

Measurement of Nutritional Status Using Body Mass Index, Waist-to-Hip Ratio, and Waist Circumference to Predict Treatment Outcome in Females and Males with Acute First-Ever Ischemic Stroke

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Background: We aimed to investigate whether increased waist-to-hip ratio (WHR), waist circumference (WC), or improper body mass index (BMI) may differently predict short-term outcomes in females and males with first-ever acute ischemic stroke. *Methods:* This was a retrospective study of consecutive patients (1109 females and 939 males) admitted for first-ever ischemic stroke between 2003 and 2015. Data were collected in a detailed hospital stroke registry. BMI of 18.5-24.9 kg/m² and gender-specific normal values of WHC and WC were used as references for comparisons. Logistic regression was used to calculate the odds of in-hospital death or being dead or dependent at discharge, adjusted for patients' age and prestroke disability. *Results:* In both sexes a high WHR increased the odds of death or dependency at discharge (odds ratio [OR], 1.8; 95% confidence interval [CI], 1.05-3.08 for females and 1.43; 95% CI, 1.00-2.04 for males), but not in-hospital death alone. Increased WC was significantly associated with lower odds of either death or death and dependency at discharge in females only (OR, .36; 95% CI, .22-.58 and .69; 95% CI, .48-.97, respectively). BMI did not show any clear predictive value in either sex. *Conclusions:* Our findings suggest that being overweight measured with WC is a strong predictor of good outcome in women but not in men. The WHR less consistently predicts stroke outcome, as it is not associated with death at discharge alone; however, the WHR seems to be of similar clinical relevance in both genders. BMI seems to have the least clinical value in predicting stroke outcome in both genders. **Key Words:** Body mass index—waist-to-hip ratio—waist circumference—obesity—malnutrition—stroke outcome—ischemic stroke.

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Received April 24, 2017; accepted August 12, 2017.

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1052-3057/\$ - see front matter

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<http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2017.08.016>

Introduction

Stroke is a public health challenge. It is the second leading cause of death and the first cause of disability in adults worldwide.¹ There were reports suggesting that low body mass index (BMI) is associated with poor short- and long-term outcomes.^{2,3} On the other hand, overweight paradoxically can predict favorable outcomes in stroke survivors.⁴ Although overweight or underweight have been reported to increase the risk of stroke, their role in stroke prognosis has not been established.^{4,6}

Abdominal obesity is observed in every third man and nearly every second Polish woman, and an excess of abdominal fat has increased in both sexes during the last decade.⁷ Additionally, females and males have different distributions of body fat.⁸

The predictive value of different overweight measures after stroke has not yet been established, especially in terms of gender differences. Although the majority of studies were focused on BMI, many authors pointed that waist circumference (WC) or the waist-to-hip ratio (WHR) may represent more appropriate ways to measure adiposity and better predict stroke outcomes.⁹⁻¹¹

Our aim was to investigate the value of WC, WHR, and BMI as early outcome predictors in acute first-ever ischemic stroke, separately for males and females.

Materials and Methods

We analyzed consecutive acute stroke patients admitted between January 2003 and December 2015 to a single center providing neurological care for a population of approximately 200,000-250,000 inhabitants of a highly urbanized area (Warsaw, Poland).

Data were prospectively collected in a detailed registry developed as an adaptation of the National Institute of Neurological and Communicative Disorders and Stroke Data Bank protocols. The registry included information on patients' demographics, risk factors and comorbidities, prestroke medications and dependency, type of stroke, routine laboratory tests, neuroimaging, and the course of stroke throughout the hospital stay. Information about WC, WHR, and BMI has been collected in our registry since 2003.

Waist and hip circumference was routinely measured by a trained nurse on admission to the stroke unit when the patient was supine. Body weight was also measured on admission or stated directly by the patient or his or her proxy if necessary. Height was measured by a nurse in an upright position, and when not possible, reported by the patient or his or her proxy. Based on BMI we distinguished between underweight (<18.5 kg/m²), normal range (18.5-24.9 kg/m²), overweight (25.0-29.9 kg/m²), and obesity (≥ 30.0 kg/m²). A normal WHR was defined as less than or equal to .78 in women and as less than or equal to .92 in men. Normal waist circumference was defined as less than 94 cm in men and less than 80 cm in women.¹²

The diagnosis of stroke was based on the World Health Organization definition.¹³ Routine brain imaging at admission included noncontrast computed tomography, which in selected cases was complemented or substituted with magnetic resonance. The outcome was evaluated at discharge from hospital and expressed in modified Rankin Scale (mRS) scores. Unfavorable outcome was defined as in-hospital death or dependency at discharge (mRS score, 3-6).

Statistical Methods

Categorical variables are presented as a number of valid observations with percentage. Proportions were calculated with the exclusion of unknown values from the denominator. Due to non-normal distribution, continuous variables are presented as a median and interquartile range. Comparisons were made using the chi-square test, Kruskal-Wallis test, or Mann-Whitney *U*-test, as appropriate.

Logistic regression was applied to calculate odds ratios (ORs) with 95% confidence intervals (CIs) of hospital death or being dead or dependent (mRS score, 3-6) at discharge. Multivariable models were arbitrarily adjusted for patients' age and prestroke disability (mRS score, 2-5).

Statistical analyses were performed with the STATISTICA 10.0 software package (Stat Soft Inc., Tulsa, OK). A *P* value of $<.05$ was considered significant.

Results

The analyzed cohort consisted of 2048 patients (1109 females and 939 males) admitted due to the first-ever acute ischemic stroke.

Characteristic of Female and Male Patients Grouped by BMI, WHR, and WC

Hypertension and diabetes were more frequently reported in overweight stroke patients. However, in males it was confirmed in all 3 measure methods, while in females according to BMI and WC but not WHR (Tables 1-3).

There were no other significant differences between overweight and normal-weight females and males in terms of age, prehospital dependency, comorbidities, or smoking status that would be consistently reported with the 3 measurement methods (Tables 1-3). However, WC discriminated patients the most—overweight patients identified by WC differed most from normal-weight and underweight patients compared with corresponding groups defined by BMI and WHR. Overweight females had congestive heart failure less frequently (20.0% versus 28.3%) than females with normal WCs, while males with WC greater than or equal to 94 cm were more burdened with hypertension (80% versus 68.8%), diabetes (31.6% versus 14.6%), and history of myocardial infarction (22.3% versus 15.2%) and were less frequently current tobacco smokers (33.5% versus 41.5%) (Table 3).

Overweight (BMI > 30 , with abnormally high WHRs or WCs) females who identified with all 3 measures had a longer hospital stay (11 versus 10 days, 10 versus 9 days, and 10 versus 9 days, respectively). However, in males there were no associations between the nutrition status and length of hospital stay.

Females with increased WCs suffered from less severe strokes and were less often dead and dead or dependent at discharge from the stroke unit (Table 3). These

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