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Clinical and Metabolic Characteristics of Ischemic Stroke in Patients with Obesity: Associations with Neurological Severity and Cerebrovascular Changes

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ABSTRACT: Currently, the World Health Organization (WHO) regards obesity as a global epidemic affecting millions of people. This article examines the problem of obesity, which substantially increases the risk of cerebrovascular disorders. The causal relationships, pathogenesis, and disturbances of cerebral hemodynamics associated with this condition are discussed.

INTRODUCTION

Worldwide, acute cerebrovascular diseases (ACVDs) remain among the leading causes of disability and mortality. More than 12 million new cases of stroke are registered globally each year, while more than 3.5 million people die from the consequences of the disease. The total number of people who have experienced ischemic stroke exceeds 65 million, and this number continues to increase. More than 60% of strokes occur in individuals younger than 70 years, and up to 16% occur in individuals younger than 50 years. In some countries, the economic costs associated with treatment, rehabilitation, and loss of working capacity exceed USD 50 billion annually. Despite a decline in age-standardized mortality, the global burden of disease remains extremely high. The increasing prevalence of stroke among the working-age population, the growing number of recurrent events, and the high cost of treatment make ischemic stroke an important medical and social problem requiring the implementation of effective strategies for early diagnosis, prevention, and personalized treatment (1–5).

Worldwide, despite the high level of medical care, ischemic stroke (IS) remains one of the leading causes of premature mortality and disability. The increasing prevalence of risk factors, particularly among the working-age population, contributes to a sustained rise in the number of new and recurrent cases. Of particular concern is the increasing prevalence of metabolic disorders, including arterial hypertension, diabetes mellitus, and dyslipidemia, which substantially increase the risk of IS even among younger individuals. Obesity is one of the key factors contributing to the development of ischemic stroke. According to large prospective studies, obesity combined with arterial hypertension substantially increases the likelihood of stroke. It has been established that, in patients with obesity and metabolic disorders, the risk of primary ischemic stroke increases by more than 30%. This emphasizes the need for an integrated approach to stroke prevention, focusing not only on body-weight reduction but also on the active identification and correction of metabolic disorders.

AIM OF THE STUDY

The aim of the study was to investigate the clinical-neurological and immunogenetic characteristics of acute cerebrovascular diseases in the setting of obesity.

MATERIALS AND METHODS

The study was conducted at the Intensive Neurology and Neurology Departments of the Multidisciplinary Clinic of Tashkent Medical Academy during 2020–2024. The study included 256 patients with confirmed cerebrovascular pathology, divided into two groups:

- **Main group (n = 181)** — patients with ACVD in the setting of obesity (BMI ≥ 30 kg/m²).
- **Control group (n = 75)** — patients with ACVD without obesity (BMI < 25 kg/m²).

RESULTS

Figure 1 shows the sex distribution in the control and main groups. In the main group, women accounted for 53.59%, which was significantly higher than the corresponding proportion in the control group (38.67%). Conversely, the proportion of men was higher in the control group (61.33%) than in the main group (46.41%).

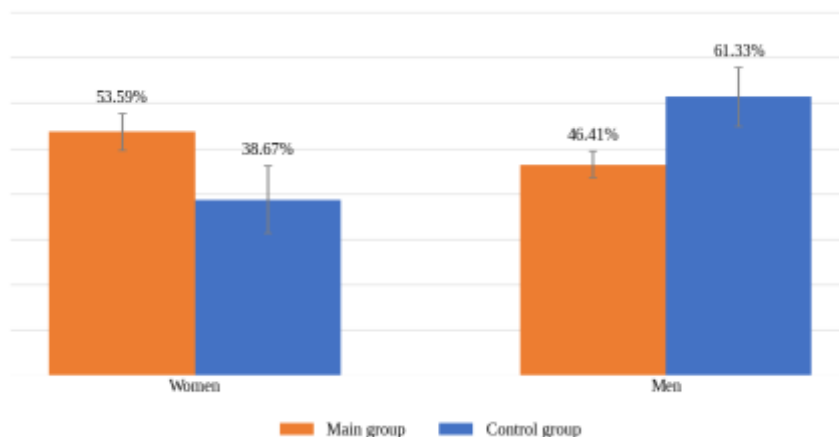


Figure 1. Sex distribution among the study groups.

The mean age of all examined patients was 62.64 ± 9.03 years. In the main group, the mean age was 61.51 ± 8.11 years, whereas in the control group it was 65.36 ± 10.52 years. Analysis of age differences by sex showed that women in the main group had a mean age of 62.93 ± 7.24 years, compared with 64.07 ± 12.62 years in the control group. Among men, the corresponding values were 60 ± 8.76 years and 66.17 ± 9.00 years, respectively. Despite the apparent differences, statistical analysis revealed no significant differences in age between the groups ($p > 0.05$), indicating that the groups may be considered conditionally comparable with respect to this parameter (Figure 2).

It is important to note that the groups may differ in terms of age and sex, since sex- and age-related characteristics of obesity development were among the factors under investigation. These parameters were analyzed separately as part of a specific stage of the study in order to determine their contribution to the clinical-metabolic and immunogenetic profiles of the patients.

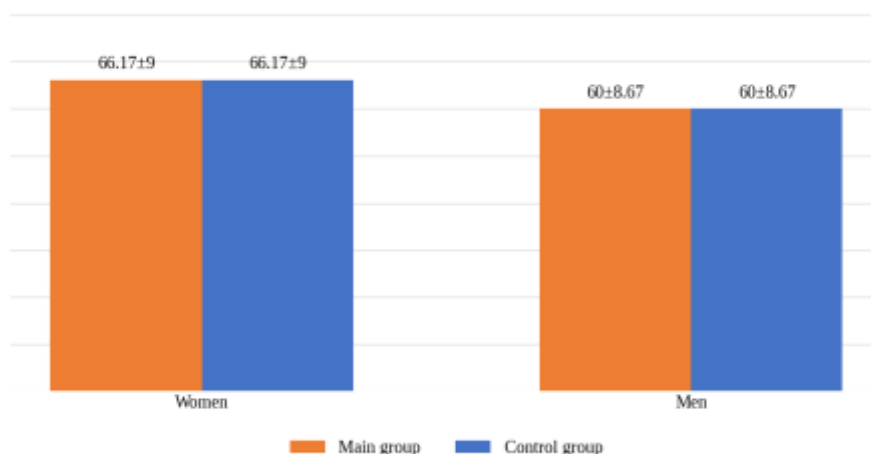


Figure 2. Mean age of patients in the study groups.

The diagnosis of ischemic stroke was confirmed by computed tomography in all 256 patients. The severity of the patients' condition and the degree of neurological deficit were assessed using the NIHSS, Barthel Index, and Scandinavian Stroke Scale on days 1, 10, and 35, as well as at 3 and 6 months of treatment. In addition, a subsample of 187 individuals was formed for molecular genetic analysis:

- **Subgroup A** — 64 patients with cerebrovascular disease and obesity;
- **Subgroup B** — 32 patients with cerebrovascular disease without obesity;
- **Control group for genetic analysis** — 91 apparently healthy individuals without a history of cerebrovascular disease or obesity.

Influence of Obesity on the Early Onset of Ischemic Stroke

We also investigated the relationship between the degree of excess body weight (pre-obesity and obesity of varying severity) and the age at onset of ischemic stroke. The analysis included all patients from the main and control groups, as well as data on sex, age, height, body weight, and calculated body mass index (BMI).

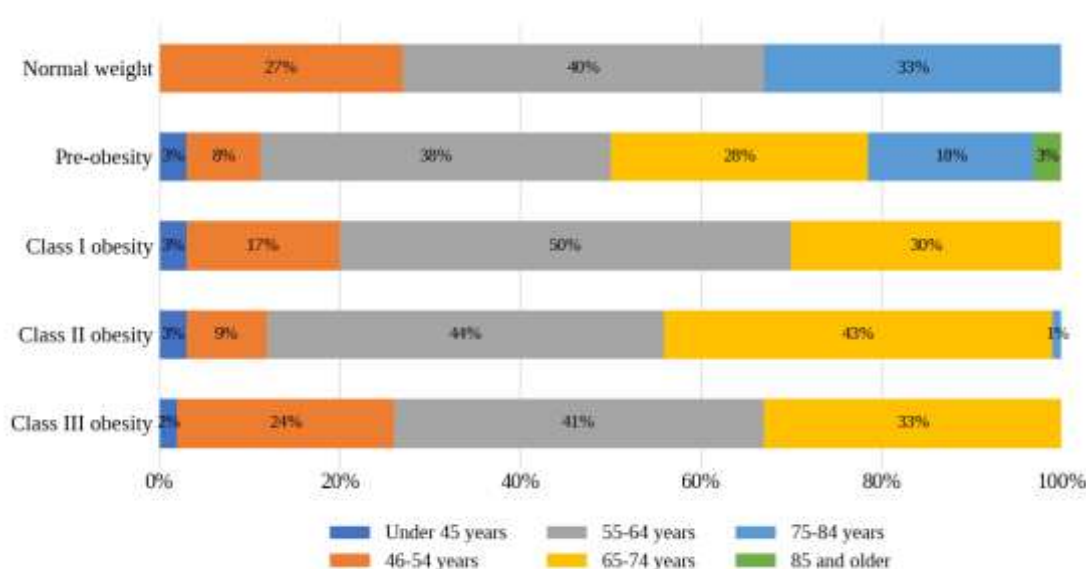


Figure 3. Distribution of patients by age group according to the degree of obesity.

The analysis showed that there were no patients with a normal BMI in the group younger than 45 years. The majority (85.7%) were overweight or obese, which may indicate that obesity at a young age is a key factor contributing to the early development of ischemic stroke. Pre-obesity and grade I obesity were each recorded in 3.33% of patients, while grade II and grade III obesity accounted for 2.86% and 1.96%, respectively. The 65–74-year age group was characterized by a gradual decrease in the degree of obesity compared with the preceding group, which may be associated either with an age-related decline in body weight or with selective survival of patients with a lower metabolic burden. Grade II obesity was identified in 42.86% of patients, grade I obesity in 30%, and grade III obesity in 33.33%. The proportion of patients with a normal BMI was zero, while pre-obesity was observed in 28.33%, indicating persistent excess body weight.

Overall, the described differences in body weight and sex distribution between the main and control groups demonstrate a substantial influence of obesity on the clinical and demographic profile of patients with cerebrovascular disease, supporting the need for subsequent stratified analysis of immunological, metabolic, and genetic parameters according to these factors.

A comparative analysis of the mean age of patients showed that ischemic stroke developed at a younger age in the obesity group (61.47 ± 8.07 years) than in the control group without obesity (65.36 ± 10.52 years); however, the difference was not statistically significant ($p > 0.05$). Among women, the mean age was 62.74 ± 7.33 years in the main group and 64.07 ± 12.62 years in the control group, whereas among men it was 60.0 ± 8.67 years and 66.17 ± 9 years, respectively. This indicates a

more pronounced shift toward an earlier age at stroke onset among men with obesity. Thus, despite the absence of statistically significant differences, a consistent trend toward earlier development of ischemic stroke was observed among patients with excess body weight and obesity, particularly among men (Figure 1).

Mean NIHSS scores differed significantly between the patient subgroups. This was attributable to the fact that more than 90% of patients with obesity were in severe (60%) or extremely severe (36.2%) condition, whereas among patients without obesity, 34.9% were classified as moderately severe, 60.2% as severe, and only 4.8% were admitted in an extremely severe condition (Figure 4).

To assess the severity of dyslipidemia, threshold levels were used to classify patients with obesity. In patients with obesity, all blood lipid profile parameters exceeded the reference ranges; low-density lipoprotein (LDL) levels were elevated in more than one-third of patients, while triglyceride levels exceeded the threshold value in all patients (100%).

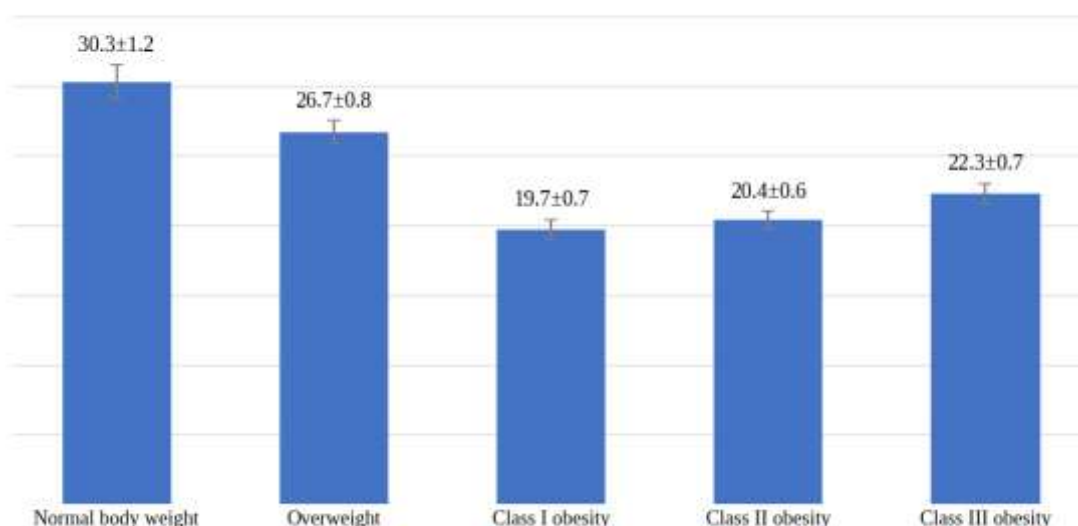


Figure 4. Relationship between the degree of obesity and stroke severity according to the NIHSS.

In the subgroup without obesity, many lipid profile parameters exceeded normal values in more than half of the patients. A marked deviation in high-density lipoprotein (HDL) levels was recorded in 81.9% of patients. Determination of blood cholesterol levels allowed the identification of three degrees of alteration in this parameter. In both subgroups, patients with a mild increase in cholesterol levels predominated: 52.4% among patients with obesity and 50.6% among those without obesity.

Hyperglycemia was detected in all patients with obesity; in 98.10% of them, fasting blood glucose levels exceeded 7.1 mmol/L, indicating a severe disturbance of glucose metabolism. A direct relationship was identified between the severity of the patients' condition and blood glucose levels ($r = 0.54$; $p > 0.001$). This was reflected in significant differences in mean values between the following groups: the mean glucose level in patients with a moderately severe course of IS was 7.1 (6; 8.3) ($p < 0.001$), whereas in patients with an extremely severe course it was 10.35 (8.5; 15.7) ($p < 0.001$). No statistically significant difference was identified in the severe-course group (9 (6.05; 10.9), $p = 0.902$).

The results of duplex scanning differed significantly between the patient subgroups. Comparative analysis showed that pathological vascular changes were more frequently detected in patients with obesity. The greatest difference was observed among patients with complete vascular occlusion. Of these patients, 78.57% had ischemic stroke in the setting of obesity, whereas 21.43% had ischemic stroke without obesity.

Analysis of duplex scanning findings and NIHSS scores showed that among patients in an extremely severe condition, complete vascular occlusion (36.36%) and vascular lumen occlusion exceeding 60% (40.91%) predominated. Occlusion of less than 60% was diagnosed in 18.18% of patients in this group. Among patients with a severe disease course, occlusion

exceeding 60% (30.77%) and occlusion below 60% (42.31%) predominated. Patients with complete vascular occlusion accounted for 7.69% of the total number of individuals in this group.

In contrast, among patients with a moderately severe disease course, a normal vascular lumen (55.56%) or occlusion of less than 60% (33.33%) was predominantly observed. No patients in this group had complete vascular occlusion, while occlusion exceeding 60% was present in 11.11% of the examined patients.

CONCLUSIONS

1. Obesity and acute cerebrovascular disease presenting as ischemic stroke were significantly more frequent among women (53.04% versus 38.67% in the control group without obesity, $p = 0.04$). The BMI in the main group was 33.76 ± 5.54 compared with 26.55 ± 1.68 in patients without obesity ($p < 0.05$). Obesity was associated with a more severe neurological deficit, increased levels of glucose, insulin, insulin resistance, C-reactive protein, total cholesterol, and triglycerides, as well as reduced HDL levels ($p < 0.05$).
2. Impaired lipid metabolism was established in patients with ischemic stroke in the setting of obesity, predominantly characterized by increased triglyceride levels and decreased HDL concentrations. Hemodynamic studies demonstrated that atherosclerotic lesions of the carotid arteries were detected in the vast majority of patients with ischemic stroke in the setting of obesity (95% of patients with IS and obesity versus 61% of patients with IS without obesity). The severity of these lesions was closely associated with BMI and waist circumference.

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