Effects of Dietary Calcium Levels on Human Blood Pressures

Janice Mearkle
Western Kentucky University

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Janice Hagmann

1987
EFFECTS OF DIETARY CALCIUM LEVELS
ON HUMAN BLOOD PRESSURES

A Thesis
Presented to
The Faculty of the Department of Health and Safety
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In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
Janice Hagmann Mearkle
August 1987
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Elmer Gray
Dean of the Graduate College
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The prevalence of hypertension in the U.S. and similar industrialized countries continues to rise. Millions of people are affected in America alone. Usual treatment includes a low sodium diet, weight loss if needed, and drug therapy. Some health providers also encourage stress management as an adjunct to therapy. These treatments have been shown to be effective but patient compliance continues to be poor. Past research has explored the relationships between dietary calcium and hypertension and has found that there is an interaction between blood calcium levels and high blood pressure. The research reported here was a test of the relationship between dietary calcium and hypertension. Using data gathered by the U.S. Health and Nutrition Examination Survey, the author compared subjects (n=3854) on the basis of daily calcium intake and blood pressure levels. Findings supported previous research: high calcium intake was associated with lower blood pressure levels. Further study is needed before definite recommendations can be made. Discussion includes the implications for therapy, compliance, and treatment success.
Chapter One

Introduction

Hypertension has become endemic in American Society, currently affecting an estimated one-quarter of the population -- thirty-five million diagnosed cases with at least another twenty-five million borderline hypertensives. Epidemiologically, this disease crosses all social and economic strata -- affecting men, women, and children. Hypertension is an especially serious problem for blacks of all ages and pregnant women.

Many people do not even realize that they have hypertension until they suffer the consequences -- renal failure, peripheral vascular disease, cerebral vascular accident, impaired vision, or myocardial infarction -- all of which are common expected outcomes of this insidious disease. Hypertension control begins with the detection of elevated blood pressure and requires continued surveillance to avoid sequelae.

Some authorities have suggested that of those diagnosed with hypertension only half comply with the prescribed treatment plan. It has been further suggested that lack of compliance may be directly related to the difficulty many patients have with altering life-styles. Presently, in order to treat hypertension, "an individual must make a
decision or choice to sacrifice something that (may) interfere with his or her life-style in order to improve health." These types of changes occur more commonly among those with higher levels of education, but knowledge alone will not lead to behavioral change even though a better understanding of the disease leads to increased patient participation in the prescribed therapy.

Persistent hypertension will require life long treatment in most cases to minimize risks. Concern for patient participation in therapy begins as soon as the health provider and patient decide on a treatment regimen. A patient must be able to integrate the concept of a chronic, symptomless disease into his/her life since therapy will not cure but will only control blood pressure elevations and help prevent the onset of severe sequelae. Elevation of a patient's response to controlling the disease is the first step in treatment and should include receptiveness to patient education and alternative treatments available.

Systemic management of hypertension, by a qualified health provider, combined with health education can reduce the death rate for hypertensive patients by a significant percentage and seems to be the most promising treatment to date. In order for the provider to ensure compliance, it is essential that treatment programs for blood pressure reduction involve as many alternatives as can be devised.
Patient compliance can be increased by designing treatment modalities to fit the patient's life-style and cultural mores.

The Problem

Because of the silent nature of hypertension, education concerning the long-term benefits of dietary control is usually resisted by patients, and eating behaviors remain unmodified. Within three to five years three-quarters of detected hypertensives have not maintained therapy. Successful adjustment to such a diagnosis and therapy requires the assumption of responsibility by the patients for their own care within psychological and physical limits. Planning long-term dietary changes includes considering established food preferences, eating practices, overall health, economic and educational factors.

Traditionally, dietary hypertension control has included recommendations for reducing sodium and cholesterol intake. If adequate control could be achieved or facilitated by additional dietary means patient compliance might be enhanced.

Need for the Study

"Hypertensive cardiovascular disease remains the principal cause of morbidity and mortality in the United States." Aside from the toll of needlessly lost lives the financial costs continue to rise.

Insurance premiums increase as health care costs rise. Income is lost by employers and employees alike from missed
work days. Tax revenues must be used to offset the financial burdens of those who cannot afford medical care.

Local health departments, with funding from federal and state sources, expend many resources on hypertension related activities including screening, education, and prevention programs. Many industries are currently making use of federal funding to carry out the same types of programs for their employees.22

The need remains to pinpoint the cause(s) of hypertension and to identify as many predisposing and aggravating factors as possible. Options might facilitate treatment for those already affected. Investigators are not exploring other possible causes of hypertension including the availability of certain inorganic components of blood, especially minerals and trace elements.23 Previous literature indicates a need for a dietary study of metabolic factors including calcium.24

The present researcher pursued an avenue of research opened by David McCarron of the Oregon Health Sciences University in an attempt to establish a relationship between calcium intake and hypertension. Data used in his study are from the Health and Nutrition Examination Survey (HANES) 1, 1971-1975.25 McCarron has demonstrated a probable link between dietary calcium levels and hypertension, suggesting that increased consumption of dietary calcium may be an important nutritional weapon in the treatment and prevention
of high blood pressure. The practical outcome of this research will be to add to the growing body of knowledge concerning the possible metabolic causes of hypertension. Such research has important implications for all health professionals. In this study the ultimate aim is to increase patient compliance to hypertensive regimens by the addition of acceptable alternative treatments.

Assumptions

It is assumed that the information in the HANES I Surveys as well as the Augmentation Survey is reliable and valid.

Hypothesis

Among participants in the HANES I Dietary Frequency and Adequacy Survey, those with low daily calcium intakes will show a greater incidence of hypertension than those with higher daily calcium intakes when age, gender, race, dietary sodium, and obesity are controlled.

Delimitations

This study is delimited to individuals who participated in the HANES I Dietary Frequency and Adequacy Survey and who were also included in the Medical Examination and Medical History Surveys.
Definition of Terms

Adequate calcium intake: Recommended daily allowance (RDA) of 800-1200 mgs of calcium daily for an adult.

Borderline hypertension: Blood pressure readings at the high side of normal -- systolic 90-94 mmHg; diastolic 140-159 mmHg; also called moderate hypertension.

Hypertension (primary or essential): Persistent systolic blood pressure readings equal to or greater than 160 mmHg, or diastolic blood pressure readings equal to or greater than 95 mmHg, or both; unrelated to any underlying disease process.
Chapter Two

Review of Literature

A review of the literature related to hypertension revealed numerous studies examining health education and patient compliance, chemical interactions between hormones, proteins, minerals, and trace elements. However, there are few studies relating dietary calcium intake and its relationship to hypertension. Recent evidence suggests that calcium is an important factor in controlling blood pressures.27,28,29,30

The groundwork in this area, and most subsequent studies, has been done by David McCarron. McCarron has isolated calcium as a major element often low in hypertensives. McCarron's first laboratory research using spontaneously hypertensive rats strongly suggested that an increase of dietary calcium lowers blood pressure in both normotensive and hypertensive animals.31

Epidemiologic study results quoted by McCarron have shown that hypertension is more prevalent in populations that have low calcium intakes.32 Calcium intakes below 379 mgs daily have been linked to an increased risk of eclampsia in pregnancy, a condition characterized mainly by severe hypertension with its associated hazards.33
In 1983 McCarron and his associates conducted a pilot study observing 90 human subjects from the University Clinic. It was found that the 46 patients who had hypertension consumed 20-25% less calcium than the normotensive patients. McCarron concluded from dietary analyses of those subjects that a variation of 184-218 mgs of dietary calcium intake below the RDA could be a significant predictor of hypertension. The results of this research also revealed the ambiguous role which sodium and potassium play in hypertension and indicated that calcium may act as a mediator for both elements. 34

In his 1984 study McCarron analyzed data collected from the HANES I Survey. He again demonstrated a lower dietary calcium intake in those subjects with hypertension. In that study dietary relationships in more than 10,000 people were examined. A computer assisted analysis was used to assess the relationship of 17 nutrients to blood pressures. Significant difference in the consumption of calcium was one of the factors which distinguished normotensives from hypertensives, and was the most consistent factor found. Higher intakes of calcium corresponded with lower mean systolic blood pressures. 35

A southern California study examined the relationship between dietary calcium intake and blood pressure. It was reported that males with hypertension consumed less calcium from milk than normotensive males. 36 Adding calcium to
deficient diets has accomplished positive results in two studies. When healthy young adults added 1000 mgs of calcium daily over a period of six months, significant decreases in diastolic pressures resulted. Adding 2000 mgs of calcium to the diets of otherwise healthy pregnant females 20-35 years old resulted in significantly lower third trimester blood pressures than those of women receiving a 1000 mg supplementation or none at all.

A randomized, double blind, controlled study design was carried out for eight weeks on 39 hypertensives who were receiving no conventional medical treatment. The addition of 1000 mgs of calcium lowered their systolic pressures.

Health professionals need to consider low dietary calcium intake as a possible predictor of hypertension or as a potentially contributing factor. Much remains to be explored concerning intake, with particular emphasis on the therapeutic effects that may be possible for hypertensives by the addition of calcium to their diets.

Nothing was found in the literature concerning the relative advantages of calcium with regard to compliance or ease of incorporating increased calcium consumption into a daily diet. It is not known whether calcium supplementation will significantly increase the level of controlled hypertension.
Chapter Three
Methods and Procedures

This research was based on an analysis of data available from the First Health and Nutrition Examination Survey (HANES I) conducted between April 1971 and September 1975. The HANES project includes a scientifically designed representative sample of the U.S. population and involved surveying 20,749 noninstitutionalized Americans between the ages of 25 and 74. A subsample was also interviewed for a more detailed health component of HANES I referred to as the Augmentation Survey. Included were detailed physical examinations, health histories, and blood chemistries.

The HANES I sample design was a multistage, stratified, probability sample of loose clusters of people in specified geographic areas. The successive elements dealt with in the process of sampling were primary sampling units, census enumeration districts, segment (cluster) households, eligible persons, and sample persons.

The sample covered many age groupings and emphasis was placed on low-income persons, women of childbearing age, and the elderly because these were groups on which detailed information was most needed. The design took into consideration the sample size requirements for the population subgroups to obtain an optimum mix for representative
estimates.

The Augmentation Survey design had two basic requirements: The sample was selected in specified locations to constitute a national probability sample of the target population and when considered jointly with those receiving the detailed examination the sample would be a 100 primary sampling unit national probability sample.

The HANES I data has been used to determine if those participants with low daily calcium intakes showed a higher incidence of hypertension than those with higher intakes. The 3854 subjects used for this analysis were derived from those cases represented in the Dietary Frequency and Adequacy survey, the complete Medical History Survey, and the Medical Examination Survey. All of the 3854 cases had both calcium and blood pressure data. Variables identified as being relevant to this study included dietary calcium intake, systolic and diastolic blood pressures, age, gender, race and obesity.
Chapter Four
Analysis of Data

This study was conducted using the HANES I Survey to determine if those with low daily calcium intakes will show a greater incidence of hypertension than those with higher calcium intakes. The number of people in the survey (n=3854) has been identified and the frequency of occurrence of the specified blood pressure categories has been compared for frequency in the high or low calcium intake groups. If those with lower calcium intake have significantly higher blood pressures than those with higher calcium intake, it may be concluded that calcium intake is associated with blood pressures.

To assess how blood pressures may be associated with dietary calcium intakes the HANES I respondents were divided into the three most common categories of hypertension described in the literature: no clinical hypertension—systolic levels at or below 140 mmHg and diastolic levels at or below 90 mmHg; moderate (borderline) hypertension—systolic levels from 141 mmHg to 159 mmHg and/or diastolic levels from 91 mmHg to 104 mmHg; and severe hypertension—systolic levels of 160 mmHg and above and diastolic levels of 105 and above or both. These have been compared with the three categories of calcium intake, high—1200 mgs or more per day; medium---801-1199 mgs per day; and low—800 mgs or less per day.
Other variables, obesity and dietary sodium, were included in the Analysis of Covariance to rule out a false positive relationship between blood pressure and calcium intake. The Analysis of Covariance also controlled for the demographic variables age, gender, and race.

The design of analysis began with a Chi Square test to determine if there was any association between blood pressure groups and dietary calcium intake groups. The Chi Square test allows decisions to be made concerning the statistical significance of the relationships between both systolic and diastolic blood pressures and calcium intake levels using frequency data. Because an association was found a Pearson Correlation was performed to test the continuous association between blood pressure and calcium intake. The Pearson Correlation analysis assesses the strength of the relationship observed in the Chi Square analyses, providing a measure of the relationships between the continuous variables of systolic and diastolic blood pressure and a single continuous variable, dietary calcium.

In order to more rigorously test the statistical associations found in the first two tests, an Analysis of Variance was done. This test compared mean blood pressures among three dietary calcium level groupings.

Finally, an Analysis of Covariance was used to relate dietary calcium intake with blood pressure, controlling for age, race, gender, dietary sodium, and obesity. The test controlled the influence of those variables on blood pressures.
Chapter Five  
Findings and Interpretations  
The demographic variables of the population studied included age, gender, race, education, income (at 1974 level), and marital status. These are shown in Table 1. Although low income rural residents were favored in the HANES I sample, the majority of respondents were married white females with at least an eleventh grade education, making less than $7000 per year. Table 2 describes the distribution of dietary calcium intakes, systolic and diastolic blood pressures among the 3854 subjects.  
The Chi Square analyses (Tables 3 and 4) show a relationship between the dependent and independent variables. Low dietary calcium is associated with elevated diastolic blood pressures while high dietary calcium levels are associated with decreases in blood pressures, especially diastolic. This relationship is small but is strengthened by the large sample size.  
The Pearson Correlation Coefficient showed a small but statistically significant negative relationship between calcium intake and both systolic ($r=.1012$) and diastolic ($r=0.0768$) blood pressures at 0.001 level of significance. Again, the relationship is small and would be insignificant except for the large sample size.
The Analysis of Variance (Table 5) was significant at p<0.005, and showed a relationship between high dietary calcium intake and decreased blood pressures.

### Table 1
Demographic Information of HANES I
Augmentation Survey Sample (n=3854)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>%</th>
<th>Systolic Blood Pressures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>140</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-43</td>
<td>1265</td>
<td>32.8</td>
<td>90</td>
</tr>
<tr>
<td>44-57</td>
<td>1270</td>
<td>33.0</td>
<td>66.9</td>
</tr>
<tr>
<td>58-74</td>
<td>1319</td>
<td>34.2</td>
<td>45.8</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50.25 years old</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1839</td>
<td>47.7</td>
<td>68.1</td>
</tr>
<tr>
<td>Female</td>
<td>2015</td>
<td>52.3</td>
<td>66.6</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>612</td>
<td>15.9</td>
<td>53.9</td>
</tr>
<tr>
<td>White</td>
<td>3208</td>
<td>83.2</td>
<td>69.9</td>
</tr>
<tr>
<td>Other</td>
<td>34</td>
<td>.9</td>
<td>61.8</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>up to 10th Grade</td>
<td>1615</td>
<td>41.9</td>
<td>56.4</td>
</tr>
<tr>
<td>over 10th Grade</td>
<td>2239</td>
<td>58.1</td>
<td>74.0</td>
</tr>
<tr>
<td>Income (1974 levels)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 6,999</td>
<td>61.3</td>
<td>56.4</td>
<td>17.5</td>
</tr>
<tr>
<td>≧ 7,000</td>
<td>37.5</td>
<td>74.0</td>
<td>14.6</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>2914</td>
<td>75.6</td>
<td>70.2</td>
</tr>
<tr>
<td>Widowed</td>
<td>397</td>
<td>10.3</td>
<td>45.1</td>
</tr>
<tr>
<td>Never married</td>
<td>241</td>
<td>6.3</td>
<td>66.4</td>
</tr>
<tr>
<td>Separated/Divorced</td>
<td>299</td>
<td>7.8</td>
<td>66.6</td>
</tr>
</tbody>
</table>
Table 2
Distribution of Dietary Calcium, Systolic, and Diastolic Blood Pressures in HANES I Sample (n=3854).

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary Calcium (mgs)</td>
<td>689.4</td>
<td>565.9</td>
<td>N/A</td>
</tr>
<tr>
<td>Systolic Pressure (mmHg)</td>
<td>135.3</td>
<td>130.3</td>
<td>130</td>
</tr>
<tr>
<td>Diastolic Pressure (mmHg)</td>
<td>84.4</td>
<td>82.4</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 3
Relationship Between Level of Dietary Calcium and Level of Systolic Blood Pressure

<table>
<thead>
<tr>
<th>Systolic Blood Pressure*</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Row Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary Calcium</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>782</td>
<td>212</td>
<td>271</td>
<td>1271</td>
</tr>
<tr>
<td>%</td>
<td>61.5</td>
<td>16.7</td>
<td>21.8</td>
<td>33.1</td>
</tr>
<tr>
<td>Medium</td>
<td>865</td>
<td>190</td>
<td>213</td>
<td>1268</td>
</tr>
<tr>
<td>%</td>
<td>68.2</td>
<td>15.0</td>
<td>16.8</td>
<td>32.9</td>
</tr>
<tr>
<td>High</td>
<td>946</td>
<td>205</td>
<td>164</td>
<td>1315</td>
</tr>
<tr>
<td>%</td>
<td>71.9</td>
<td>15.6</td>
<td>12.5</td>
<td>34.1</td>
</tr>
<tr>
<td>Total</td>
<td>2593</td>
<td>607</td>
<td>648</td>
<td>3854</td>
</tr>
<tr>
<td>%</td>
<td>67.3</td>
<td>15.8</td>
<td>16.8</td>
<td>100.0</td>
</tr>
</tbody>
</table>

* Chi Square=44.98630 with 4 df
p<.005
### Table 4

**Relationship Between Level of Dietary Calcium and Level of Diastolic Blood Pressure**

<table>
<thead>
<tr>
<th>Dietary Calcium</th>
<th>Diastolic Blood Pressure*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Low</td>
<td>907</td>
</tr>
<tr>
<td>%</td>
<td>71.3</td>
</tr>
<tr>
<td>Medium</td>
<td>960</td>
</tr>
<tr>
<td>%</td>
<td>75.7</td>
</tr>
<tr>
<td>High</td>
<td>1024</td>
</tr>
<tr>
<td>%</td>
<td>78.3</td>
</tr>
<tr>
<td>Total</td>
<td>2895</td>
</tr>
<tr>
<td>%</td>
<td>75.1</td>
</tr>
</tbody>
</table>

*Chi Square=37.006641 with 4 df
p.<.005

### Table 5

**Analysis of Variance Between Dietary Calcium Levels and Systolic and Diastolic Blood Pressures**

<table>
<thead>
<tr>
<th>Dietary Calcium Levels</th>
<th>Systolic Blood Pressure</th>
<th>Diastolic Blood Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>137.8</td>
<td>85.7</td>
</tr>
<tr>
<td>%</td>
<td>1265</td>
<td>1265</td>
</tr>
<tr>
<td>STD Dev.</td>
<td>26.19</td>
<td>14.74</td>
</tr>
<tr>
<td>Medium</td>
<td>135.5</td>
<td>84.3</td>
</tr>
<tr>
<td>%</td>
<td>1260</td>
<td>1260</td>
</tr>
<tr>
<td>STD Dev.</td>
<td>25.11</td>
<td>13.96</td>
</tr>
<tr>
<td>High</td>
<td>132.8</td>
<td>83.2</td>
</tr>
<tr>
<td>%</td>
<td>1307</td>
<td>1307</td>
</tr>
<tr>
<td>STD Dev.</td>
<td>21.91</td>
<td>12.27</td>
</tr>
</tbody>
</table>

*F=13.437
p<.005

**F=10.734
p<.005
An Analysis of Covariance (Table 6) was used to relate dietary calcium intakes with blood pressures while controlling for age, race, gender, dietary sodium intake, and obesity which might have an effect on blood pressures. In the HANES I population 24.4% were obese. Because the Analysis of Covariance was significant at p<.005 it may be concluded that the relationship between calcium intake and systolic blood pressure is valid and may not be due to the influence of other factors which were controlled. This negative relationship was not valid for systolic blood pressure. These findings support other research which has shown a relationship between high dietary calcium intake and decreased blood pressures. The hypothesis of this thesis has been supported by statistical measures.

Table 6

Comparison of Levels of Blood Pressure with Dietary Calcium Controlling for Age, Gender, Race, Dietary Sodium and Obesity

<table>
<thead>
<tr>
<th>Calcium Level (mgs.)</th>
<th>Systolic*</th>
<th>Diastolic**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>n</td>
</tr>
<tr>
<td>0 - 395</td>
<td>137.9</td>
<td>1265</td>
</tr>
<tr>
<td>396 - 761</td>
<td>135.5</td>
<td>1261</td>
</tr>
<tr>
<td>762 - 5055</td>
<td>132.8</td>
<td>1307</td>
</tr>
</tbody>
</table>

*F=1.494, n.s.
**F=3.455, signif. at 0.005 level

Summary of findings include an inverse relationship between dietary calcium and both systolic and diastolic blood pressures and a significant negative relationship between
dietary calcium levels and diastolic blood pressures even when age, gender, race, dietary sodium intake, and obesity were controlled.

These findings have important implications for the treatment and possible prevention of hypertension in some patient populations. Lowering mild hypertension with increased dietary calcium alone should be possible in some patients, provided other vitamin and mineral levels are adequate. Increasing dietary calcium may also enhance medical therapies for treating moderate hypertension. The results of research do not support the efficacy of using dietary calcium for severe hypertension because observed changes in blood pressures were small. However, adequate calcium ingestion may play an important part in the therapy of all hypertensives.

Advantages of lowering blood pressures by dietary calcium intake include noninvasiveness of therapy, since calcium can be added via selected foods, and possibility of increased patient compliance related to a better acceptance of a dietary treatment that does not involve a perceived deprivation (as in sodium restriction). There may be greater patient willingness and success in using calcium supplements as opposed to conventional medical therapies which frequently have unpleasant side effects.

Many calcium-rich foods are available for those who do not care for dairy foods, although dairy products are the best utilized source of dietary calcium. Supplementation
is available in tablet form and is well tolerated by most patients.

Average calcium intake of most Americans is far below the USDA recommended daily allowance and continues to decline. Blacks of all ages and the elderly are especially vulnerable, possibly due to a high incidence of milk (lactose) intolerance in these groups.

There are complex physiological variables involved in dietary calcium usage. These include conversion of dietary calcium to serum calcium, vitamin and mineral availability, and hormonal responses which have only just begun to be studied in man. Causative factors in hypertension remain largely unknown. Many risk factors have been identified including genetics, demographic characteristics, physiological and psychological patient makeup. There is a need for more study in all these areas to delineate possible causes of elevated blood pressures.

Although many questions remain unanswered, the potential remains for dietary intervention in calcium intake to prevent hypertension in some groups. At the very least, increasing the amount of calcium in a patient's diet can aid in controlling hypertension.
NOTES


8 Ibid.


15 Op Cit. Green.


18 Op Cit. Giblin.

19 Op Cit. Joint National Committee.


23 Op Cit. McCarron and Morris.

24 Op Cit. McCarron and Morris.


26 Op Cit. McCarron and Morris.


36 Op Cit. Belizan et al.

37 Op Cit. Belizan et al.

38 Op Cit. Morris et al.


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