Korean Nationwide Blood Pressure Study

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A Nationwide arterial blood pressure survey in Korea was conducted for the first time with 9,790 persons selected as a probability sample. The survey was done from March to September 1980.

The objectives of the survey were to measure the distribution of arterial blood pressures and the magnitude of hypertension by demographic and socioeconomic variable characteristics in the Korean cultural setting. To examine more critically the local notions, beliefs and hypotheses related to hypertension, as well as the relation between salt intake and blood pressure, were also part of the objectives of the study.

General patterns of distributions of blood pressures by age and sex were found to be very similar to that of other countries.

However, remarkably lower mean systolic blood pressures found at all ages in females, consistently low prevalence rates for hypertension in both sexes, low rates for systolic hypertension in females and remarkably higher rates for diastolic hypertension in both sexes were found.

The more educated, those with higher incomes, the more mental work done and dwellers of the larger cities had the higher blood pressures. These findings are compatible with beliefs long held by Koreans. A negative correlation was also observed indirectly, however, between salt intake and blood pressure.

Key Word: Blood pressure

Along with the rapid economic growth, the leading causes of death in Korea have completely changed within the past 10 years from those of infectious diseases to chronic noninfectious diseases (Lee, 1979). Common causes of death even among the rural population are cerebrovascular disease (CVD) and malignant neoplasms (Kim and Lee, 1977).

The death and incidence rates for cardiovascular disease, which is the major cause of death in most of the western developed countries, have been reported as unusually low in Korea. It has not yet even appeared in the 10 leading
causes of death. On the other hand, according to a study done in rural Korea (Kim et al., 1980), the specific death rate for CVD exceeds 180 per 100,000 which is considered to be very high by world standards.

Essential hypertension has been well known as a major intermediate cause of CVD. Hypertension, therefore needs to receive more attention as a factor related to the high CVD death rates in Korea.

It has long been hypothesized that the prevalence rate for hypertension would be very high among Koreans even though this was not supported by any concrete scientific information. This is because all the foods, associated with the hypotheses so far developed for the causes of essential hypertension, exist in sufficient quantity in the Korean average diet. For instance, low protein and high salt intakes have been hypothesized by Japanese epidemiologists as being major factors associated with the incidence of hypertension (Komachi, 1977; Hatano et al., 1976). It has been well known that Koreans consume very large amounts of salt. Dr. Kesteloot has recently measured salt intake in Korea and reported that Koreans on the average consume the unusually large amount of 20-25 gms of salt a day (Cha and Suh, 1970). It is also well known that Koreans had consumed relatively little animal protein until recently. The low serum cholesterol level of Koreans further supports this fact well (Tanaka et al., 1977; Sohn et al., 1968).

It is generally believed that people living in the southern part of the country consume more salt than those in the north, and those in rural areas more than those in cities. Further, it is thought that people living in rural areas belong to a lower socioeconomic class and thus consume less protein. As a corollary, it has long been believed, and observed by physicians and the general population, that hypertension in Korea is a disease of the rich and the educated. This belief is at variance with the experience of most western countries (Jenns, 1934; National Center for Health Statistics, 1974).

Despite all these beliefs and hypotheses, however, there have been no clear studies on the magnitude and distribution of blood pressure elevations in Korea and very few attempts to prove or disprove those various beliefs and hypotheses.

The specific objectives of the study reported here were to use a nationwide survey
1) To measure the magnitude and distribution of arterial blood pressures of Koreans and
2) To identify and clarify the general notions, beliefs and hypotheses related to hypertension in Korea.

METHODS

1) Population studied

This study was designed to be nationwide in scale using representative samples from the entire population and to be carried out in conjunction with the 4th national T.B. prevalence survey.

The Ministry of Economic Planning Board (EPB) has already established a sampling frame for a nationwide census. This divides the nation into 86,452 Enumeration Districts(ED). One ED consists of approximately 35 households in urban areas and 70 households in rural ones.

For the routine collection of information on economic activities, 423 EDs are sampled, with a multistaged stratified sampling method, by the Economic Planning Board.

For the arterial blood pressure study, only those who were over the age of 30 were selected. The total number of the population over the age of 30 in sampled population was 9,790, 5,594 and 4,196 for urban and rural areas respectively.
All these 9,790 persons were chosen as the population for this study while this sample size of 9,790 persons may be larger than necessary. Ninety seven hundred and eighteen persons (98.2%) out of the 9,790 were actually examined and measured. The demographic structures of the entire population and the sample population were compared and the sample found to be fairly representative (Fig. 1).

![Graph](image)

**Fig. 1.** Age and sex structure of sampled and reference population.

2) Methods of B.P. Examination

A semi-automatic sphygmomanometer with aneroid manometer was used for this study to reduce experimental errors. The sphygmomanometer was designed to blink and beep from the starting point of the systolic pressure and to disappear at the 5th Korotkoff sound of the diastolic. The semi-automatic sphygmomanometers were regularly tested against standard, mercury type sphygmomanometers and found to be acceptable.

Four nurses were hired and trained largely according to the recommendations of the American Heart Association (Kirkendall et al., 1976).

The subjects were informed on the previous evening to come with an empty bladder, having not smoked for two hours, and were asked to relax for at least 5 minutes before measurements were begun.

Two independent measurements of B.P. of the subjects were taken 5 minutes a part. During the two blood pressure measurements, very brief questions were asked in order to obtain additional information as well as to help the clients relax so as to ensure a base line blood pressure. The second measurement was used for the analysis because the second measurement was assumed to be obtained with the subject in a more relaxed state. 5th phase diastolic pressures were recorded and used for the analysis.

Basic demographic variables and the socioeconomic variables were obtained from previous survey results of the EPB collected for other purposes. For the collection of health behaviour variables the subjects were questioned at the time of the examination.

The occupation of the subjects was largely divided into three categories: mental worker, physical worker and others. The income of the group was broken down into three categories also: high (a monthly income above W300,000), middle (a monthly income between W100,000 and W290,000) and low (a monthly income less than W100,000).

The area of residence was divided into three categories: large city, small and medium cities, and rural. The place of birth was also divided into three categories: north, middle and south.

RESULTS

1) Distribution of Blood Pressures

The distributions of systolic blood pressures of the total population, by sex, are shown in fig. 2. They show a smooth unimodal curve, skewed to the right. The peak of the curve for males is located between 120-129 mmHg and for females between 110-119 mmHg. The peaks of the modes of the two sexes, therefore,
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Fig. 2. Distribution of systolic blood pressures by sex for age over 30.

Fig. 4. Systolic blood pressures for males by age.

Fig. 3. Distribution of diastolic blood pressures by sex for age over 30.

Fig. 5. Systolic blood pressures for females by age.

differs by about 10 mmHg with the higher being that of males (Fig. 2).

The distributions of diastolic blood pressures also shows unimodal curves with peaks between 75-84 mmHg in both sexes. The distributions of diastolic pressures for males is slightly deviated to the right compared with that of the female. The diastolic pressure curves of both sexes show a slight skew to the right but far less than that of the systolic blood pressures (Fig. 3).

When the distributions of systolic blood pressures are drawn according to age intervals, more skewedness to the right is observed in the older age group. This is true for both sexes, the peaks of both curves tending to move to the right. This tendency is most marked for the age of 70-and-over in both sexes (Fig. 4, 5).

The distributions of diastolic blood pressures by age show very consistent unimodal curves with peaks between 75-84 mmHg in both sexes regardless of their ages. The tendency of skewedness to the right of older persons is seen but is
far less marked than that of systolic blood pressures (Fig. 6, 7).

2) Distribution of Mean Blood Pressures

Fig. 8 shows the distributions of mean systolic and diastolic blood pressures by age and sex. The mean systolic blood pressures increased by age in both sexes but are higher in male, the differences between two sexes being larger in younger age groups.

The mean diastolic blood pressures show a different pattern than that of the systolic blood pressures. They do not increase consistently by age. The mean diastolic blood pressures increase from age 30 up to 55 but then maintain a plateau until the age 70-and-over when they show a slight drop (Fig. 8).

Fig. 8. Mean systolic and diastolic blood pressures by age and sex.
sive, borderline and hypertensive, the prevalence rates for hypertension over the age of 30 are 14.0% for males and 9.8% for females. An interesting finding is that the prevalence rates for diastolic hypertension are about 3 times higher in males, and 2.5 times higher in females, than that of systolic hypertension. When adjusted for age, the finding is still consistent. When the age specific prevalence rates are compared, these findings are again consistent in all ages and in both sexes.

Figures 9, 10, 11 show prevalence rates for hypertension by age and sex. The prevalence rates for systolic hypertension increase steeply by age in both sexes, with males being about 5% higher. In general, however, the prevalence rates for systolic hypertension are fairly low. Even for the 70-and-over age group, prevalence rates were only 29.2% for males and 21.8% for females.

The prevalence rates for diastolic hypertension by age do not show the same pattern as that of systolic hypertension. In males, the rates increase from age 35 to 45 and thereafter maintain a plateau. In females, the prevalence rates of hypertension increase by age up to 69 and thereafter begin to drop.

3) Distribution of Blood Pressures by Selected Socioeconomic Variables

(1) Residential Area: The mean systolic and diastolic blood pressures of males by age and
residential area clearly show that people residing in large urban areas show higher mean blood pressures than those residing in rural areas. Also the differences among males in the mean blood pressures of the three areas of residence are bigger in the older age groups, especially for diastolic pressures. In females, however, this tendency does not appear for the systolic pressures at all and only very slightly for the diastolic (Fig. 12, 13).

(2) Place of Birth: The mean systolic and diastolic blood pressures in males by age clearly show that higher mean blood pressures, both systolic and diastolic, are recorded for people born in the north than for those born in the south. The mean blood pressures of males born in the middle areas is found to be the lowest of all, for all ages.

The mean blood pressures of females do not show, however, any appreciable differences according to place of birth.

(3) Education: In males, both mean systolic and diastolic blood pressures are lower in the less educated and higher in the more educated at all ages, except for those who are 70-and-over. This tendency is more distinct in the mean diastolic blood pressures in males than in the mean systolic pressures. This tendency is reversed in females in regard to mean systolic blood pressures. On the other hand, diastolic blood pressures of females up to age 60 show no distinction by the level of education. From age of 60, however, a clear quantitative difference is seen among the three categories but without any relationship to the level of education.

(4) Occupation: In males, the mean systolic and diastolic blood pressures of mental workers are higher at almost all ages compared to the physical workers. These findings, however, are not shown in females for either systolic or diastolic blood pressures at all ages.
(5) Family income: The mean systolic and diastolic blood pressures of males are seen to be highest in the higher income group, lower in the middle and lowest in the low income group. The mean blood pressures in females show no differences by income groups.

DISCUSSION

The general pattern of the distributions of systolic and diastolic blood pressures of Koreans by age and sex appear to be very similar to that of other countries without any notable specific characteristics (National Center for Health Statistics, 1974; Lee et al., 1967; Eilertsen and Humerfelt, 1968; Stortz and Shorr, 1973; Sive, 1971).

The distribution of mean blood pressures, however, disclose very interesting findings when compared with that of other countries. The reversal phenomenon of systolic blood pressures between the sexes in older ages, as is seen in other countries (National Center for Health Statistics, 1974; Lee et al., 1977; Eilertsen and Humerfelt, 1968; Stortz and Shorr, 1973; Nemet et al., 1968) does not appear in this study even though the differences in systolic pressures between the two sexes does become smaller in the older age groups.

The pattern of distributions of mean systolic and diastolic blood pressures by ages for males is more or less similar to that of other studies done in other countries except for slightly higher diastolic blood pressures (Fig. 14). But for females, the mean systolic blood pressures by age are seen to be consistently and remarkably
Fig. 16. Prevalence rates for hypertension by age and sex compare with the U.S.A. and Korea.

lower than those of other studies although the pattern of distributions of mean diastolic blood pressures is compatible with those of other studies (Fig. 15). These remarkably lower mean systolic blood pressures might explain the lack of the reversal phenomenon.

Using the WHO definition, the prevalence rates for hypertension is relatively low for all ages in both sexes as shown in Fig. 16 as compared with that of the USA. When the rates are broken down into systolic, diastolic and sexes, they show interesting features. In males, the prevalence rates for diastolic hypertension are remarkably higher than those of other studies for all ages while the rates for systolic hypertension are more or less similar to that of the USA (Fig. 17).

In females, the prevalence rates for systolic

Fig. 17. Prevalence rates for systolic and diastolic hypertension for males from three studies.

Fig. 18. Prevalence rates for systolic and diastolic hypertension for females from three studies.
hypertension are remarkably lower in all ages than those of other studies. Wider differences were shown in older ages. The prevalence rate for diastolic hypertension, however, were characteristically higher in all ages than those of other countries (Fig. 18).

The apparent higher prevalence rates for higher diastolic blood pressures than those of systolic blood pressures in both sexes in all ages are consistent findings throughout this study. As shown in table 1, the prevalence rates for higher diastolic blood pressure is three times greater than that of elevated systolic pressures in males and 2.5 times that in females.

This confirms that diastolic hypertension is characteristic of Koreans. All the studies done in Korea also showed compatible findings (Hong, 1972; Kim et al., 1979; Shon et al., 1967).

This distribution of blood pressure by various socioeconomic factors studied so far did not show any consistent findings from study to study. In general, however, in western countries, the findings tend to agree that the less educated, the poorer, the more physical work oriented and the smaller city or rural dwellers had higher blood pressures (National Center for Health Statistics, 1974; Sive, 1971; Lowe, 1964; Nemet et al., 1968). In this study, however, the findings showed very much the opposite. The more educated, those with a higher income and the more mental work oriented show higher blood pressures. This fact is compatible with the beliefs that Koreans have held for a long time, but there is no way at this time to provide a plausible explanation for these findings. It would however be worth pursuing with further study.

The salt hypothesis was not accepted in this study even though the assumptions were not quantitated. It was hypothesized that those who were born in the south and resided in a rural area could be assumed to have consumed a larger amount of salt than those who were born in the north and resided in an urban area, a practice resulting in higher blood pressures among the former. The study findings, however, are not compatible with this hypothesis. Rather, they tend to suggest just the opposite.

The low prevalence rate for hypertension in general does not provide a plausible explanation for the high CVD death rate in Korea. This also requires further study.

The entire survey took 7 months from March to September. The temperature at the time of measurement varied from $3^\circ C$ to $26^\circ C$ in this period. The mean blood pressures differ significantly according to the differences in the temperature at the time of measurement. The mean blood pressures measured in hot seasons were significantly lower than those measured in both cool and cold seasons at all ages for both sexes. The relationship between temperature and blood pressure in this survey is compatible with other studies (Miall and Lovel, 1967; McKeown et al., 1963). Since the measurement schedules for urban and rural areas, as well as other socioeconomic variables, were evenly distributed throughout the survey period and, also, since the majority of the study population was measured in a cool and comfortable temperature (87%), the influence of this temperature difference on the results of this study does not appear to be significant.

About 90% of measurements were done from 7 to 9 O'clock in the morning because the majority of examinees wanted to be measured before going to work. Therefore, the time of measurement seems to be fairly constant.

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