"From Apennines to Andes:" Does Body Mass Index Affect the Relationship Between Age and Blood Pressure?

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. . . after all those days of travel across that endless plain, he saw before him a chain of mountains which reminded him of the Alps. They were the Andes . . .
—Heart Novel, Edmondo De Amicis

Even small differences in blood pressure (BP) significantly impact the lifetime risk for cardiovascular disease. In a meta-analysis involving ≈1 million adults with no previous vascular disease enrolled in 61 prospective observational studies, within each decade of age, even minor differences in the usual systolic or diastolic BPs were associated with different risks of mortality for stroke and ischemic heart disease. These age-specific associations were similar in men and women.[1] A recent meta-analysis from 18 cohort studies showed a substantially lower lifetime risk of cardiovascular disease in subjects with BP <120/80 mm Hg and low-risk profile than in subjects with higher BP.[2] Age is of major importance in determining BP levels, and the age-related rise in BP is primarily responsible for an increase in both incidence and prevalence of hypertension with aging.

Some longitudinal surveys of the general population carried out in the past provided an opportunity to explore the relations between changes of BP and age. Studies from industrialized countries confirmed the presence of age-related changes in systolic and diastolic BPs.[3–5] A report from 3 different longitudinal Swedish population studies for a total of 1304 men and 1246 women followed for ≤12 years showed that the mean systolic/diastolic BP in untreated subjects increased in men from 138/91 mm Hg at 50 years of age to 159/91 mm Hg at age 79 years and from 123/79 mm Hg at age 38 years to 168/93 mm Hg at age 70 years in women.[3] Similar results were obtained from a representative sample of the population of 5 Belgian districts in which BP readings were recorded at home visits.[4] This cross-sectional analysis showed that systolic BP increased with age at least until the eighth decade of life, whereas diastolic BP rose only until 50 years of age. After middle age, both systolic and diastolic BPs became higher in women than in men, whereas the reverse was true in the first half of life.[4]

At variance, traditionally living populations around the world usually have lower BP than those from Western societies, with such difference decreasing as non-Westerners adapt to Western culture and lifestyle. Epidemiological studies from unacculturated populations reported minimal or no changes in BP with age. For example, hypertension prevalence in Tsimane adults, a population of forager-horticulturalists in the Bolivian Amazon, who still live a relatively traditional lifestyle (fishing, hunting, engaged in horticulture, gathering, and living in extended family clusters) without much access to modern amenities showed that, from age 20 to 70 years, systolic BP modestly increased by 16% for women and by 3% for men.[5] Overall, prevalence of hypertension among adults ≥20 years of age was only 3.5%.[5] Similar findings have been reported in another tribal group from Amazon.[6]

The observation that BP does not show any apparent increase with age in some unacculturated ethnic groups has long supported the hypothesis that acculturation to Western society may negatively affect the association between age and BP. In this context, a recent meta-analysis[7] established the strength of the association between acculturation and BP and examined the influence of contextual factors (world region, length of residence in new culture, sex, and age) as potential effect moderators. Briefly, increased acculturation to Western society was related to higher BP: the more acculturated subjects had an average 4-mm Hg higher systolic BP than less acculturated individuals.[7] The effect of acculturation on BP showed similar effect sizes across all of the regions of the world. In addition, changes in BP attributed to acculturation were not related to body mass index (BMI) or serum cholesterol levels but they were indeed related to length of residence in the new culture. Migration from rural to urban settings resulted in sudden cultural changes associated with larger effect sizes.[7] Accordingly, the authors concluded that the stress of cultural changes seems to be more influential on BP than changes in diet or physical activity.[7] However, most studies included in this systematic review were small, of poor methodological quality, and had a cross-sectional design.[7]

In the new analysis of the Tsimane Health and Life History Project published in this issue of *Hypertension*, Gurven et al[8] raised some concerns about the direct effect of modernization and stress of cultural changes on BP and proposed a new approach to overcome some limitations of previous studies. The goal of this mixed cross-sectional and longitudinal analysis was to add new data on the association between age and BP and to explore the independent effects of moderniza-

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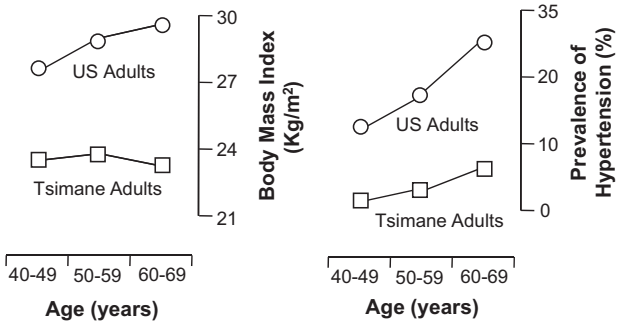

Figure. Relation of age with body mass index and prevalence of hypertension in US adults and Tsimane adults. Adapted from Gurven et al.[5]

tion, age, and lifestyle factors on BP changes. Overall, 2248 Tsimane adults aged 20 to 90 years were recruited from July 2002 to December 2010, and 61% of subjects were longitudinally sampled at least twice, and 36% ≥4 times. Prevalence of hypertension was very low, just 3.9% for women and 5.2% for men. It increased with age, but the rate of hypertension was still smaller than in Western countries. As pointed out in the article, the age-related increases in BP were modest when compared with Western subjects included in the National Health and Nutrition Examination Survey, and BMI had the most substantial effect on BP level. Notably, no indicator of modernization (smoking, Spanish fluency, or schooling) showed negative effects on BP or predicted a greater age-related increase in BP.[8]

The comparison of demographic and BP profiles between Tsimane and US adults also offers the basis for a better understanding of BP control in Westernized countries. As Marco, in the journey from Italy to Argentina narrated by Edmondo De Amicis, found similarities between the Alps and the Andes, Gurven et al[8] in the exploration of age-related changes in BP noted that the Tsimane profile shares similarities with that of Western individuals. Although different slopes in the relation between age and BP were noted between Tsimane and Americans enrolled in the National Health and Nutrition Examination Survey, in both populations there was a continuous, approximately linear, increase in systolic BP with age. Furthermore, the relationship between age and BP was significantly influenced by BMI, and its change exerted a similar effect on BP among Tsimane and Westernized subjects.[8]

These similarities suggest that, although age influences the distribution of BP levels within a population, it seems to have less bearing on the difference in BP levels between populations. More importantly, the significant influence of BMI on the association between age and BP (Figure) suggests that behavioral and environmental factors, including diet and physical activity, are important determinants of BP within and between different populations in countries at different stages of socioeconomic and epidemiological transition and in different races and ethnic groups.

The association between BMI and BP is not new. Although the potential mechanisms through which increased BMI may raise BP are not entirely clear, several mechanistic processes that link changes in weight to its physiological consequences for BP regulation have been proposed. Excess renal sodium reabsorption and hypertensive reset of pressure natriuresis may initiate the process of BP rise associated with weight gain. Increased weight may also trigger sympathetic nervous system overactivity and insulin resistance. Adipose tissue produces substantial amounts of angiotensinogen, and a correlation between BP and angiotensinogen has been documented.[9]

In summary, this study suggests that weight control throughout the entire life may play an important role to prevent the rise in BP with age. Although in the past there was some debate as to why acculturation adversely affects the prevalence of hypertension, recent findings support the hypothesis that the higher prevalence of hypertension and the close relation between age and BP observed in Western society compared with unacculturated populations are significantly influenced by behavioral and environmental factors, including diet and physical activity. Gradually with a changing socioeconomic environment, marked increase in BP and overweight or obesity was noted among Tsimane.[8] Conversely, positive lifestyle changes may greatly influence the risk pattern of populations and can be targeted to prevent cardiovascular disease. Fortunately, the process may be reversible. In the PREMIER Study, for example, lifestyle changes, with or without the addition of the Dietary Approaches to Stop Hypertension diet, significantly reduced body weight and BP among individuals with prehypertension or stage 1 hypertension when compared with subjects who received advice only.[10]

Disclosures

None.

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