HHS Public Access
Author manuscript
Obesity (Silver Spring). Author manuscript; available in PMC 2013 July 01.

Published in final edited form as:
Obesity (Silver Spring). 2013 January ; 21(1): E10–E13. doi:10.1002/oby.20010.

THE BURDEN OF OBESITY ON BLOOD PRESSURE IS REDUCED IN OLDER PERSONS: THE SARDINIA STUDY

M.I. Pikilidou[1,2], **A. Scuteri**[1,3], **C. Morrell**[1,4], and **E.G. Lakatta**[1]

[1]Laboratory of Cardiovascular Science, Gerontology Research Center, National Institute of Aging, Baltimore, MD, USA

[2]1st Department of Internal Medicine, Aristotle University of Thessaloniki, AHEPA Hospital, Thessaloniki, Greece

[3]Istituto di Neurogenetica e Neurofarmacologia (INN), Consiglio Nazionale delle Ricerche, c/o Cittadella Universitaria di Monserrato, Monserrato, Cagliari, Italy 09042

[4]Loyola University Maryland, Baltimore, Maryland, 21210 USA

Abstract

Being overweight or obese increases the risk of elevated blood pressure. However differences of their effects on blood pressure in different age groups are not clear.

The aim of the present study was to evaluate differences of the effects of adiposity on the odds of having hypertension in different age groups. 3056 subjects (1532 women and 1524 men) which consist of the drug naïve subjects from the SardiNIA study. Logistic regression models with backward elimination were used to determine and compare the association between categories of obesity on hypertension within young (≤39), middle aged (40–59), and older (60+) subjects. Additional terms controlled for in the model were smoking and alcohol intake status.

The relationship of body mass index on hypertension differed by age, as indicated by the significant interaction term of age with body mass index ($p < 0.01$). Older subjects had higher odds of having hypertension than younger subjects but these odds were lower for obese than for lean subjects (OR 10.45, 95% CI's 4.58–23.85 in obese versus OR 33.89, 95% CI's 17.94–64.02 in lean subjects). A similar trend was also observed in middle aged subjects.

This study shows that among men and women, older age was associated with a lesser effect of body mass index on the odds of having hypertension.

Keywords

obesity; adiposity; body-mass index; waist circumference; hypertension; aging

---

Correspondence and Reprint Requests: MI. Pikilidou MD, MSc, PhD, 1st Department of Internal Medicine, AHEPA University Hospital, St Kiriakidi 1, Thessaloniki, 54636, Greece, Tel: +302310217760, Fax:+302310217760, pikilidou@gmail.com.

Introduction

The prevalence of being overweight and obese has become a growing concern at all ages. Recent studies however, seem to negate the common presumption that older adults with higher body mass index (BMI) are at a risk of shortened survival. This “obesity paradox” indicates that in older persons, higher BMI is associated with a lower mortality (1).

In light of this evidence, the 2005 dietary guidelines for Americans indicate that there is less certainty about the importance of treating overweight patients at older ages than at younger ages.(2).

In this context it seems that age modifies the relationship between BMI and cardiovascular mortality. However, there is not much evidence on whether BMI modifies the relationship of age with each of the risk factors that contribute to the cardiovascular mortality.

Amongst these risk factors, hypertension seems to be the most ominous, even in the elderly. This fact was highlighted by studies that showed a reduction in cardiovascular events in elderly subjects who received antihypertensive medication for the control of their blood pressure (3). Whether body-mass modifies the association of age on hypertension is currently not well established.

Using data from the SardiNIA study, we investigated differences in the association between adiposity and hypertension in different age groups

Methods

Study population

The SardiNIA study recruited 6148 men and women from a Sardinian founder population. Over a 3-year period, from November 2001 to December 2004, all residents aged 14 years and older in four towns of the Sardinia Region, Italy were invited to participate in the Study. Participants came to the clinic after fasting overnight, participated in an informed consent process, and after donating a blood sample underwent a detailed medical history and full medical examination, including blood pressure (BP), anthropometric measurements. In this cross-sectional analysis of the SardiNIA study only the drug naïve population (n=3056) was selected (1532 women and 1524 men).

The study was approved by both the Sardinian and the National Institute on Aging’s Institutional Review Boards.

Blood pressure measurements

Blood pressure measurements were performed in the morning with the subjects in the seated position following a 5 minute quiet resting period. Blood pressure was measured in both arms with a mercury sphygmomanometer using an appropriately sized cuff. Values for systolic BP (SBP) and diastolic BP (DBP) were defined by Korotkoff phase I and V, respectively. The average of the second and third measurements on both the right and left arms was used in the analysis. The subjects were characterized as hypertensive if their SBP was >140 mmHg or their DBP was >90 mmHg.

Anthropometric measurements

Height, weight, and waist circumference were determined for all participants. The National Heart, Lung and Blood Institute guidelines were used to define underweight (BMI<18.5 Kg/m^2), lean (BMI=18.5–24.9 Kg/m^2), overweight (BMI=25–29.9 Kg/m^2), and obese individuals (BMI >30 Kg/m^2).

Statistical analysis

Logistic Regression was used to describe whether the association between age groups (young (≤39), middle aged (40–59), and older (60+) subjects) and blood pressure is different in various BMI levels.

Other variables controlled for in the model were gender, smoking, and alcohol intake. Additional logistic regression tests were run including a number of interaction terms terms (age group with BMI category, age with gender, age with smoking, age with alcohol intake) to determine if the relationship of age and other variables on hypertension was different in various BMI levels. We used backward elimination to omit factors and interactions that were not significant.

Obesity association with blood pressure: effects of age

SBP and DBP were higher in obese than in overweight and lean subjects (Obese 133.9/81.9 mmHg, overweight 130.9/79.8 mmHg, and lean 125.8/76.3 mmHg, $p<0.05$ across groups). The difference in SBP between young and older subjects was steeper in lean than in obese subjects. Indeed, SBP in lean subjects showed an average 25 mmHg increase from younger subjects to those 60 years and older. For obese subjects the increase in SBP from younger to older subjects was 20 mmHg. On average, DBP showed an increase of 10 mmHg from younger to older subjects in lean subjects, an increase of 8 mmHg in overweight subjects, and an increase of 8 mmHg in obese subjects.

Linear regression analysis that included interaction terms revealed that the interaction between age and BMI categories was significant for SBP ($p <0.0001$) but not for DBP. In other terms, the age-associated change in blood pressure differed significantly across BMI categories for SBP but not for DBP.

Age and hypertension: does the relationship change with body mass index?

The prevalence of hypertension increased with increasing BMI category in all age groups. Of note, the effect of obesity on hypertension prevalence was similar to that of aging. In fact, the prevalence of hypertension in middle aged obese subjects (43.5%) was similar to that observed in lean older subjects (48.9%).

Multiple logistic regression showed that overweight (OR=2.11, 95% CI 1.67–2.68, $p<0.05$) and obese individuals (OR=3.44, 95% CI 2.54–4.67, $p<0.05$) were more likely to have hypertension than their lean counterparts.

In secondary analysis, the interaction term between age and BMI categories was significant – indicating that the odds of having hypertension for increasing BMI differed between younger and older subjects. In fact older obese subjects had lower odds of having hypertension than younger obese subjects (OR = 10.45, 95% CI 4.58–23.85 in obese versus OR = 33.89, 95% CI 17.94–64.02 in lean subjects) after adjusting for confounders (Table 1b). A similar trend was also observed in middle aged subjects. Men were at higher risk of having hypertension (Table 1a, OR = 2.25, 95% CI 1.76 – 2.88). However, no gender-specific difference in the likelihood of having hypertension with advancing age was found.

Thus, a sort of dose-response effect of BMI categories on the odds of having hypertension can be envisioned. This effect was not affected by gender.

Discussion

These results reported above, suggest that among men and women, higher BMI was associated with lower odds of having hypertension in older subjects. The models that were used to examine this interplay of age and BMI showed that age interacted with BMI in describing SBP but not DBP. In addition, the burdensome effect of BMI on both SBP and DBP was attenuated from young (<40) to middle-aged (40–60), to older (>60) individuals.

In the older person, the role of obesity as an independent risk factor for cardiovascular mortality is controversial. Recent longitudinal studies have reported that obesity and is associated with greater mortality risk in younger adults, whereas the associations between obesity and mortality are null or inverse in older adults(4). Literature on whether age modifies the effect of obesity on individual cardiovascular risk factors in older individuals is emerging.

It is true that higher BMI relates to higher BP levels throughout the whole life span. Few studies however, have reported a difference in the rate of risk increase or odds ratios of obesity related hypertension in different age ranges (5), (6).

Specifically, in the Humboldt study, as age progressed, the effect of a 1 kg/m^2 increase in BMI on SBP and DBP was attenuated for both men and women(7). Moreover, in a large community-based cross-sectional study (n=157,902 workers) in Yamagata, Japan, the relationships of BMI with systolic and diastolic blood pressures became weaker with advancing age in both men and women after 30 and 40 years of age, respectively(5).

In addition, data from the Croatian Adult Health Survey 2003, which is a cross-sectional study (n=9,070 Croatian adults), showed that in both men and women aged 18–64 years, increased BMI and waist circumference were associated with higher odds of hypertension compared to those of 65 years and older. (6). Also, in the Greek Epic cohort, in men there was suggestive evidence for an interaction of BP with BMI. The association of BMI with DBP was stronger among those younger than 55 years than in men 55 years or more (8). Similarly, the Nord-Trøndelag Health Study (HUNT) that involved 15,971 men and 13,846 women showed that the adjusted odds ratio for having hypertension was 1.8 for men and 1.6 for women aged 20–49 years who had increased their BMI over 10 years than those who had stable BMI(9).

Finally, the National Health and Nutrition Examination Survey (NHANES) III concluded that the prevalence of high BP and mean levels of SBP and DBP increased as BMI increased at ages younger than 60 years. Among older men (60 to 79 and over 80) there was a less pronounced increase in high blood pressure prevalence with increasing BMI category (10). Another analysis of NHANES III, showed that in older individuals (≥55 years) a steeply graded association between weight class and high BP was observed even in the overweight class compared with normal weight individuals, but respective prevalence ratios were almost 3 times (11) higher in men and 1.5 higher in women in the younger group (<55years).

Mechanisms that link obesity and hypertension have emerged mainly from studies that included young and middle-aged individuals. These include activation of the sympathetic nervous system and the renin-angiotensin-aldosterone system, increased endothelial dysfunction and renal functional abnormalities, as well as disturbances of leptin signalling(12). Hypertension in the elderly on the other hand, is less obesity-related and mainly caused by an increase in arterial stiffness.

Several other explanations can be proposed for this reverse epidemiology of obesity in the elderly. Overweight and obese individuals who live longer may have characteristics that protect them from developing the adverse effects of being overweight or obese such as having hypertension. This is known as the “survival effect” that favors these healthy obese subjects. Individuals who are susceptible to the complications of obesity may have already died, leaving behind those that are more resistant.

Accumulating data shows that hypertension in the elderly is not benign and should be treated accordingly. Studies such as Systolic Hypertension in the Elderly Program (SHEP) study, Swedish Trial in Old Patients with Hypertension (STOP), Medical Research Council Trial of Treatment of Older Adults (MRC Older) and the more recent HYVET study demonstrate that good blood pressure control reduces morbidity/mortality (3, 13–15). Therefore controlling hypertension in this age group is of importance.

In the present study DBP was not affected significantly by the interplay of BMI and age. This could simply be the result of attenuation due to DBP typically having a smaller range of values than SBP. Larger studies or studies with a prospective design could better describe the interaction of aging and BMI in describing DBP.

The present study had several limitations such as its cross-sectional design and the inclusion of subjects of the same ethnicity that constituted a homogeneous patient population. Moreover, the Sardinian population is known for its exceptional longevity. Reports show that more men live past 100 on this Italian island, proportionally, than other regions, so the results of the study can not be easily extrapolated to other populations (15). In addition, it is noteworthy that in aging, osteoporosis and changes in body composition make the interpretation of anthropometry more challenging.

In summary, our study demonstrates that elderly subjects have decreased odds of having hypertension if they are overweight or obese compared to younger subjects. Since mean values of BP increase in the elderly, and mainly in the lean, differences in mechanisms that induce hypertension in this age group, compared to younger subjects, need to be elucidated since direction of a less aggressive weight reduction in the elderly might soon become common practice.

Acknowledgments

Funding

The SardiNIA team was supported by Contract NO1-AG-1-2109 from the NIA.

This research was supported in part by the Intramural Research Program of the NIH, National Institute on Aging (USA).

Reference List

1. Bales CW, Buhr G. Is obesity bad for older persons? A systematic review of the pros and cons of weight reduction in later life. J Am Med Dir Assoc. 2008; 9:302–312. [PubMed: 18519110]
2. NIH Publication NO 98–4083. 1998. Clinical guidelines on the identification evaluation and treatment of overweight and obesity in adults.
3. Prevention of stroke by antihypertensive drug treatment in older persons with isolated systolic hypertension. Final results of the Systolic Hypertension in the Elderly Program (SHEP). SHEP Cooperative Research Group. JAMA. 1991; 265:3255–3264. [PubMed: 2046107]
4. Kuk JL, Ardern CI. Influence of age on the association between various measures of obesity and all-cause mortality. J Am Geriatr Soc. 2009; 57:2077–2084. [PubMed: 19754497]
5. Wakabayashi I. Relationships of body mass index with blood pressure and serum cholesterol concentrations at different ages. Aging Clin Exp Res. 2004; 16:461–466. [PubMed: 15739597]
6. Uhernik AI, Milanovic SM. Anthropometric indices of obesity and hypertension in different age and gender groups of Croatian population. Coll Antropol. 2009; 33 (Suppl 1):75–80. [PubMed: 19563150]
7. Chen Y, Rennie DC, Reeder BA. Age-related association between body mass index and blood pressure: the Humboldt Study. Int J Obes Relat Metab Disord. 1995; 19:825–831. [PubMed: 8589786]
8. Benetou V, Bamia C, Trichopoulos D, Mountokalakis T, Psaltopoulou T, Trichopoulou A. The association of body mass index and waist circumference with blood pressure depends on age and gender: a study of 10,928 non-smoking adults in the Greek EPIC cohort. Eur J Epidemiol. 2004; 19:803–809. [PubMed: 15469038]
9. Droyvold WB, Midthjell K, Nilsen TI, Holmen J. Change in body mass index and its impact on blood pressure: a prospective population study. Int J Obes (Lond). 2005; 29:650–655. [PubMed: 15809666]
10. Brown CD, Higgins M, Donato KA, et al. Body Mass Index and the Prevalence of Hypertension and Dyslipidemia. Obesity. 2000; 8:605–619.
11. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. JAMA. 1999; 282:1523–1529. [PubMed: 10546691]
12. Rahmouni K, Morgan DA. Hypothalamic arcuate nucleus mediates the sympathetic and arterial pressure responses to leptin. Hypertension. 2007; 49:647–652. [PubMed: 17190874]
13. Medical Research Council trial of treatment of hypertension in older adults: principal results. MRC Working Party. BMJ. 1992; 304:405–412. [PubMed: 1445513]
14. Dahlof B, Lindholm LH, Hansson L, Schersten B, Ekbom T, Wester PO. Morbidity and mortality in the Swedish Trial in Old Patients with Hypertension (STOP-Hypertension). Lancet. 1991; 338:1281–1285. [PubMed: 1682683]
15. Beckett NS, Peters R, Fletcher AE, et al. Treatment of hypertension in patients 80 years of age or older. N Engl J Med. 2008; 358:1887–1898. [PubMed: 18378519]

Table 1a

Logistic regression model with hypertension (yes/no) as the dependent variable after backward elimination of non-significant variables.

Hypertension (yes)	p-value
BMI	<0.0001
Age	<0.0001
Gender	<0.0001
Alcohol intake	0.0027
Smoking status	0.041
Age*BMI	0.014
Age*smoking status	0.013
Area under the ROC curve	0.83

Age represents the three age categories (Young, Middle age and Old), bmi represents three categories (Lean, Overweight and Obese) and smoking status is coded as current smoker, past smoker and non smoker.

Table 1b

Odds ratios of having hypertension between the three age groups in lean overweight and obese subjects.

	Hypertension (yes) OR (95% CI)		
	Lean	**Overweight**	**Obese**
Old vs Young (alcohol=no)	33.89 (17.94 to 64.02)†	12.84 (7.13 to 23.10)†	10.45 (4.58 to 23.85)†
Middle age vs Young (alcohol=no)	10.98 (6.72 to 17.92)†	5.64 (3.38 to 9.40)†	4.23 (2.06 to 8.67)†
Old vs Middle age (alcohol=no)	3.09 (1.71 to 5.58)†	2.28 (1.37 to 3.77)†	2.47 (1.29 to 4.72)†
Old vs Young (alcohol=yes)	19.16 (10.86 to 33.80)†	7.26 (4.52 to 11.67)†	5.90 (2.76 to 12.66)†
Middle age vs Young (alcohol=yes)	5.09 (3.18 to 8.14)†	2.62 (1.75 to 3.90)†	1.96 (0.99 to 3.86)
Old vs Middle age (alcohol=yes)	3.76 (2.23 to 6.32)†	2.78 (1.87 to 4.09)†	3.01 (1.66 to 5.46)†

†Statistically significant odds ratios

CI: Confidence intervals