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Research Article

# Influence of Anthropometric Weight Indicators on Blood Pressure in Third-Year Students of Grodno State Medical University

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**Abstract**

Leiomyosarcomas of the urinary bladder are rare smooth muscle tumours which constitute one per cent (1%) of all urinary bladder malignancies. Even though uncommon, leiomyosarcoma is a clinically significant disease, which usually manifests as a high-grade advanced malignancy with associated substantial morbidity and mortality, if not treated early. The diagnosis of primary leiomyosarcoma of the urinary bladder could be delayed because of the asymptomatic manifestation until the tumour reaches an advanced stage. Pathological examination of specimens of primary leiomyosarcoma of the urinary bladder is highly cellular with infiltrative, interlacing fascicles of spindle cells and associated mitosis, cellular atypia and necrosis. Immunohistochemistry studies of specimens of primary leiomyosarcoma of the urinary bladder does demonstrate tumour cells that exhibit positive staining of muscle-specific-actin, desmin, and caldesmon; with negative staining for ALK-1, EMA, Cytokeratins and GATA3. Other spindle cell lesions including, leiomyoma, inflammatory myofibroblastic tumor and sarcomatoid carcinoma need to be excluded based upon pathology examination of specimens of leiomyosarcoma based upon their immunohistochemistry staining features that are different from the staining features of leiomyosarcoma of the urinary bladder because they represent the differential diagnoses, that need to be excluded by their morphology and immunohistochemistry examination features. All clinicians need to be aware of the occurrence of leiomyosarcomas, which could, on rare occasions, afflict the urinary bladder. Even though rare, primary leiomyosarcomas of the urinary bladder generally portend a poor outcome. The differential diagnosis of spindle cell lesions is extensive, including close benign and malignant mimics, the treatment of all being very different. Immediate radical cystectomy has been associated with longer survival rates for leiomyosarcoma. Leiomyosarcoma, being aggressive, with an associated high recurrence rate and metastatic potential, an early correct diagnosis would aid in the institution of proper management.

**Key words :** primary leiomyosarcoma; urinary bladder; rare; biopsy; histopathology; immunohistochemistry; muscle-specific-action; cystectomy; early detection

## Introduction

Obesity is a serious global health problem that has reached pandemic proportions in the third decade of the 21st century. According to the WHO, in 2022, more than 390 million children and adolescents aged 5 to 19 were overweight, including 160 million who were obese. Since 1990, the obesity rate among adults worldwide has more than doubled, and among adolescents, it has increased fourfold [1]. According to the World Obesity Atlas 2023, it is predicted that by 2035, more than 4 billion people (51% of the world's population) will be overweight or obese if current trends continue [2]. The prevalence of arterial hypertension is significantly higher among obese individuals than among normal-weight individuals. Obesity is the main independent risk factor for the development of hypertension. 78% of primary hypertension in men and 65% in women is associated with overweight or obesity. Even a 5% increase in body weight is associated with a 20-30% increase in the incidence of primary hypertension [3]. Recent longitudinal studies emphasize that the transition from adolescence to young adulthood (18-25 years) is a "critical window" where weight gain most strongly correlates with a permanent shift in the hemodynamic set-point, leading to early-onset cardiovascular aging [4]. The mechanisms by which obesity leads to hypertension are complex and include excessive activation of the sympathetic nervous system, stimulation of the renin-angiotensin-aldosterone system, increased cytokines produced by adipose tissue, insulin resistance, and structural and functional changes in the kidneys [5]. Furthermore, contemporary research highlights the role of "metabolic inflammation" (meta-inflammation) and adipokine dysregulation in young adults, where even moderate increases in hip or waist circumference act as endocrine triggers for vascular stiffness in those who are increasingly exposed to sedentary digital lifestyles [6, 7].

## The aim of the work

is to study anthropometric weight indicators in third-year students of the Grodno State Medical University for the 2025/2026 academic year with different categories of blood pressure, as well as with the presence/absence of episodes of high blood pressure in the anamnesis.

## Research methods.

The study involved 545 third-year students (385 females and 160 males) enrolled in the 2025-2026 academic year at Grodno State Medical University, Republic of Belarus. Voluntary informed consent was obtained from the students. Blood pressure (BP) was measured according to WHO recommendations using a mechanical tonometer using the Korotkov method [8]. Students who smoked or consumed tea, coffee, or energy drinks within 1 hour or less of the study were excluded from the study. BP levels were categorized according to the 2023 European Society of Cardiology guidelines: optimal BP (<120/80 mmHg), normal BP (120-129/80-84 mmHg), elevated normal BP (130-139/85-89 mmHg), elevated BP (≥140/90 mmHg), low BP (<100/60 mmHg). [9]. Waist circumference (WC) was also measured in accordance with WHO recommendations at the midpoint between the lower edge of the last palpable rib and the upper part of the iliac crest, hip circumference (HC) was measured around the widest part of the buttocks. Body mass index (BMI = body weight/(height, m)$^2$) and waist-to-hip ratio (WHR) were calculated.

An anonymous survey of students was conducted regarding episodes of high and low blood pressure (BP). The responses included "no," "yes," and "I don't know." Individuals who answered "I don't know" to this question were then excluded from the analysis.

Data are presented as median [25th;75th percentiles]. The nonparametric Mann-Whitney test was used to compare values. A p-value of less than 0.05 was considered statistically significant. Statistical data processing was performed using StatSoft STATISTICA 10.0.

## Results and discussion.

The distribution of male students by BP category was as follows: 2.3% (2 people) with low BP, 15.4% (12 people) with optimal BP, 38.5% (30 people) with normal BP, 23.1% (18 people) with elevated normal BP, and 20.5% (16 people) with high BP (Table 1).

In male students with elevated normal BP, BMI was higher than in the optimal BP group: 24.91 (22.09; 28.29) and 20.91 (18.95; 22.34) kg/m$^2$, respectively (p=0.007); WC was 82.0 (72.0; 93.0) and 73.5 (68.5; 80.0) cm, respectively (p=0.037); and HC was 101.0 (92.0; 104.0) and 89.5 (85.5; 96.5) cm, respectively (p=0.009).

| Indicator | n | BMI, kg/m$^2$ | WHR | WC, cm | HC, cm |
|---|---|---|---|---|---|
| **Low BP** | 2 | - | - | - | - |
| **Optimal BP** | 12 | 20.91 (18.95; 22.34) | 0.79 (0.76; 0.83) | 73.5 (68.5; 80.0) | 89.5 (85.5; 96.5) |
| **Normal BP** | 30 | 22.70 (21.13; 23.73) | 0.78 (0.74; 0.83) | 75.5 (70.0; 82.0) | 96.0 (93.0; 100.0) |
| **Elevated normal BP** | 18 | 24.91* (22.09; 28.29) | 0.80 (0.78; 0.86) | 82.0* (72.0; 93.0) | 101.0* (92.0; 104.0) |
| **Elevated BP** | 16 | 22.74* (21.89; 24.95) | 0.79 (0.77; 0.84) | 78.0 (75.5; 82.0) | 99.5* (96.5; 102.0) |

**Note: 1** – * – statistically significant difference from the optimal blood pressure group, p < 0.05

**Table 1: Weight characteristics of third-year male students at GrSMU in 2025/2026 with different blood pressure categories, Me (25%; 75%)**

Male students with high BP had a higher BMI than those in the optimal BP group: 22.74 (21.89; 24.95) and 20.91 (18.95; 22.34) kg/m$^2$, respectively (p = 0.037); as well as a higher WC: 99.5 (96.5; 102.0) and 89.5 (85.5; 96.5) cm, respectively (p = 0.004).

The female students were distributed among the BP categories as follows: 9.9% (23 people) with low BP, 36.2% (84 people) with optimal BP, 30.2% (70 people) with normal BP, 14.7% (34 people) with elevated normal BP, and 9.1% (21 people) with elevated BP (Table 2). The BMI of female students with low BP was 18.96 (17.92; 21.26) kg/m$^2$ and was lower than that of girls with optimal BP (p=0.03), normal BP (p=0.002), elevated normal BP (p=0.008), and elevated BP (p=0.003).

| Indicator | n | BMI, kg/m$^2$ | WHR | WC, cm | HC, cm |
|---|---|---|---|---|---|
| **Low BP** | 23 | 18,96 (17,92; 21,26) | 0,67 (0,66; 0,71) | 64,0 (59,0; 67,0) | 90,0 (87,0; 97,0) |
| **Optimal BP** | 84 | 20,93 * (18,73; 22,52) | 0,7 (0,67; 0,73) | 64,0 (60,0; 69,5) | 92,5 (88,0; 98,0) |
| **Normal BP** | 70 | 21,12 * (19,81; 23,53) | 0,72 *□ (0,68; 0,75) | 68,0 *□ (63,0; 73,0) | 95,0 * (92,0; 99,0) |
| **Elevated normal BP** | 34 | 21,32 * (19,47; 23,12) | 0,71 *□ (0,68; 0,76) | 69,5 *□ (62,0; 73,0) | 96,0 (90,0; 100,0) |
| **Elevated BP** | 21 | 21,97 * (20,03; 24,84) | 0,7 (0,67; 0,73) | 68,0 *□ (65,0; 78,0) | 98,0 *□◊☼ (95,0; 105,0) |

**Notes:**

1 – * – statistically significant difference from the low BP group, p<0.05,

2 – □ – statistically significant differences from the optimal BP group, p<0.05,

3 – ◊ – statistically significant differences from the normal BP group, p<0.05,

4 – ☼ – statistically significant differences from the high normal BP group, p<0.05

**Table 2 – Weight characteristics of third-year female students of GrSMU, 2025/2026 year of study, with different blood pressure categories, Me (25%; 75%)**

In female students with normal BP, the WHR was higher than in female students with low and optimal BP: p=0.013 and p=0.028, respectively. In female students with high normal BP, the WHR was also higher than in female students with low and optimal BP: p=0.006 and p=0.042, respectively. In female students with normal BP, the WHR was higher than in female students with low and optimal BP: p=0.002 and p=0.002, respectively; in girls with high normal BP, the WC was also higher than in female students with low and optimal BP: p=0.01 and p=0.03, respectively;

and in female students with high BP, the WC was higher than in female students with low and optimal BP: p=0.005 and p=0.01, respectively. In female students with normal BP, the HC was higher than in girls with low BP: p = 0.011. In female students with high BP, the HC was higher than in

female students with low BP (p < 0.001), optimal BP (p < 0.001), normal BP (p = 0.015), and elevated normal BP (p = 0.024). These results are consistent with large international studies demonstrating that obesity, especially visceral obesity (assessed by WC), is a powerful predictor of the development of hypertension and other cardiovascular diseases [10].

In male students with episodes of elevated BP, WC, HC, and BMI were higher compared to these indicators in male students without episodes of elevated BP (Table 3). WC was 83.0 (76.0; 90.0) and 77.0 (70.0; 84.0) cm, respectively (p = 0.005). HC – 102.0 (96.0; 106.0) and 97.0 (91.0; 100.0) cm, respectively (p=0.009). BMI – 26.0 (22.5; 27.7) and 22.3 (20.6; 24.5) kg/m$^2$, respectively (p<0.001).

| Indicator | No episodes of elevated BP (n=99) | Episodes of elevated BP present (n=37) |
|---|---|---|
| **WC, cm** | 77,0 (70,0; 84,0) | 83,0 (76,0; 90,0) * |
| **CH, cm** | 97,0 (91,0; 100,0) | 102,0 (96,0; 106,0) * |
| **BMI, kg/m$^2$** | 22,3 (20,6; 24,5) | 26,0 (22,5; 27,7) * |
| **WHR** | 0,8 (0,76; 0,83) | 0,8 (0,78; 0,86) |

**Note: 1** – * – statistically significant difference from the "No episodes of elevated BP" group, p<0.05

**Table 3: Anthropometric weight characteristics of third-year male students of GrSMU in 2025/2026 with/without a history of high blood pressure, Me (25%; 75%)**

In female students with episodes of elevated BP, all the studied anthropometric weight indicators were higher compared to these indicators in female students without episodes of elevated BP (Table 4). WC was 70.0 (65.0; 78.0) and 65.0 (61.0; 70.0) cm, respectively (p<0.001). HC was 98.0 (93.0; 103.0) and 93.0 (89.0; 98.0) cm, respectively (p<0.001). BMI was 22.5 (20.8; 24.8) and 20.4 (18.7; 22.7) kg/m$^2$, respectively (p<0.001). WHR was 0.73 (0.69; 0.76) and 0.7 (0.67; 0.72), respectively (p<0.001). Thus, the obtained results indicate a pathogenetic link between anthropometric weight indicators and hemodynamic changes manifested by the presence of episodes of elevated blood pressure, even in the young age group. It should be noted that both girls and boys with a history of elevated blood pressure episodes showed an increase in the indicator reflecting the gluteal-femoral type of obesity. This is likely due to the metabolic activity of adipose tissue, which can affect the sympathetic nervous system and vascular tone.

| Indicator | No episodes of elevated BP (n=74) | Episodes of elevated BP present (n=250) |
|---|---|---|
| **WC, cm** | 65,0 (61,0; 70,0) | 70,0 (65,0; 78,0) * |
| **CH, cm** | 93,0 (89,0; 98,0) | 98,0 (93,0; 103,0) * |
| **BMI, kg/m$^2$** | 20,4 (18,7; 22,7) | 22,5 (20,8; 24,8) * |
| **WHR** | 0,7 (0,67; 0,72) | 0,73 (0,69; 0,76) * |

**Note: 1** – * – statistically significant difference from the "No episodes of elevated BP" group, p<0.05

**Table 4: Anthropometric weight characteristics in third-year female students of GrSMU (2025/2026) with/without a history of elevated blood pressure episodes, Me (25%; 75%)**

## Conclusions.

1. In third-year students at GrSMU, increases in indicators characterizing the amount of body fat, such as body mass index, waist circumference, and hip circumference, were observed with increasing blood pressure. Even within the normal BP range, a gradual increase in weight was observed. This indicates a preclinical link between changes in BP regulation and fat accumulation.
2. Third-year students at GrSMU with a history of high blood pressure showed increases in anthropometric weight indicators: body mass index, waist circumference, and hip circumference.
3. The study shows that weight control at a young age, when blood pressure levels are still normal, is essential for preventing high blood pressure.

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