Blood Pressure in a Rural West Bengal Fishing Community: An Epidemiologic Profile

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Abstract Blood pressure readings were collected from the inhabitants of a small fishing village in West Bengal, India. Anthropometric measurements, pulse rate, and interview data on demography, occupation, eduation, smoking and alcohol use were also collected. Sex differences in blood pressure are not significant in this population, although significant age trends do exist. Some anthropometric variables have low but statistically significant correlations with adult blood pressure, particularly for diastolic pressure in females. Smoking behavior in adult males has an inverse association with blood pressure, but not with anthropometric variables or pulse rate. Educational level, which may reflect socio-economic differences in males, has a significant positive association with blood pressure, height, weight, and subscapular skinfold thickness. When the effects of anthropometrics, smoking, and education on blood pressure were assessed simultaneously through stepwise multiple regression, only educational level entered the regression equation for systolic pressure and only smoking predicted diastolic pressure in males. In females, anthropometric variables alone predict blood pressure, however there is extremely little variability in female education and smoking behavior. The results for men suggest that education and smoking exert opposite effects on blood pressure in this population, and that they do not operate primarily through their effect on body size or fatness.

The determinants of hypertension have been thoroughly explored in western populations. In addition to genetic predisposition (Acheson et al. 1967; Annest et al. 1979; Biron et al. 1976; Havlik et al. 1979; Johnson et al. 1965; Miall and Oldham 1963), numerous aspects of the physical and social environment, such as diet, stress, and smoking, have been shown to influence blood pressure (Castelli 1982). In western culture, socioeconomic status and occupation generally have negative associations with blood pressure, that is, those at the highest levels in terms of income or status have lower blood pressure than those in the

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working classes (Henry and Cassel 1969; Scotch and Greiger 1963). Large body size and fatness are associated with high blood pressure in industrialized nations (Chiang et al. 1969). The purpose of this paper is to examine the relationships among socioeconomic status, as reflected in level of education, anthropometric measurements, smoking, pulse rate, and blood pressure in a non-western population.

Materials and Methods

The study location is in the state of West Bengal, India, about 180 km. southwest of Calcutta. A total of 440 people in 53 households was measured for height, weight, three skinfolds (biceps, triceps, and subscapular), and blood pressure. The first two systolic and diastolic readings were taken by the same investigator five minutes apart with an electronic digital readout instrument. The third measurement was taken by a second investigator using a standard mercury sphygmomanometer. Multivariate analysis of variance with a repeated measures design indicates that significant systematic differences exist between measurements made with the two devices. The difference averages 6% between the first and third readings. This suggests that caution must be exercised when comparing studies using the newer digital technology with those using the standard mercury instrument. For this reason, further analysis in this paper will involve the mercury readings. Two measurements of pulse rate were also recorded. The mean of the two readings is used for analysis.

In addition to anthropometric and blood pressure measurements, data on household composition, pedigree structure, education, occupation, smoking and alcohol use, previous diagnosis of hypertension, and use of anti-hypertensive drugs were collected. Individuals under treatment for hypertension were not included in the analysis of blood pressure.

The sample breakdown for adults ($\geq$20 years of age) in terms of occupation, education, and smoking behavior is given in Table 1. As might be expected in a traditional fishing village, the majority of adult men (71%) gave "fishing" as their occupation. A small proportion were involved in manual labor, agriculture, or white collar work; the "other" category includes older "retired" men. The vast majority of women classified themselves in the "other" category, which includes the equivalent of "housewife".

In terms of educational level, 62% of the sample is unable to read and write. This proportion is largest in adult females, 80% of whom fall into this category. The range of educational levels is wider in men, with a small proportion (3%) having graduated from secondary school.

The amount of smoking was categorized in terms of the number of cigarettes or bidis smoked per day. A light smoker consumes less than 10 cigarettes or 15 bidis per day, a medium smoker between 10 and 20 cigarettes or 15-30

Table 1. **Occupation, Education, and Smoking in Adults**

	Sex			
	Males		*Females*	
Occupation				
Fishing	110	71%	3	2%
Manual Labor	4	2	1	0
Agriculture	3	1	0	0
White Collar	6	3	0	0
Other	32	20	144	97
Total	156	100	149	100
Education				
Illiterate	69	44%	119	80%
Below Primary	27	17	13	8
Primary	38	24	12	8
Secondary	16	10	4	2
Graduate	5	3	0	0
Total	155	100	148	100
Smoking				
Non-smoker	23	14%	140	92%
Light	31	20	3	2
Medium	77	50	3	2
Heavy	23	14	1	0
Total	154	100	147	100

bidis, and a heavy smoker more than 20 cigarettes or 30 bidis per day. Although the breakdown in males is fairly even, only 7 women admitted to any level of smoking.

All subjects indicated that they were of the Hindu religion. Although they are distributed among 10 different castes, it is likely that diet, activity level, and lifestyle habits are similar among castes in this village. No females admitted any alcohol use, and only seven men said that they ever drank alcohol.

Twelve of the respondents indicated a previous diagnosis of hypertension; four of them are presently on anti-hypertensive drug therapy. Another nine subjects indicated that they were taking anti-hypertensive drugs. Blood pressure readings for all 13 subjects on anti-hypertensive drugs were deleted from the sample in subsequent analysis. An additional six individuals were found to be suffering from hypertension according to the usual definition (above 160 mmhg. systolic or 95 mmhg. diastolic). This would bring the total prevalence of hypertension in adults to 6%.

Sex differences and age trends in the entire sample are examined through the use of analysis of covariance with sex as a categorical variable and age, age^2, and age^3 as covariates. The relationships among pulse rate, anthropometric measurements, and blood pressure in adult males and females are assessed by product-moment correlation coefficients. The effects of smoking and education on these variables in males is evaluated through analysis of variance. Finally, anthropometric variables, smoking, and educational level are used to predict blood pressure in adult males and females using stepwise multiple regression.

Results

Age and Sex. Systolic and diastolic blood pressure plotted by sex and age cohort are presented in Figure 1. In both sexes, an upward trend with age is found. Males exceed females in the 20's and 30's, but females in this sample have higher pressures in their 60's. Sex differences and age trends were investigated by analysis of covariance with age, age^2, and age^3 as covariates and sex as a categorical variable (Table 2). Only the covariates were found to exert significant effects on blood pressure variation. The age trend is primarily linear for systolic and quadratic for diastolic pressure.

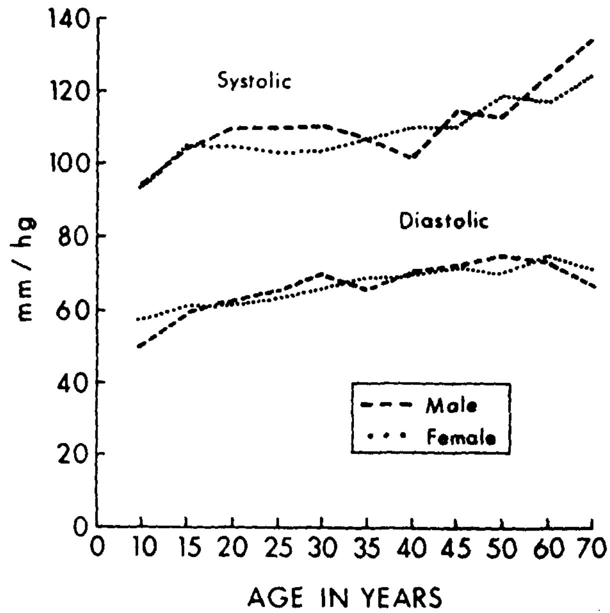

Figure 1. Systolic and diastolic blood pressure readings by age-sex cohort.

Table 2. **Manova F-Ratios for Age and Sex Effects on Mercury Blood Pressure Readings**

Source	*Systolic*	*Diastolic*
Covariates: Age	98.32***	95.16***
Age^2	0.09	33.55***
Age^3	2.22	0.31
Age*Sex	0.18	0.04
All Covariates:	25.20***	32.27***
Main Effects: Sex	1.59	1.08
Total Explained	20.48***	26.03***

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Pulse Rate and Anthropometrics. Pearson product-moment correlation coefficients for age adjusted blood pressure, pulse rate, and anthropometric variables in adults are shown in Table 3. Systolic and diastolic blood pressure are highly correlated in both sexes. The only other significant blood pressure correlation for males is between systolic pressure and weight, whereas for females, triceps skinfold is significantly correlated with systolic pressure, and weight, triceps, and subscapular skinfolds are significantly correlated with diastolic blood pressure. As shown in the remainder of Table 3, the anthropometric variables are quite highly intercorrelated, suggesting that multivariate techniques may reveal a different pattern of relationship between anthropometrics and blood presure than that found in the bivariate analyses.

Smoking and Educational Level. Variation in smoking behavior and education is insufficient for analysis of variance in women. The results of analysis of variance for systolic and diastolic blood pressures by smoking category in men are presented in the first two columns of Table 4. Group means are significantly different for both variables. Age-adjusted blood pressure is lower in smokers than in non-smokers, and heavy smokers have the lowest values of the four groups. A test for linearity of the decline is significant for diastolic but not systolic pressure. Significant deviation from linearity exists for both variables, primarily because the "medium" smokers have higher values than predicted by a linear relationship. The Student-Newman-Keuls multiple comparison test was used to determine which group means are significantly different. For both measurements, the distinction is between non-smokers and all smokers, except that for systolic blood pressure, non-smokers could not be distinguished from medium smokers. Surprisingly, smoking status has no significant effect on pulse rate or anthropometric variables. Therefore, the relationship between smoking and lower blood pressure is not simply due to the effect of smoking on body fat.

Table 3. **Correlations among Blood Pressure, Pulse Rate, and Anthropometric Measurements in Adults**

	Systolic BP	*Diastolic BP*	*Pulse Rate*	*Height*	*Weight*	*Biceps SKF*	*Triceps SKF*	*Subscap. SKF*
Systolic BP		0.660***	−0.011	0.121	0.165*	0.115	0.066	0.095
Diastolic BP	0.683***		0.093	0.129	0.077	0.035	0.065	0.077
Pulse Rate	0.133	0.277**		−0.065	−0.032	0.118	0.056	0.034
Height	−0.049	0.091	−0.099		0.600***	0.177	0.162*	0.173*
Weight	0.153	0.235**	0.090	0.448***		0.547***	0.573***	0.691***
Biceps SKF	0.100	0.156	0.156	0.011	0.578***		0.753***	0.688***
Triceps SKF	0.176*	0.210*	0.148	0.054	0.663***	0.783***		0.774***
Subscap. SKF	0.156	0.230**	0.175*	0.012	0.645***	0.727***	0.806***	

Correlation coefficients for males in upper right triangle; correlation coefficients for females in lower left triangle.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Table 4. **Age-Adjusted Blood Pressure, Pulse Rate, and Anthropometric Means by Level of Smoking for Adult Males**

Smoking	*n*	*Systolic BP*	*Diastolic BP*	*Pulse Rate*	*Height*	*Weight*	*Biceps SKF*	*Triceps SKF*	*Subscap. SKF*
Non-smoker‘	21	0.443	0.716	−0.015	−0.011	−0.070	0.159	0.210	−0.057
Light	30	−0.262	−0.239	−0.005	0.092	0.163	−0.013	−0.120	−0.067
Medium	74	0.093	−0.002	−0.028	−0.153	0.026	0.039	0.062	0.124
Heavy	23	−0.387	−0.461	−0.083	0.372	−0.168	−0.296	−0.211	−0.199
Analysis of Variance:									
Among groups:		3.598*	6.555***	0.053	1.172	0.518	0.896	0.892	0.744
Linearity:		3.425	11.152**	0.090	0.302	0.215	1.488	0.802	0.002
Deviation:		3.685*	4.257*	0.034	2.424	0.670	0.600	0.937	1.115

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

A possible intervening factor in the smoking-blood pressure-fatness relationship is socio-economic status. SES in this community cannot be measured by occupation, since most men are involved in fishing. Instead, education may give some information about SES. As shown in Table 5, education is associated with higher blood pressure, larger body size and increased fatness. Smoking and educational level are inversely related in adult males, with lower educational level associated with higher levels of smoking (Kendall's Tau = −0.212, $p < .01$). Men with more education are larger and heavier, are less likely to smoke, and have higher mean blood pressure levels than those with less education.

Multiple Regression. To evaluate the effects of body size, smoking, and education on blood pressure simultaneously, a stepwise multiple regression was conducted separately for adult males and adult females, with age adjusted systolic and diastolic blood pressures as dependent variables and age adjusted anthropometric measurements, smoking status, and educational level as independent variables. A quadratic term for smoking level and an interaction term for smoking and education were also included. For males, education is the only significant predictor of systolic blood pressure, explaining 5% of the variation. Smoking status is a significant predictor of diastolic pressure in males ($R^2 = .06$), and education is nearly significant ($p = 0.069$). The effect of smoking on diastolic pressure remains, even when all the anthropometric variables and educational level are forced to enter the regression equation first.

For females, triceps skinfold is the best predictor of systolic pressure ($R^2 = 0.03$), and weight the best predictor of diastolic pressure ($R^2 = 0.05$). Because most females are non-smokers and have little education, it is difficult to assess the effects of these variables on their blood pressures.

Discussion

Unlike urban Indians (Rao 1983) or recently acculturated groups (Cassel 1974), the rise in blood pressure with age is moderate in this population, and is not severely sharper in females than in males.

A negative relationship between smoking and blood pressure is not a completely new finding (Berglund and Wilhelmsen 1975). Previous authors have suggested that the relationship operates through the intervening variable of weight or fatness (Havlik et al. 1980; Hart 1980). In this population, however, there is no relationship between smoking and anthropometric measures of weight or fatness. Neither is there a relationship between the anthropometric variables and blood pressure in males. This suggests that the relationship be-

Table 5. **Age-Adjusted Blood Pressure, Pulse Rate, and Anthropometric Means by Level of Education for Adult Males**

Education	n	*Systolic*	*Diastolic*	*Pulse*	*Height*	*Weight*	*Biceps*	*Triceps*	*Subscapular*
Illiterate	65	−0.191	−0.256	0.091	−0.229	−0.247	−0.164	−0.939	−0.154
Below Primary	26	0.233	0.193	−0.199	−0.238	−0.112	0.114	−0.108	−0.095
Primary	38	−0.101	−0.007	−0.204	0.033	0.072	−0.070	−0.023	−0.018
Secondary	15	0.159	0.220	0.718	0.884	0.775	0.361	0.277	0.688
Graduate	5	1.345	1.072	−0.003	1.101	0.673	0.568	0.625	0.276
Analysis of Variance:									
Among groups:		3.649**	3.158*	0.746	6.276***	4.310*	1.462*	1.006	2.523*
Linearity:		7.341**	9.142**	0.509	19.443***	14.177**	3.911*	2.970	5.803*
Deviation:		2.418	1.164	0.825	1.886	1.021	0.645	0.351	1.429

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

tween smoking and blood pressure is not due to the effects of smoking on body composition.

The finding that higher levels of education are associated with higher mean blood pressure is contrary to results from U.S. populations (Stamler et al. 1967), but agrees with Hutchinson's (1986) results from the Caribbean. In more traditional societies where advanced education is unusual, well educated individuals may be subjected to stress due to greater responsibility in the community and family, as well as the disparity between their training and the types of work available to them. At the same time, well educated men are less likely to smoke than less well educated men. Therefore, the negative relationship between smoking and blood pressure may be due to the stressful effects of higher education and its sequelae in a rural, traditional community.

At the same time, however, education may exert its effect on blood pressure through increased body size, since well educated men are heavier and fatter than other men in this population. To test this hypothesis, anthropometrics, smoking, and education were used to predict blood pressure in a stepwise multiple regression analysis. For men, none of the anthropometric variables enter the regression equations. Education is the only significant predictor of systolic blood pressure, and only smoking predicts diastolic pressure in men. In women, body fatness and weight are the only significant predictors of blood pressure. Since there is very little variation in female education or smoking behavior, it is not possible to hypothesize about the effects of these variables on female blood pressure. The results in men, however, suggest that education and smoking exert opposite effects on blood pressure, and that they do not operate primarily through their effects on body size.

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