

Association of obesity with hypertension

Wilbert S. Aronow

Cardiology Division, Department of Medicine, Westchester Medical Center and New York Medical College, Valhalla, NY, USA

Correspondence to: Wilbert S. Aronow, MD, FACC, FAHA. Professor of Medicine, Cardiology Division, Westchester Medical Center and New York Medical College, Macy Pavilion, Room 141, Valhalla, NY 10595, USA. Email: waronow@aol.com.

Submitted Jun 12, 2017. Accepted for publication Jun 21, 2017.

doi: [10.21037/atm.2017.06.69](https://doi.org/10.21037/atm.2017.06.69)

View this article at: <http://dx.doi.org/10.21037/atm.2017.06.69>

Overweight is a body mass index between 25.0 to 29.9 kg/m² (1). Obesity is a body mass index of 30 kg/m² or higher (1). Obesity and obesity are risk factors for hypertension, dyslipidemia, and diabetes mellitus (2). The Framingham Study demonstrated that obesity was about twice as prevalent in obese men and in obese women as in men and in women with a normal Metropolitan relative weight (3). The Framingham Study also demonstrated that both men and women had an increase in blood pressure with increased overweight (4). Persons in the highest body mass index quartile had a 16 mmHg higher systolic blood pressure and a 9 mmHg higher diastolic blood pressure than persons in the lowest body mass index quartile (4). In this study, the systolic blood pressure increased 4 mmHg for each 4.5 kg of increased weight (4). Insurance industry data have also shown a positive relationship between overweight or obesity with hypertension (5).

In 19,841 Canadians aged 18 to 74 years, the prevalence of hypertension in men and in women increased with increasing body mass index, especially in those aged 18 to 34 years (6). In the younger adults, men and women with a body mass index of more than 30 kg/m² had a 5 times higher prevalence of hypertension than persons with a body mass index less than 20 kg/m² (6). A cohort of 82,473 female nurses in the United States, aged 30 to 55 years were followed every 2 years since 1976 (7). In 1992, the body mass index was positively associated with the development of hypertension (7). Compared with a weight change of 2 kg or less, the risk of hypertension was 15% less in women who lost 5 to 9.9 kg, 26% less in women who lost 10 kg or more, increased 74% in women who gained 5 to 9.9 kg, and increased 5.21 times in women who gained 25 kg or more (7).

In the nationwide Community Hypertension Evaluation Clinic screening of more than 1 million men and women,

the prevalence of hypertension in overweight persons aged 20 to 39 years was twice that of persons with a normal weight and 3 times higher than that of underweight persons (8). In the overweight persons aged 40 to 64 years, the prevalence of hypertension was 50% higher than that of persons with a normal weight and 100% higher than that of underweight persons (8). In 22,354 Korean men and women, there was an association between body mass index and systolic and diastolic blood pressure over a body mass index range of 16 to 31 kg/m² (9). Attributable risk estimates from the Framingham Offspring Study of 2,027 men and 2,267 women aged 20 to 49 years followed for 8 years showed that obesity may be responsible for 78% of hypertension in men and for 65% of hypertension in women (10). Changes in body fat over 8 years were associated with changes in both systolic and diastolic blood pressure. Markedly obese women in their fourth decade had a 7 times increase in hypertension than did lean women of the same age (10).

The second Nurses' Health Study was a prospective cohort study of 83,882 women aged 27 to 44 years with a normal blood pressure who were followed for 14 years through 2005 for incident hypertension (11). The strongest risk factor for developing hypertension was an increased body mass index with obese women having a 4.7 times higher incidence of hypertension than did women with a body mass index less than 23.0 kg/m² (11). In this study, 40% of new hypertension cases were attributed to overweight or obesity, and 50% of new hypertension cases were attributable to a body mass index of 23 kg/m² or higher (11).

An analysis of data from 4 prospective studies in 6,328 persons that measured childhood and adult body mass index with a follow-up of 23 years demonstrated that overweight

or obese children who were obese as adults increased the risk of hypertension 2.7 times (12). Becoming normal weight reduced the risk of developing hypertension to a level similar to persons who were never obese (12). The Cardiovascular Risk in Young Finns Study included 2,625 persons followed up for 21 to 27 years for the development of adult hypertension (13). This study showed that childhood overweight or obesity increased the risk of adult hypertension 1.65 times (13). The association between being overweight or obese with hypertension is even stronger for waist-to-hip ratio and computed tomographic measures of central fat distribution than is measurement of body mass index (14).

Obesity and overweight may have a major role in impairing renal pressure natriuresis in persons with chronic hypertension (15). Obesity increases sodium reabsorption in the kidneys and impairs renal pressure natriuresis by activating the renin-angiotensin and sympathetic nervous systems and by altering intrarenal physical forces (15). Chronic obesity also causes structural changes in the kidneys that cause a loss of nephron function, further increasing arterial pressure (15). The blood-pressure lowering effect of weight loss probably results from an improvement in insulin sensitivity and a reduction in sympathetic nervous system activity (14). Mechanisms for blood pressure reduction with weight loss in overweight hypertensive persons with a hypocaloric diet without a reduction in sodium intake are reduced sympathetic activity caused by a reduced activation of the renin-angiotensin-aldosterone system, natriuresis, contracted plasma volume, and reversal of the high cardiac output state (16).

Loss of weight in overweight persons lowers blood pressure (16). A meta-analysis of 18 studies showed that loss of 3% to 9% of body weight reduced systolic blood pressure 3 mmHg and diastolic blood pressure 3 mmHg (17). In the Trial of Nonpharmacological Interventions in the Elderly (TONE) study, a diet that reduced weight by 3.5 kg in persons aged 60 to 80 years of age with hypertension reduced blood pressure by 4.0/1.1 mmHg (18).

In the Trials of Hypertension Prevention, phase 1 study, 181 men and women aged 30 to 54 years old were randomized to 1 of 2 18-month lifestyle interventions weight loss or dietary sodium restriction or to a usual care control group (19). After 7 years of follow-up, the incidence of hypertension was 18.9% in the weight loss group versus 40.5% in its control group and 22.4% in the sodium reduction group versus 32.9% in its control group. After

logistic regression analysis, the odds of hypertension was reduced by 77% in the weight loss group and by 35% in the sodium reduction group compared with their control groups (19).

A meta-analysis was performed in 25 randomized controlled trials with 34 strata including 4,874 persons, mean age 37 to 66 years, investigating the effect of weight reduction on blood pressure (20). A reduction of 5.1 kg of body weight was associated with a reduction in systolic blood pressure of 4.44 mmHg and in diastolic blood pressure of 3.57 mmHg (20). In persons who lost more than 5 kg, the reduction in systolic blood pressure was 6.63 mmHg, and the reduction in diastolic blood pressure was 5.12 mmHg (20).

Bariatric surgery is an accepted treatment for obesity. A meta-analysis was performed of 3 studies reporting hypertension after bariatric surgery in 2 studies of 808 patients after gastric bypass and in 1 study of 247 patients after a gastric band (21). Remission of hypertension was defined as a blood pressure below 140/90 mmHg without medications. The long-term remission rates for hypertension were 38.2% after gastric bypass and 17.4% after a gastric band (21). Bariatric surgery was performed in 87 black patients with morbid obesity, mean age 42 years (22). Of these patients, 74% had hypertension. The mean body mass index decreased from 57.1 kg/m² before surgery to 39.2 kg/m² at 1 year after bariatric surgery. Hypertension was resolved at 1 year after bariatric surgery in 45% of patients who had hypertension prior to bariatric surgery (22).

Acknowledgements

None.

Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

References

1. Cornier MA, Despres JP, Davis N, et al. Assessing adiposity. A scientific statement from the American Heart association. *Circulation* 2011;124:1996-2019.
2. Aronow WS, Fleg JL, Pepine CJ, et al. ACCF/AHA 2011 expert consensus document on hypertension in the elderly: a report of the American College of Cardiology

- Foundation Task Force on Clinical Expert Consensus Documents. Developed in collaboration with the American Academy of Neurology, American Geriatrics Society, American Society for Preventive Cardiology, American Society of Hypertension, American Society of Nephrology, Association of Black Cardiologists, and European Society of Hypertension. *J Am Coll Cardiol* 2011;57:2037-114.
3. Hubert HB, Feinleib M, McNamara PM, et al. Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. *Circulation* 1983;67:968-77.
 4. Higgins M, Kannel W, Garrison R, et al. Hazards of obesity--the Framingham experience. *Acta Med Scand Suppl* 1988;723:23-36.
 5. Harsha DW, Bray GA. Weight loss and blood pressure control (pro). *Hypertension* 2008;51:1420-5.
 6. Rabkin SW, Chen Y, Leiter L, et al. Risk factor correlates of body mass index. Canadian Heart Health Surveys Research Group. *CMAJ* 1997;157:S26-31.
 7. Huang Z, Willett WC, Manson JE, et al. Body weight, weight change, and risk for hypertension in women. *Ann Intern Med* 1998;128:81-8.
 8. Stamler R, Stamler J, Riedlinger WF, et al. Weight and blood pressure. Findings in hypertension screening of 1 million Americans. *JAMA* 1978;240:1607-10.
 9. Jones DW, Kim JS, Andrew ME, et al. Body mass index and blood pressure in Korean men and women: the Korean National Blood Pressure Survey. *J Hypertens* 1994;12:1433-7.
 10. Garrison RJ, Kannel WB, Stokes J 3rd, et al. Incidence and precursors of hypertension in young adults: the Framingham Offspring Study. *Prev Med* 1987;16:235-51.
 11. Forman JP, Stampfer MJ, Curhan GC. Diet and lifestyle risk factors associated with incident hypertension in women. *JAMA* 2009;302:401-11.
 12. Juonala M, Magnussen CG, Berenson GS, et al. Childhood adiposity, adult adiposity, and cardiovascular risk factors. *N Engl J Med* 2011;365:1876-85.
 13. Juhola J, Oikonen M, Magnussen CG, et al. Childhood physical, environmental, and genetic predictors of adult hypertension: the cardiovascular risk in young Finns study. *Circulation* 2012;126:402-9.
 14. Mertens IL, Van Gaal LF. Overweight, obesity, and blood pressure: the effects of modest weight reduction. *Obes Res* 2000;8:270-8.
 15. Hall JE. The kidney, hypertension, and obesity. *Hypertension* 2003;41:625-33.
 16. Reisin E, Frohlich ED. Effects of weight reduction on arterial pressure. *J Chronic Dis* 1982;35:887-91.
 17. Mulrow CD, Chiquette E, Angel L, et al. Dieting to reduce body weight for controlling hypertension in adults. *Cochrane Database Syst Rev* 2000;(2):CD000484.
 18. Whelton PK, Appel LJ, Espeland MA, et al. Sodium reduction and weight loss in the treatment of hypertension in older persons: a randomized controlled trial of nonpharmacological interventions in the elderly (TONE), TONE Collaborative Research Group. *JAMA* 1998;279:839-46.
 19. He J, Whelton PK, Appel LJ, et al. Long-term effects of weight loss and dietary sodium reduction on incidence of hypertension. *Hypertension* 2000;35:544-9.
 20. Neter JE, Stam BE, Kok FJ, et al. Influence of weight reduction on blood pressure. A meta-analysis of randomized controlled trials. *Hypertension* 2003;42:878-84.
 21. Puzifferri N, Roshek TB 3rd, Mayo HG, et al. Long-term follow-up after bariatric surgery. A systematic review. *JAMA* 2014;312:934-42.
 22. Onyewu SC, Ogundimu OO, Ortega G, et al. Bariatric surgery outcomes in black patients with super morbid obesity: a 1-year postoperative review. *Am J Surg* 2017;213:64-8.

Cite this article as: Aronow WS. Association of obesity with hypertension. *Ann Transl Med* 2017;5(17):350. doi: 10.21037/atm.2017.06.69