

MAGNESIUM DEFICIENCY IN AFRICAN-AMERICANS: DOES IT CONTRIBUTE TO INCREASED CARDIOVASCULAR RISK FACTORS?

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African-Americans are known to be disproportionately impacted by many chronic diseases such as diabetes, hypertension, cardiovascular, and renal disease. Lower levels of dietary and serum magnesium have been associated with an increased prevalence of hypertension, insulin resistance, and diabetes. Studies suggest a greater prevalence of occult magnesium deficiency among African-Americans compared to other populations. This increased prevalence of hypomagnesemia may contribute to increased insulin resistance leading to accelerated atherosclerosis and premature death. Trials that correct magnesium status/levels among African-Americans, whether through dietary intervention or direct magnesium replacement/supplementation need to be completed to characterize this relationship more completely. (*J Natl Med Assoc.* 2003;95:257-262.)

Key words: magnesium ♦ African-American ♦ insulin resistance ♦ atherosclerosis

Accelerated atherosclerosis and early death from cardiovascular disease are unfortunately, well known phenomena in the African American community. Both hypertension and diabetes, which contribute to atherosclerosis, are devastating conditions in this population. Sur-

veillance data compiled by the Centers for Disease Control and Prevention¹, notes marked excess morbidity and mortality for both diabetes and hypertension compared to whites. The age-adjusted prevalence of hypertension is 80% higher for blacks than whites. For diabetes, the age-adjusted prevalence is 107% higher among African-Americans.

In persons under age 65 years, mortality among African Americans with diabetes is 263% higher than mortality among whites

In the population over age-65 years, the overall mortality excess among African-Americans is 166%. Most of this excess is due to increased mortality from cardiovascular disease.¹ In fact, African-Americans demonstrate higher mortality rates for several common diseases. (Table 1)².

Health surveillance data compiled by the

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Table 1. Age-adjusted Mortality Rates Among African-Americans and Whites by Gender, for Selected Causes of Death, 1999

Cause	AA males	white males	Rate ratio	AA females	white females	Rate ratio
All causes	1412.5	1035.8	1.36	955.0	725.7	1.32
Malignant neoplasms	340.5	246.5	1.38	200.2	168.6	1.19
Diabetes	48.6	25.8	1.88	50.5	20.5	2.46
Major cardiovascular disease	520.9	408.4	1.28	398.0	292.1	1.36
Hypertensive heart disease	25.5	6.7	3.81	21.0	6.7	3.13
Essential hypertension & Hypertensive renal disease	16.9	5.1	3.31	15.4	5.3	2.91
Cerebrovascular disease	87.4	16.1	1.46	78.1	58.7	1.33
Renal failure	32.3	14.5	2.23	25.5	9.5	2.68

Age-adjusted death rates per 100,000 population for 1999 by gender and race (2000 US standard population). Rate ratios (blacks versus whites) which are greater than 1.00 indicate excess mortality among African Americans. AA = African Americans
source: CDC/NCHS, National Vital Statistics System, Mortality.²

Centers for Disease Control and Prevention¹ notes marked excess mortality among African Americans compared to whites. Overall mortality rates are 36% higher among African American males and 32% higher among African American females compared to white males and females, respectively. However, these disparities in death rates widen considerably when other causes of death are examined (table 1). For example, diabetes mortality rates among African American males are 88% higher and for African American females 146% higher compared to whites. Mortality differences between African Americans and whites are even more marked for death due to hypertensive heart disease and renal failure (see table 1).

According to the American Diabetes Association, one in every ten African-Americans has diabetes. Diabetes affects an estimated 3 million blacks, who overall, are 80% more likely than whites to have diabetes. African-Americans also experience higher rates of serious end organ damages including blindness, amputation, and end-stage renal disease.³ In New York State, there are over 100,000 African-Americans with diabetes. The direct (medical care) and indirect (lost productivity) costs are estimated at \$305,000,000 per year in this state

alone.⁴ This comes out to an increased cost of \$3,050/year or \$254 per patient per month.

It is well known that African-Americans are at very high risk for the deleterious effects of hypertension. This was emphatically stated by Dr. Claude Lenfant, director of the National Heart, Lung, and Blood Institute (NHLBI) in his report on the Task Force on Research in Epidemiology and Prevention of Cardiovascular Disease where he stated:

Despite improvements in the treatment and control of hypertension in recent years, blacks continue to experience higher morbidity and mortality from hypertension, and develop the disease earlier in life than whites.⁵

One of the key mechanisms responsible for this accelerated atherosclerosis in African-Americans is insulin resistance. Studies of African American populations have shown increased insulin resistance, even among non-diabetic patients.⁶ Insulin resistance is known to contribute to pathologic changes resulting in hypertension, diabetes, hyperlipidemia, and atherosclerosis.⁷⁻¹⁵

A large number of animal and human studies demonstrate a link between magnesium deficiency and clinical conditions such as hypertension, insulin resistance, diabetes, hyperlipidemia,

and atherosclerosis. The American Diabetic Association and many authors have called for large scale randomized controlled trials to investigate whether magnesium supplementation will improve blood pressure, glycemic control and atherosclerosis.^{10,11,12,16-21}

Several large-scale epidemiologic studies have linked decreased dietary magnesium and low serum magnesium to both hypertension and diabetes. The Atherosclerosis Risk in Communities (ARIC) Study,¹⁶ in which over 15,000 patients were followed for 5 years, and assessed for fasting serum magnesium, lipids, fasting glucose, insulin, dietary intake of magnesium, and carotid intima-media thickness, included a large number of African American participants (n=3413). It was found that AAs had a lower dietary intake of magnesium compared to whites and this correlated with lower serum magnesium levels, as well as increased rates of hypertension, diabetes, and carotid atherosclerosis. Other epidemiologic studies such as the Honolulu Heart Study²², the Health Professions Follow-up Study²³, and the Nurses Health Study²⁴ also reported this association between low magnesium intake and the prevalence of hypertension, and diabetes. Although most of these studies had large proportions of white subjects, taken together they support the hypothesis that low magnesium intake leads to insulin resistance and accelerated atherosclerosis. A cross-sectional study of urban African-Americans demonstrated that 24% of hypertensive patients and 26% of diabetic patients were frankly hypomagnesemic compared to only 9% of patients without either hypertension or diabetes¹⁷.

Moreover, the recent National Health and Nutrition Examination Survey, (NHANES), again demonstrated that the diet of African-Americans remains deficit in magnesium, calcium, and potassium intake while excess amounts of sodium are consumed.²⁵ Couple this with the fact that low dietary magnesium is associated with insulin resistance in young, non-diabetic African-Americans⁶, and it raises the intriguing question of whether occult mag-

nesium deficiency is a significant contributing factor for hypertension, diabetes, increased cardiovascular disease, and premature death.

A recent literature search in Pub Med during October 2002 using the key words "magnesium" and "blacks" revealed 44 articles. An identical search in Medline from 1966-October 2002 revealed 26 articles, all of which were also contained in the Pub Med search. Magnesium deficiency in adults was not the primary focus in 20 articles, 10 articles were about pregnant women or children and two were review articles. Findings from the other 12 articles are summarized in Table 2.

Eight of these papers were clinical trials, three were cross-sectional studies and one was a longitudinal study. The articles uniformly showed that blacks consumed less magnesium and had lower measurements of intracellular magnesium. Both of these findings were consistently correlated with hypertension. There were over 5,000 black subjects were involved in these trials. What was true in African Americans was also true for South African blacks.²⁶⁻²⁹ In addition, two articles revealed that decreased magnesium was associated with insulin resistance.^{6,7,30} Also, low serum magnesium was associated with an increased rate of premature ventricular contractions in AA.³¹

If decreased magnesium intake is contributing to insulin resistance, accelerated atherosclerosis, and early death, then there are two potential ways of approaching therapeutic interventions. One approach would be to change the dietary habits of African-Americans to promote increased magnesium intake. The other approach would be to supplement the diet with magnesium.

The diet that works best to treat hypertension, the DASH diet, has been developed by the NHLBI; DASH is an acronym that stands for Dietary Approaches to Stop Hypertension.³² This diet is composed mostly of fruits, vegetables, and low fat dairy products, is high in magnesium, calcium, and potassium, but low in sodium.

Inverse relationships between serum and di-

Table 2. Studies Examining Magnesium Deficiency Among Adult African-Americans

AUTHOR(S)	POPULATION (n = # subjects)	RESULTS
SIMPSON ³¹	n = 15,792, (3413 AA) longitudinal epidemiologic study (ARIC)	<ul style="list-style-type: none"> Lower serum magnesium levels associated with increased number of premature ventricular contractions
RESNICK ³³	n = 84, (42 AA) randomized clinical trial	<ul style="list-style-type: none"> Using an ion-specific electrode to measure intracellular magnesium, blacks observed to have lower intracellular magnesium levels compared to whites
FORD ²⁴	n = 8272, (2226 AA) cross-sectional epidemiologic study (NHANES)	<ul style="list-style-type: none"> Lower dietary intake of magnesium associated with a higher prevalence of hypertension
FOX ¹⁷	n = 104, (104 AA), cross-sectional study	<ul style="list-style-type: none"> Hypomagnesemia observed among 26% of hypertensives and 24% of diabetic patients compared to only 9% subjects without either hypertension or diabetes
HUMPHRIES ⁶	n = 179, (179 AA) clinical trial	<ul style="list-style-type: none"> Decreased intake of magnesium associated with insulin resistance
MANOLIO ³⁰	N = 5115 (2463 AA), cross-sectional epidemiologic study (CARDIA)	<ul style="list-style-type: none"> Inverse association between serum magnesium levels and fasting insulin levels
MA ¹⁶	n = 15,792, (3413 AA) longitudinal epidemiologic study (ARIC)	<ul style="list-style-type: none"> Decreased magnesium (intake or serum levels) in blacks (AAs) associated with increased carotid intimal thickness
YAMAMOTO ⁴⁸	n = 698 (73 blacks), randomized clinical trial, (TOHP)	<ul style="list-style-type: none"> Supplementing with calcium or magnesium not associated with primary prevention of hypertension
STEYN ²⁶	n = 976 (976 blacks) cross sectional Epidemiologic study	<ul style="list-style-type: none"> Lower consumption of magnesium, calcium, and potassium among black South African hypertensive subjects
TOUYZ ²⁷	n = 76 (52 blacks), randomized clinical trial	<ul style="list-style-type: none"> South African blacks had lower platelet magnesium than whites and higher arterial pressures
TOUYZ ²⁸	N = 154 (104 blacks), randomized clinical trial	<ul style="list-style-type: none"> Decreased intracellular magnesium and potassium and increased calcium and sodium in black South African hypertensives.
TOUYZ ²⁹	N = 463 (463 blacks), randomized clinical trial	<ul style="list-style-type: none"> Erythrocyte magnesium levels inversely related to blood pressure

etary magnesium levels and the prevalence of cardiovascular disease, hypertension, diabetes, and insulin resistance, and carotid arterial wall thickness have been reported in numerous studies:^{13,14,15,16,19} In an editorial published in the *American Journal of Hypertension*, Dr. Lawrence Resnick, a leading expert on both hypertension and magnesium metabolism stated, "... short- and longer-term therapeutic trials of magnesium supplementation in hypertension and diabetes mellitus are clearly needed in the near future."¹⁸

There have been a number of trials with

magnesium supplementation among subjects with hypertension, diabetes, and hyperlipidemia. The results of these studies have been mixed. Among 16 studies of hypertension, eleven of these showed a positive effect,³³⁻⁴³ The average blood pressure reduction in these studies was 6mm systolic, and 3 mm diastolic. Five of these showed no effect in reducing blood pressure.⁴⁴⁻⁴⁸

A recent magnesium replacement study involving Type 1 diabetic patients showed both improved lipid status and decreased insulin stimulated glucose uptake by 35%.⁴⁹ It should

be emphasized that none of these studies were done in a predominantly African American population.

Based on published scientific literature, there appears to be a link between disordered magnesium status in African-Americans and increased insulin resistance and accelerated atherosclerosis. There is also a strong association between hypertension, diabetes and low serum magnesium levels. This has been shown to be up to 25% in two published studies.^{17,50} It is unknown whether decreased intracellular magnesium values represent a true magnesium deficient state or serves as a marker for a nutritional imbalance between magnesium, potassium, and calcium, on the one hand, and sodium on the other. Therefore, two fertile areas for future research that could potentially improve the health of African-Americans would be an education campaign promoting the DASH principles and/or therapeutic trials of magnesium supplementation in African-Americans with hypertension or diabetes. Any improvement, even a modest one, with one or both of these interventions could result in dramatic reductions in premature morbidity and mortality rates when applied across the population of African Americans.

In conclusion, there is compelling clinical evidence from a number of published studies noting both decreased dietary intake and decreased intracellular magnesium levels exists among African-Americans. These observations may be related to insulin resistance, accelerated atherosclerosis and premature death among this population. Research seeking to further characterize the relationship between decreased magnesium levels and insulin resistance, glycemic control, hypertension, and cardiovascular disease needs to be pursued among African Americans.

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