Body mass and blood pressure

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Abstract

Background: Probably metabolic syndrome is a chronic low-grade inflammatory process on vascular endothelium, and effect of excess weight on blood pressure (BP) may be the major cause of inflammation.

Methods: We took consecutive patients between the ages of 35 and 70 years.

Results: There were 105 cases (18.9%) in the normal weight, 240 cases (43.2%) in the overweight, and 208 cases (37.4%) in the obesity groups with similar mean ages (48.0, 50.4, and 52.3 years, respectively, p>0.05 for both). Female ratio was significantly higher in the obesity group (78.8%) than the others (47.6% and 47.5%, p<0.001 for both). Prevalence of sustained normotension (NT) decreased gradually from the normal weight towards the obesity groups (74.2%, 52.5%, and 26.9%, p<0.001 for both). Whereas prevalence of white coat hypertension (WCH) increased gradually in the same direction (17.1%, 34.1%, and 51.9%, p<0.001 for both). Similarly, prevalence of hypertension (HT) increased gradually in the same direction again (7.6%, 13.3%, and 21.1%, p<0.01 for both). Parallel to BP, prevalences of diabetes mellitus (DM), hyperbetalipoproteinemia, dyslipidemia, and coronary artery disease (CAD) increased parallel to increased body mass index again (p<0.05 nearly in all steps).

Conclusion: Excess weight affects 80.7% of the population at and above the age of 35 years in Turkey, and obesity is found nearly four-time more common in females. Parallel to the increased body mass, prevalences of sustained NT decreased and WCH and HT increased beside the increased prevalences of other parameters and consequences of the metabolic syndrome including DM, hyperbetalipoproteinemia, dyslipidemia, and CAD.

Key words: Body mass index, blood pressure, metabolic syndrome, endothelial inflammation

Introduction

Due to the prolonged survival of human being, systemic atherosclerosis may be the major health problem in this century, and its association with sedentary lifestyle, excess weight, smoking, and alcohol is collected under the heading of metabolic syndrome (1, 2). The syndrome is characterized by a chronic low-grade inflammatory process on vascular endothelium in whole body (3). The inflammatory process is particularly accelerated by some factors including sedentary lifestyle, excess weight, smoking, alcohol, chronic inflammation and infections, and cancers (4, 5). The syndrome can be slowed down with appropriate nonpharmaceutical approaches including lifestyle changes, diet, exercise, cessation of smoking, and withdrawal of alcohol (6). The syndrome contains reversible parameters including overweight, white coat hypertension (WCH), impaired fasting glucose, impaired glucose tolerance, hyperlipoproteinemias, alcohol, and smoking for the development of irreversible consequences including obesity, hypertension (HT), type 2 diabetes mellitus (DM), chronic obstructive pulmonary disease, cirrhosis, chronic renal disease, peripheric artery disease, coronary artery disease (CAD), and stroke (7). In another perspective, the metabolic syndrome may be the most significant disease of human being decreasing quality and duration of human lifespan at the moment. The syndrome has become increasingly common all over the world, for instance 50 millions of people in the United States affected (8). The syndrome induced accelerated atherosclerosis in whole body may be the leading cause of end-organ failures, early aging, and premature death for both genders. For example, CAD is the leading cause of death in developed countries. Although sedentary lifestyle, excess weight, smoking, alcohol, chronic inflammation and infections, and cancers induced chronic low-grade inflammation on vascular endothelium may terminate with significant health problems, there is not enough knowledge about direct effects of excess weight on blood pressure (BP) in the literature.

Material and methods

The study was performed in the Internal Medicine Polyclinic of the Dumlupinar University between January and September 2006. We took consecutive patients between the ages of 35 and 70 years to be able to see the possible consequences of excess weight on BP and to avoid debility induced weight loss in elder individuals.

Their medical histories including smoking habit and already used medications were learnt, and a routine check up procedure including fasting plasma glucose (FPG), low density lipoproteins (LDL), triglyceride, high density lipoproteins (HDL), and an electrocardiography was performed. Current daily smokers at least for the last 12-month and cases with a history of five pack-years were accepted as smokers. Insulin using diabetics and patients with devastating illnesses including malignancies, acute or chronic renal failure, chronic liver diseases, hyper- or hypothyroidism, and heart failure were excluded to avoid their possible effects on weight. Additionally, body mass index (BMI) of each case was calculated by the measurements of the Same Internist instead of verbal expressions. Weight in kilograms is divided by height in meters squared, and obesity is defined as a BMI of 30 kg/m2 or greater, overweight as between 25.0 and 29.9 kg/m2, normal weight as between 18.5-24.9 kg/m2, and underweight as lower than 18.5 kg/m2 (9). Office blood pressure (OBP) was checked after a 5-minute of rest in the seated position with the mercury sphygmomanometer on three visits and no smoking was permitted during the previous 2-hour. A 10-day twice daily measurement of blood pressure at home (HBP) was obtained in all cases, even in the normotensives in the office due to the risk of masked HT, after a 10-minute education about proper BP measurement techniques (10). The education included recommendation of upper arm while discouraging wrist and finger devices, using a standard adult cuff with bladder sizes of 12 x 26 cm for arm circumferences up to 33 cm in length and a large adult cuff with bladder sizes of 12 x 40 cm for arm circumferences up to 50 cm in length, and taking a rest at least for a period of 5-minute in the seated position before measurement. A 24-hour ambulatory blood pressure monitoring (ABPM) was not required due to its equal effectiveness with HBP measurements (11). HT is defined as a BP of 135/85 mmHg or greater on average HBP (11). WCH is defined as OBP of 140/90 mmHg or greater, but average HBP of less than 135/85 mmHg, and sustained normotension (NT) as average HBP of lower than 135/85 mmHg and OBP of lower than 140/90 mmHg, so the white coat effect is defined as the difference between the office and average HBP (11). Masked HT is defined as OBP of lower than 140/90 mmHg, but average HBP of 135/85 mmHg or greater (11). Cases with an overnight FPG level of 126 mg/dL or greater on two occasions or already using antidiabetic medications were defined as diabetics. An oral glucose tolerance test with 75-gram glucose was performed in cases with a FPG level between 100 and 126 mg/dL, and diagnosis of cases with a 2-hour plasma glucose level of 200 mg/dL or greater is DM. Additionally, patients with dyslipidemia were detected by means of the National Cholesterol Education Program Expert Panel's recommendations for defining dyslipidemic subgroups (9). Dyslipidemia is diagnosed with a LDL value of 160 mg/dL or greater and/or a triglyceride value of 200 mg/dL or greater and/or a HDL value of lower than 40 mg/dL. A stress electrocardiography was performed in suspected cases, and a coronary angiography was obtained just for the stress electrocardiography positive cases. Eventually, all cases were divided into four groups as underweight, normal weight, overweight, and obesity, and their mean ages, gender distributions, and prevalences of smoking, sustained NT, WCH, HT, DM, hyperbetalipoproteinemia, dyslipidemia, and CAD were compared between them. Mann-Whitney U Test, Independent-Samples T Test, and comparison of proportions were used as the methods of statistical analyses.

Results

The study included 555 cases (328 females and 227 males), totally. There were just two cases (0.36%) within the underweight, 105 cases (18.9%) within the normal weight, 240 cases (43.2%) within the overweight, and 208 cases (37.4%) within the obesity groups. In another word, 80.7% of the cases at and above the age of 35 years have excess weight. Due to the just two cases (two males) of the underweight group, this group was not taken for comparison. The mean ages of the normal weight, overweight, and obesity groups were similar (48.0, 50.4, and 52.3 years, respectively, p>0.05 for both). Although the female ratios were similar in the normal weight and overweight groups (47.6% versus 47.5%, respectively, p>0.05), 78.8% of the obesity group were female (p<0.001). On the other hand, prevalence of smoking was significantly lower in the obesity (19.2%) than the overweight (31.6%, p<0.001) and the normal weight groups (35.2%, p<0.001) but the female predominance of the obesity group was probably the cause of such difference since 112 of 153 smokers were male in the present study. In another word, smoking was found as nearly three-time more common in male gender. As the most significant results of the study, prevalence of sustained NT decreased from 74.2% of the normal weight to 52.5% of the overweight (p<0.001) and 26.9% of the obesity groups (p<0.001), significantly. Whereas prevalence of WCH increased from 17.1% of the normal weight to 34.1% of the overweight (p<0.001) and 51.9% of the obesity groups (p<0.001), significantly. Similarly, prevalence of HT increased from 7.6% of the normal weight to 13.3% of the overweight (p<0.01) and 21.1% of the obesity groups (p<0.01), significantly. Parallel to the BP results, prevalences of DM, hyperbetalipoproteinemia, dyslipidemia, and CAD increased significantly from the normal weight towards the obesity groups nearly in all steps as the other parameter and consequences of the metabolic syndrome (p<0.05 nearly in all) (Table 1).

Table 1: Characteristic features of the study cases

Variables	Normal weight	*p*-value	Overweight	*p*-value	Obesity
Ratio	18.9% (105)	<0.001	43.2% (240)	Ns*	37.4% (208)
Mean age (year)	48.0 ± 8.7 (35-70)	Ns	50.4 ± 9.6 (35-70)	Ns	52.3 ± 8.8 (35-70)
Female ratio	47.6%	Ns	47.5%	<0.001	78.8%
Prevalence of smoking	35.2%	Ns	31.6%	<0.001	19.2%
Prevalence of sustained NT†	74.2%	<0.001	52.5%	<0.001	26.9%
Prevalence of WCH‡	17.1%	<0.001	34.1%	<0.001	51.9%
Prevalence of HT§	7.6%	<0.01	13.3%	<0.01	21.1%
Prevalence of DM‖	9.5%	<0.001	19.5%	Ns	20.1%
Prevalence of hyperbetalipoproteinemia	11.4%	Ns	14.5%	<0.05	19.7%
Prevalence of dyslipidemia	20.0%	<0.001	32.9%	Ns	36.0%
Prevalence of CAD¶	10.4%	Ns	10.4%	<0.001	17.7%

*Nonsignificant (p>0.05)
†Normotension
‡White coat hypertension
§Hypertension
‖Diabetes mellitus
¶Coronary artery disease

Discussion

Probably obesity is found among one of the irreversible endpoints of the metabolic syndrome, since after development of obesity, nonpharmaceutical approaches provide limited benefit either to heal obesity or to prevent its complications. Excess weight probably leads to a chronic low-grade inflammation on vascular endothelium that is associated with many coagulation and fibrinolytic abnormalities (12). The chronic inflammatory process is characterized by lipid-induced injury, invasion of macrophages, proliferation of smooth muscle cells, endothelial dysfunction, and increased atherogenicity (13, 14). Elevation of C-reactive protein (CRP) levels in serum carries predictive power for the development of atherosclerotic end-points (15, 16), and excess weight is considered as strong factors for controlling of CRP concentration in serum, because adipose tissue produces biologically active leptin, tumor necrosis factor-alpha, plasminogen activator inhibitor-1, and adiponectin. So adipose tissue is involved in the regulation of cytokines, and individuals with excess weight have elevated CRP levels in serum (17, 18). On the other hand, individuals with excess weight will have an increased circulating blood volume as well as an increased cardiac output, thought to be the result of increased oxygen demand of the extra tissue. The prolonged increase in circulating blood volume may also lead to myocardial hypertrophy and decreased compliance. In addition to the atherosclerosis and HT, fasting plasma glucose and serum total cholesterol levels were elevated with the increased BMI again (19). Similarly, prevalences of CAD and ischemic stroke increased with an elevated BMI (20). On the other hand, the chronic low-grade inflammatory process may also cause genetic changes on the epithelial cells, and the systemic atherosclerotic process may decrease clearance of malignant cells by the immune system, effectively (21). Eventually, the risk of death from all causes including cardiovascular diseases and cancers increased throughout the range of moderate to severe weight excess in all age groups (22).

It was shown in many studies that excess weight causes significant health problems (23), and the risk of all-cause mortality increases with the increasing BMI, gradually (22). Similarly, the BP pattern changed from the sustained NT to WCH and HT parallel to the increasing BMI in the present study. WCH is a condition characterized by elevated BP in medical settings combined with normal ABPM or self-measured HBP, and it may be an indicator of something going bad for health. As already detected in the above study that the ABPM and self-measured HBP were equally effective for the diagnosis of WCH (11). Similarly, recent HT guidelines propose self-measurement of HBP as an important means to evaluate response to antihypertensive therapy, to improve compliance with therapy, and as an alternative to ABPM to confirm or refute the WCH (24). Therefore, we preferred measurement of HBP due to its simplicity in the present study. We detected very high prevalences of WCH in early decades such as 33.3% in the second, 46.6% in the third, and 50.0% in the fourth, 48.9% in the fifth, 36.9% in the sixth, 19.2% in the seventh, and 8.3% in the eighth decades of life, and prevalence of HT initially started to be higher than 40.0% in the sixth decade, and it reached up to 75.0% in the eighth decade of life (11). The high prevalences of WCH in the society were also shown in some other papers (25, 26). So as a hypothesis, we come to the result that all HT cases may arise from the previously WCH cases but WCH probably is an acute phase reactant for several other health problems. Although it was postulated in a recent review that patients with WCH are characterized by absence of target organ damage induced by HT, absence of risk of future cardiovascular disease related to HT, and absence of lowering of BP from antihypertensive therapy (27), we evaluated WCH not a cause of HT or atherosclerosis alone but as an acute phase reactant mainly alarming gaining weight and many associated disorders in the future in another study (28). Similar to the present study, when we compared the underweight, normal weight, and overweight groups according to BP variability, beside the significantly decreased prevalences of sustained NT from the underweight towards the normal weight and overweight groups, the prevalences of WCH increased in the same direction, significantly (28). Eventually, the prevalence of WCH reached up to 68.4% in the overweight group, and only 31.5% of the overweight cases had sustained NT although the very young mean age of them (24.8 years) (28). On the other hand, when we compared the sustained NT, WCH, and HT groups in the previous study (4), WCH cases were found in between according to the prevalences of almost all of the following disorders including obesity, impaired glucose tolerance, DM, hypertriglyceridemia, hyperbetalipoproteinemia, and dyslipidemia, and nearly all of the above disorders showed a gradual and significant progression in frequency from the sustained NT towards the WCH and HT cases. On the other hand, 19.6% and 35.6% of WCH cases in the underweight and normal weight groups, respectively, may indicate that WCH may be an acute phase reactant influenced by several factors instead of BMI alone (28-30), but the BMI may be the major determining factor of BP. In addition to the WCH and HT, other parameters and consequences of the metabolic syndrome including DM, hyperbetalipoproteinemia, dyslipidemia, and CAD showed significant increases parallel to the increasing BMI in the present study.

As a conclusion, excess weight affects 80.7% of the population at and above the age of 35 years in Turkey. Additionally, obesity was found nearly four-time more common in females, which probably can be explained by the physical inactivity of them. Parallel to the increased body mass, prevalences of sustained NT decreased and WCH and HT increased beside the increased prevalences of other parameters and consequences of the metabolic syndrome including DM, hyperbetalipoproteinemia, dyslipidemia, and CAD.

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