

Anthropometric Indices of Obesity and Hypertension in Different Age and Gender Groups of Croatian Population

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ABSTRACT

The aim of this study was to investigate the association of hypertension with the obesity indices – body mass index and waist circumference. The study was based on the data from the Croatian Adult Health Survey 2003, which is a cross-sectional study on the representative sample of 9,070 Croatian adults. The results showed that in both men and women aged 18–64 years and 65 years and older increased BMI and waist circumference were associated with higher odds of hypertension. Odds of hypertension for obese (BMI ≥ 30) and persons with abdominal obesity (waist circumference ≥ 102 cm for men, ≥ 88 cm for women) was higher among young and middle aged than among elderly persons. No differences in odds of hypertension were recorded between persons with increased BMI and persons with increased waist circumference. Both BMI and waist circumference exhibited equally strong association with hypertension in Croatian population, in both men and women, and in those who are below or over 65 years of age.

Key words: body mass index, waist circumference, weight, hypertension, Croatia

Introduction

Obesity is a significant health problem in majority of developed countries due to its association with numerous diseases, including hypertension which is an important risk factor for circulatory diseases^{1,2}. Results from many epidemiological studies show that obesity is directly associated with hypertension in both genders and in all age groups. Strength of that association varies due to differences among populations in the prevalence of obesity, age and gender structure, ethnicity and lifestyle^{3–5}. Risk of hypertension is two to six times higher in obese individuals^{6–10}. In some studies this risk was higher among younger age groups and females^{11,12}. Weight loss can prevent hypertension in obese individuals and also lower their blood pressure if already increased.

Body mass index (BMI) is most widely used obesity indicator. However, there are studies which indicate that waist circumference is more intensively associated with hypertension because of its closer correlation to visceral abdominal fat^{13,14}. Amount of visceral abdominal fat is associated with metabolic disorders which lead to different diseases, including hypertension.

In a large cross-sectional study on the sample representative for entire Croatian adult population we explored which anthropometric obesity indicator (BMI or waist circumference) is more strongly associated with hypertension and whether there are any differences in this association among different gender and age groups.

Sample and Methods

Sample

The sample comprised of 9,070 respondents older than 18 years from all parts of Croatia. The potential examinees were selected in a complex sampling scheme, which was based on the random sample of households in six regions of Croatia. Details on sampling methodology and weighting procedure are described in detail elsewhere¹⁵.

Public health nurses took anthropometric measures such as height and weight and interviewed respondents. Blood pressure was measured twice using a mercury

sphygmomanometer, with respondents seated for 20 minutes between the measurements. Lifestyle habits were reported by respondents and recorded on a questionnaire by public health nurse during interview.

Variables

Respondents who stated that they had been diagnosed with hypertension previously (which included those who stated that they used anti-hypertensive drugs as well as those who stated that they did not use hypertensive drugs, although they had been diagnosed with hypertension) or whose average blood pressure calculated from two measurements was equal or higher than 140 mmHg for systolic or equal or higher than 90 mmHg for diastolic blood pressure, were categorized as hypertensive.

Respondents whose BMI was 25 kg/m² or higher, but below 30 kg/m² were classified as overweight, while respondents with BMI 30 kg/m² and higher were classified as obese. Waist circumference of 80 cm and higher, but lower than 88cm for women and 94 cm and higher, but lower than 102cm for men was considered as the first stage abdominal obesity (regardless of BMI), while waist circumference of 88 cm and higher for women and 102 cm and higher for men was considered as a second stage abdominal obesity, in accordance with accepted mild and strict criteria for abdominal obesity measured by waist circumference¹⁶.

Statistics

Distribution and association of BMI and waist circumference with high blood pressure were calculated

separately for male and female respondents in two representative age groups: 18–64 years (young and middle-aged) and 65 years and older (elderly). Association between hypertension and both anthropometric indices of obesity was assessed by multiple logistic regression analysis, separately for men and women unadjusted as well as adjusted for other potential risk factors for hypertension: smoking, alcoholic beverages consumption, coffee consumption, adding salt and leisure time physical activity.

Statistical analysis was performed using SPSS (version 14.01; License: Croatian National Institute of Public Health) and BOOTVARE_V21.SPS Program (Version 2.1; author: Statistics Canada), which computes variances for ratios and logistic regression by using »bootstrap» method which takes into account sample design information when calculating variance estimates. Coefficient of variation (CV) calculated by BOOTVARE_V21.SPS Program is used for measuring the potential size of the sampling error in order to determine whether estimates from this survey can be applied to the general population. Estimates with CV less than 16.5% are considered to be acceptable^{17–18}.

Results

In respondents aged 18–64 years, prevalence of overweight was higher in men than in women, while there was no difference between genders in prevalence of obesity. Prevalence of first stage abdominal obesity was the same in men and women, but prevalence of second stage abdominal obesity was higher in women than in men. Hypertension was more prevalent in men (Table 1).

TABLE 1
CHARACTERISTICS OF THE STUDY PARTICIPANTS

| Characteristic | 18–64 years | | | | | |
|---|--------------------|-----------|-----|-------|-----------|-----|
| | Men | 95% CI | CV | Women | 95% CI | CV |
| Prevalence of overweight and obesity (%) | | | | | | |
| Overweight (BMI ≥ 25 kg/m ² and < 30 kg/m ²) | 42.0 | 39.1–44.9 | 3.5 | 30.8 | 29.1–32.4 | 2.7 |
| Obesity (BMI ≥ 30 kg/m ²) | 19.8 | 17.8–21.8 | 5.1 | 17.8 | 16.5–19.1 | 3.7 |
| Prevalence of abdominal obesity (%) | | | | | | |
| First stage (W ≥ 80 cm and < 88 cm for females, W ≥ 94 cm and < 102 cm for males) | 24.4 | 22.2–26.5 | 4.5 | 21.0 | 19.3–22.6 | 3.9 |
| Second stage (W ≥ 88 cm for females, W ≥ 102 cm for males) | 31.6 | 28.9–34.2 | 4.3 | 42.8 | 40.9–44.7 | 2.2 |
| Prevalence of hypertension (%) | 40.7 | 38.0–43.4 | 3.4 | 33.1 | 31.3–34.9 | 2.7 |
| Characteristic | 65 years and older | | | | | |
| | Men | 95% CI | CV | Women | 95% CI | CV |
| Prevalence of overweight and obesity (%) | | | | | | |
| Overweight (BMI ≥ 25 kg/m ² and < 30 kg/m ²) | 49.0 | 45.3–52.7 | 3.8 | 43.0 | 39.7–46.3 | 3.9 |
| Obesity (BMI ≥ 30 kg/m ²) | 21.6 | 18.4–24.8 | 7.6 | 29.7 | 26.9–32.4 | 4.7 |
| Prevalence of abdominal obesity (%) | | | | | | |
| First stage (W ≥ 80cm and < 88cm for females, W ≥ 94cm and < 102 cm for males) | 22.4 | 18.4–26.4 | 9.1 | 13.7 | 11.4–16.0 | 8.6 |
| Second stage (W ≥ 88 cm for females, W ≥ 102 cm for males) | 52.2 | 47.6–56.9 | 4.6 | 78.7 | 75.8–81.5 | 1.9 |
| Prevalence of hypertension (%) | 76.9 | 73.7–80.2 | 2.1 | 81.6 | 79.2–84.0 | 1.5 |

In respondents aged 65 years and older, there were no differences between men and women in prevalence of overweight, but obesity was more common in women. Prevalence of first stage abdominal obesity was higher in men, while prevalence of second stage abdominal obesity was more prevalent in women. No difference in prevalence of hypertension was recorded (Table 1).

Mean values for BMI and waist circumference were higher than normal for men and women in both age groups. Respondents aged 65 years and older had higher mean values for BMI and waist circumference. Mean values of systolic and diastolic blood pressure were also higher for older age group, with greater difference compared to younger age group in systolic blood pressure for men and in diastolic blood pressure for women (Table 2).

Among young and middle aged men, adjusted for other potential risk factors for hypertension, overweight persons had 2.8-fold higher odds of hypertension compared to those with normal weight, while obese persons had 7.6-fold higher odds of hypertension compared to those with normal weight. Persons with the first stage abdominal obesity had 3.2-fold higher odds of hypertension compared to those with normal waist circumference, while persons with the second stage abdominal obesity had 5.9-fold higher odds of hypertension compared to those with normal waist circumference.

Among elderly men, adjusted for other potential risk factors for hypertension, overweight persons had 1.9-fold higher odds of hypertension compared to persons with normal weight, while obese had 3-fold higher potential risk of hypertension compared to persons with normal weight. Relative odds of hypertension for persons with the first stage abdominal obesity was not significantly increased compared to persons with normal waist circumference, while odds for persons with the second stage abdominal obesity was 2.5-fold higher compared to persons with normal waist circumference.

When comparing odds of hypertension between overweight men under 65 years and persons 65 years old and older, no difference was recorded, but when comparing odds between the same age groups for obese persons, the odds of hypertension was higher for obese persons under 65 years. The same was recorded for the first and second stage of abdominal obesity: there was no difference in odds between two age groups for the first stage abdominal obesity, but for the persons with the second stage abdominal obesity the odds was higher for persons under 65 years. There were no differences recorded in odds of hypertension neither between overweight and the first stage abdominal obesity persons, nor between obese and the second stage abdominal obesity persons in any age groups (Table 3).

TABLE 2
MEAN VALUES OF ANTHROPOMETRIC INDICES AND BLOOD PRESSURE IN POPULATION

| Characteristic | 18–64 years | | 65 years and older | |
|---------------------------------|-------------|-------|--------------------|-------|
| | Men | Women | Men | Women |
| BMI (kg/m ²) | 26.8 | 25.5 | 27.2 | 27.9 |
| Waist circumference (cm) | 95.6 | 86 | 101.6 | 97.5 |
| Systolic blood pressure (mmHg) | 129.8 | 123.3 | 146.5 | 129.2 |
| Diastolic blood pressure (mmHg) | 80.8 | 76.9 | 82.4 | 83.1 |

TABLE 3
ASSOCIATION OF ANTHROPOMETRIC INDICES OF OBESITY WITH HYPERTENSION IN MEN

| | 18-64 years | | | | | 65 years and older | | | | | | |
|--------------------------|-------------------|-----------|---------------------------|----------|------------------------------|--------------------|-----------|---------------------------|--------|------------------------------|--------|---------|
| | % of hypertensive | 95% CI | Crude OR for hypertension | 95% CI | Adjusted OR for hypertension | % of hypertensive | 95% CI | Crude OR for hypertension | 95% CI | Adjusted OR for hypertension | 95% CI | |
| BMI (kg/m ²) | | | | | | | | | | | | |
| < 25 | 22.4 | 18.7–26.2 | 1.0 | | 1.0 | 66.2 | 59.4–72.2 | 1.0 | | 1.0 | | |
| 25–29.9 | 44.2 | 40.1–48.4 | 2.7 | 2.1–3.5 | 2.8 | 2.1–3.6 | 79.6 | 74.7–84.5 | 2.0 | 1.3–3.1 | 1.9 | 1.2–2.9 |
| ≥ 30 | 68.2 | 63.0–73.3 | 7.4 | 5.4–10.3 | 7.6 | 5.4–10.5 | 86.2 | 80.9–91.6 | 3.2 | 1.9–5.4 | 3.0 | 1.8–5.2 |
| Waist (cm) | | | | | | | | | | | | |
| < 94 cm | 22.0 | 18.2–25.8 | 1.0 | | 1.0 | 65.2 | 57.9–72.6 | 1.0 | | 1.0 | | |
| 94–101.9 cm | 46.5 | 40.9–52.2 | 3.1 | 2.3–4.1 | 3.2 | 2.3–4.3 | 76.8 | 69.7–82.8 | 1.8 | 1.0–3.0 | 1.7 | 1.0–2.9 |
| ≥ 102 cm | 62.5 | 57.6–67.3 | 5.9 | 4.3–8.1 | 5.9 | 4.2–8.2 | 83.0 | 78.9–87.1 | 2.6 | 1.7–4.0 | 2.5 | 1.6–3.8 |

Among young and middle aged women, adjusted for other potential risk factors for hypertension, overweight persons had 3-fold higher odds of hypertension compared to those with normal weight, while obese persons had 7.9-fold higher odds of hypertension compared to those with normal weight. Persons with the first stage abdominal obesity had 2.5-fold higher odds of hypertension compared to those with normal waist circumference, while persons with the second stage abdominal obesity had 7.4-fold higher odds of hypertension compared to those with normal waist circumference.

Among elderly women, adjusted for other potential risk factors for hypertension, overweight persons had 1.9-fold higher odds of hypertension compared to persons with normal weight, while obese had 2.7-fold higher odds of hypertension compared to persons with normal weight. Odds of hypertension for persons with the first stage abdominal obesity was 2.3-fold higher compared to persons with normal waist circumference, while odds for persons with the second stage abdominal obesity was 3.9-fold higher compared to persons with normal waist circumference.

When comparing odds of hypertension between female overweight persons under 65 years and persons 65 years old and older, no difference was recorded, but when comparing odds between the same age groups for obese persons, the odds of hypertension was higher for obese persons under 65 years. No differences between two age groups were recorded for the first and the second stage abdominal obesity. There were no differences recorded in odds of hypertension neither between overweight and the first stage abdominal obesity persons, nor between obese and the second stage abdominal obesity persons in any age groups (Table 4).

No differences were recorded between men and women in any age group in odds of hypertension neither for overweight and obese persons, nor for persons with the first and the second stage abdominal obesity (Table 3, 4).

Discussion

Higher prevalence of overweight measured by BMI in young and middle-aged men compared to women is in accordance with previous research results^{19–21}. Higher prevalence of obesity measured by BMI among elderly women was also recorded in previous studies²² as well as higher prevalence of abdominal obesity in women^{22,23}. This study showed that in Croatian population hypertension was more prevalent among young and middle-aged men compared to women what is in accordance with research results from other transitional countries^{24,25}. This could be caused by higher prevalence of overweight in young and middle-aged men compared to women. No gender differences in prevalence of hypertension were recorded among elderly. Possible explanation could be larger increase in prevalence of obesity during ageing among women than among men which could also cause increase in prevalence of hypertension among elderly women.

Results of this research confirm association between obesity (measured through BMI) and hypertension which was recorded in both age groups and both genders. The same association was recorded for abdominal obesity. These results are in accordance with numerous longitudinal studies which showed that increase in body mass index contributes to blood pressure increase regardless of gender and age^{6,26,27}. In both genders association was stronger among young and middle-aged compared to elderly what could point to the higher importance of obesity for hypertension etiology among young and middle-aged. The same was recorded for abdominal obesity among men, but not among women, indicating that association between BMI and hypertension among women decreases with ageing more intensively than association between waist circumference and hypertension.

Certain limitations of this study should be taken into account when interpreting the results: classification of respondents as hypertensive was made on the basis of average from only two blood pressure measurements made in relatively short time span or on the basis of respon-

TABLE 4
ASSOCIATION OF ANTHROPOMETRIC INDICES OF OBESITY WITH HYPERTENSION IN WOMEN

| | 18–64 years | | | | | | 65 years and older | | | | | |
|--------------------------|-------------------|-----------|---------------------------|----------|------------------------------|----------|--------------------|-----------|---------------------------|---------|------------------------------|---------|
| | % of hypertensive | 95% CI | Crude OR for hypertension | 95% CI | Adjusted OR for hypertension | 95% CI | % of hypertensive | 95% CI | Crude OR for hypertension | 95% CI | Adjusted OR for hypertension | 95% CI |
| BMI (kg/m ²) | | | | | | | | | | | | |
| < 25 | 17.8 | 16.0–19.6 | 1.0 | | 1.0 | | 72.8 | 67.0–78.5 | 1.0 | | 1.0 | |
| 25–29.9 | 39.7 | 36.0–43.4 | 3.0 | 2.5–3.7 | 3.0 | 2.4–3.6 | 83.3 | 79.7–86.7 | 1.9 | 1.3–2.7 | 1.9 | 1.3–2.8 |
| ≥ 30 | 65.7 | 61.6–69.9 | 8.9 | 7.1–11.1 | 7.9 | 6.3–10.0 | 87.5 | 84.0–91.0 | 2.6 | 1.7–4.1 | 2.7 | 1.7–4.4 |
| Waist (cm) | | | | | | | | | | | | |
| < 80cm | 12.5 | 10.4–14.6 | 1.0 | | 1.0 | | 59.9 | 48.2–71.5 | 1.0 | | 1.0 | |
| 80–87.9cm | 27.1 | 23.6–30.6 | 2.6 | 2.0–3.4 | 2.5 | 1.9–3.2 | 76.2 | 69.6–82.7 | 2.1 | 1.1–4.1 | 2.3 | 1.2–4.4 |
| ≥ 88cm | 53.4 | 50.3–56.4 | 8.0 | 6.4–10.0 | 7.4 | 5.9–9.3 | 84.7 | 82.3–87.2 | 3.7 | 2.2–6.2 | 3.9 | 2.3–6.6 |

dent's statement about previously diagnosed hypertension which was obtained as a part of a questionnaire and was therefore potentially prone to response and recall bias. For practical reasons, all measurements and interview were made during single visit of public health nurse to the respondent's home. The fact that measurements were made by public health nurse in respondent's home, could reduce the incidence of »white coat hypertension«.

As no differences among any of gender-age groups were recorded in strength of its association with hypertension neither between overweight and the first stage abdominal obesity, nor between obesity and the second stage abdominal obesity, we can conclude that both BMI and waist circumference expressed through mentioned three categories (normal, overweight, obese for BMI, normal, first and second stage abdominal obesity for waist circumference) exhibit equally intensive association with hypertension in Croatian population, both among men and women, below and over 65 years of age. In el-

derly men, BMI might be given advantage due to the fact that risk of hypertension was significantly higher for overweight persons compared to those with normal weight, while this was not the case for persons with the first stage abdominal obesity compared to persons with normal waist circumference. In young and middle-aged men and all women, both indicators can equally be used in research of influence of obesity on hypertension in Croatian population.

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ANTROPOMETRIJSKI POKAZATELJI PRETILOSTI I HIPERTENZIJA U RAZLIČITIM DOBNIM I SPOLNIM SKUPINAMA STANOVNIŠTVA HRVATSKE

SAŽETAK

Cilj ovog rada bio je istražiti povezanost hipertenzije s pokazateljima pretilosti – indeksom tjelesne mase i opsegom struka, na temelju podataka iz Hrvatske zdravstvene ankete 2003. Presječno istraživanje na reprezentativnom slučajnom uzorku od 9070 odraslih osoba iz Hrvatske pokazalo je da su i kod muškaraca i kod žena, kako u dobi 18–64

godine, tako i u dobi od 65 i više godina, povećan indeks tjelesne mase i opseg struka bili povezani s većom vjerojatnošću hipertenzije. Kod muškaraca i kod žena, vjerojatnost prisutnosti hipertenzije za pretile (indeks tjelesne mase ≥ 30), kao i za osobe s abdominalnom pretilošću (opseg struka ≥ 102 cm za muškarce, ≥ 88 cm za žene) bila je veća kod mladih i osoba srednjih godina, nego kod starijih osoba. Nisu zabilježene razlike u vjerojatnosti prisutnosti hipertenzije između osoba s povišenim indeksom tjelesne mase i osoba s povećanim opsegom struka. I indeks tjelesne mase i opseg struka pokazali su jednako snažnu povezanost s hipertenzijom u stanovništvu Hrvatske, kod muškaraca i kod žena u dobi do 65 godina, kao i u dobi od 65 godina i starijoj.