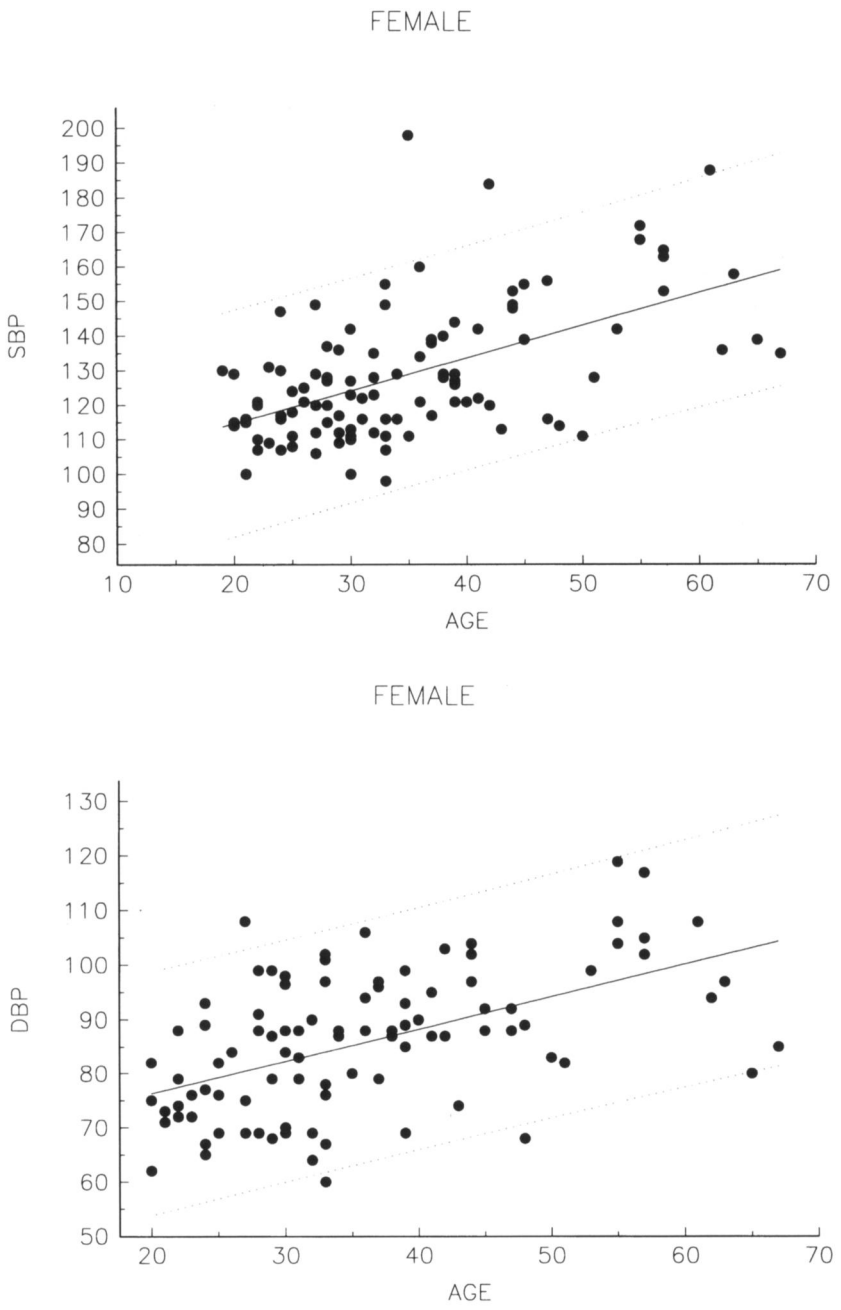

Figure 2. Continued.

Table 5. Adjusted Mean Systolic Blood Pressure by Degree of Alcohol Intake among Males

	Heavy Intake	*Light Intake*	*None*
Systolic blood pressure	134.29	130.32	122.73
n	32	65	22

this trend, albeit statistically nonsignificant, is also present for DBP among males and for both SBP and DBP among females. Several studies have already demonstrated the positive relationship between alcohol intake and blood pressure (Cooke et al. 1983; Intersalt Cooperative Research Group 1988). Kaplan (1986) observed that, although alcohol when consumed in moderate amounts appears to protect against coronary heart disease, alcohol nevertheless can elevate blood pressure, even in moderate amounts.

In our study population the proportion of hypertensive subjects [following the World Health Organization's (1962) definition of hypertension] is much higher compared with several other Indian populations studied from rural and urban areas having diverse sociocultural characteristics and dietary practices. For example, in a rural agricultural population inhabiting a southern deltaic coastal region of West Bengal and in the Marwaris of Calcutta, who are engaged in trading, the prevalences of hypertension are 1.42% and 17%, respectively (Majumder et al. 1990, 1994). Nirmala and Reddy (1991) revealed that in eight socioculturally distinguishable caste and tribal communities of Andhra Pradesh the prevalence of hypertension varied between 1.92% and 12.50% in males and between 1.10% and 12.50% in females. Gupta and Gupta (1993) reported that in rural Rajasthan, out of 306 patients with cardiovascular diseases treated in a health center over 8 years, 38 (12.4%) were suffering from hypertension. The Intersalt Cooperative Research Group's (1988) findings reveal that prevalences of hypertension among populations of Ladakh and Delhi are 10.0% and 13.6%, respectively.

Table 6. Frequency Distribution of Hypertensive Subjects, Borderline Cases, and Normotensive Subjects by Sex

	Hypertensive		*Borderline*		*Normotensive*	
Sex	*N*	*%*	*N*	*%*	*N*	*%*
Male (n = 117)	36	30.77	17	14.53	64	54.70
Female (n = 97)	25	25.77	8	8.25	64	65.98
Total (n = 214)	61	28.50	25	11.68	128	59.81

It can be surmised that the cultural practice of the study population favoring regular use of alcoholic beverages often in large quantities, especially indigenous millet beer (*chi*), is the major factor contributing to high mean blood pressure levels and a high prevalence of essential hypertension. Finally, it can also be noted that our observation of regular inclusion of black tea with salt (in addition to the free use of salt with meals and in cooked food) by many of the study subjects may play an additional important role in elevating their blood pressure levels.

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