Abstract. Introduction. According to the point of view of many scientists, the continuous growth of achievements in sports, high competition in the international sports arena require a constant search for effective methodical, organizational and management solutions in the long-term training of athletes. So, we can conclude that the main content of all stages of sports selection is the prediction of the athlete’s sports talent. Taking into account that the anthropometric parameters of athletes have been studied and are being studied to this day as well, but there are almost no works devoted to the study of the anatomical features of the femoral area of athletes of team sports.

Aim. To find out the anatomical features of the thigh circumference of football students of Bukovyna, followed by modeling for sports selection.

Materials and methods. A study was conducted on 86 student-football players of Bukovyna (the initial study was conducted during September-October 2021, and a repeat study of these same students in September-October 2022). The main group consisted of 46 (53.5%) football players and the control group - 40 (46.5%) students aged 16 to 18 years. All students were subjected to an anthropometric study, according to the method of P.P. Shaparenka (thigh circumference in the upper third, in the middle third and in the lower third, body weight, height). Welch’s test was used to distribute the established parameters in both groups by gender. A paired t-test (paired-samples t-test) was performed to compare the respondents’ indicators during the first measurement and the second one a year later. Statistical analysis of the obtained data was carried out using the licensed program RStudio.

Results. The comparison of the thigh circumference parameters of football students of the main group between boys and girls in the initial study, found a difference between the indicators, since in all measurements the indicators of the boys are higher than those of the girls (±3.02 cm), especially when the circumference of the thigh in the lower third on the right is ±5.04 cm. The comparison of the thigh circumference of the main group on the right and on the left, has established that in boys and girls the circumference in the upper third on the right is bigger by ±4.02 cm than on the left; the circumference thighs in the middle third on the left in girls and boys are bigger by ±10.01 cm; the circumference in the lower third in boys is bigger on the right by ±7.05 cm, in girls by ±5.04 cm. The comparison of the thigh circumference in dynamics after a year, in football students reveals an obvious difference with the increase in thigh parameters: in the upper third of the right in boys and girls by ±1.5 cm, in the left in boys and girls by ±4.02 cm; in the middle third by ±4.5 cm in both genders on the right and by ±4.02 cm on the left; in the lower third by ±1.5 cm on the right in boys and by ±3.02 cm in girls, on the left by ±4.02 cm in both genders. By comparing the circumference between the right and left thighs in the main group, there is a difference, because in the upper the right third of girls and boys is ±1.5 cm more than the left; in the middle third from the left, boys have more by ±9.03 cm, girls by ±8.5 cm; in the lower third on the right, boys have more by ±4.5 cm, girls have more by ±4.02 cm.

Conclusions: Model for predicting thigh circumference in the upper third (right): \( C_{pr} = \beta_1 + \beta_2 + 0.493w - 0.135h \), left: \( C_{pl} = \beta_1 + \beta_2 + 0.465w \); in the middle (right): \( C_{mr} = \beta_1 + \beta_2 + 0.460w - 0.183h \), on the left: \( C_{ml} = \beta_1 + \beta_2 + 0.449w \); in the lower third (right): \( C_{dr} = \beta_1 + \beta_2 + 0.418w \), on the left: \( C_{dl} = \beta_1 + \beta_2 + 0.387w \).

Key words: anatomy, students, football, thigh, mathematical model.

Introduction. According to the point of view of many scientists, the continuous growth of sports achievements in sports, high competition in the international sports arena require a constant search for effective methodical, organizational and management solutions in the long-term training of athletes. An important place in this system is the process of improving complex control and selection of promising athletes at all stages of long-term training. The question of sports selection is one of the most important components of the content of the work of a sports coach [1-7]. It should be noted that effective management of the training process involves the use of various models. [8-11].

Morphofunctional models include indicators that reflect the morphological features of the organism and the capabilities of its most important functional systems. Morphofunctional models can be divided into models that contribute to the choice of a general strategy of the sports selection process, sports orientation and the train-
ing process, and models that focus on achieving specific levels of perfection of certain components of the functional preparation of athletes [12-15].

So, we can conclude that the main content of all stages of sports selection is the prediction of sports talent (promising capabilities) of an athlete [16-18].

Taking into account that the anthropometric parameters of athletes have been studied and are being studied to this day as well, but works devoted to the study of the anatomical features of the femur of athletes of team sports such as football, basketball, volleyball and handball with subsequent modeling of the circumference of the thigh in three dimensions (proximal, in the middle third and distally) are almost absent [19-22].

So, in our opinion, the study of the anatomical parameters of the femoral area of athletes of team sports for the purpose of athletic selection of promising athletes to achieve high results in the respective sports is extremely relevant and requires further research.

**Aim:** to find out the anatomical features of the thigh circumference of Bukovynian students, followed by modeling for sports selection.

**Material and methods**

The study of thigh circumference was conducted on 86 Bukovynian students (the initial study was carried out during September-October 2021, and a repeat study of these same students in September-October 2022). The main group consisted of 46 (53.5%) football players and the control group - 40 (46.5%) students aged 16 to 18 years. There are 38 (82.6%) boys and 8 (17.4%) girls among the student-football players of the main group. The control group consists of 21 (52.50%) boys and 19 (47.50%) girls.

Students-football players of the main group, in addition to the physical load that was included in the program of their specialty during the year, additionally attended football sections (training, under the supervision of a coach, took place 3 times a week, for 1.5 hours on average). Students of the control group were loaded with hours of physical education, in accordance with the educational program of their specialty, and did not engage in additional sports. All students were subjected to an anthropometric study, according to the method of P.P. Shaparenka (thigh circumference in the upper third, in the middle third and in the lower third, body weight, height). The circumference of the thigh in the upper third was determined by applying a centimeter tape at the place of greatest fullness in the medial direction under the gluteal fold and closed on the outer surface of the thigh. The circumference of the thigh in the middle third was determined by applying a centimeter tape in this part in the medial direction and closing it on the outer surface of the thigh. Our and other authors opinion suggest that determining the length of the circumference of the thigh in the middle third has measurement accuracy, since it is in the middle third of the thigh that the quadriceps and triceps muscles are most pronounced. The circumference of the thigh in the lower third was determined by applying a centimeter tape 7.0-8.0 cm above the knee joint in the medial direction and closing it on the outer surface of the thigh. Determination of body weight was carried out on floor scales (mechanical), to measure height, a vertical height gauge was used [20].

Welch’s test was used to distribute the established parameters in both groups by gender. A paired t-test (paired-samples t-test) was performed to compare the respondents’ indicators during the first measurement and the second one a year later. Statistical analysis of the obtained data was carried out using the licensed program RStudio.

**Results**

The comparison of the thigh circumference parameters of football students of the main group between boys and girls in the primary study found the difference between the indicators, since in all measurements the indicators of the boys are higher than those of the girls (±3.02 cm), especially for the thigh circumference in the lower third on the right ±5.04 cm. There is also a gender difference in the representatives of the control group - the thigh parameters are bigger in boys than in girls by ±2.01 cm, and the thigh circumference in the lower third is bigger in boys by ±3.02 cm (Table. 1, 2).

According to the comparison of the thigh circumference during the initial examination, there is a difference between the representatives of both groups, since the thigh circumference in the upper third of the right is bigger in the boys of the main group by ±8.5 cm, in the girls by ±7.05 cm, but in the left, in the boys, it is bigger by ±2.01 cm, and in girls it is smaller by ±2.01 cm. The difference in the comparison of the thigh circumference in the middle third of the right and left in the boys and girls of the main group is bigger than ±1.5 cm, but the indicators of the thigh circumference in the lower third show that in the circumference of boys in the control group is bigger by ±4.5 cm, in girls by ±6.5 cm (Tables 1, 2).

Also, the comparison of the thigh circumference parameters in the main group of subjects on the right and on the left, found that the circumference of the upper third of boys and girls on the right is bigger by ±4.02 cm than on the left, the circumference of the thigh in the middle third of the left of girls and boys is bigger by ±10.01 cm, the circumference in the lower third in boys is bigger on the right by ±7.05 cm, in girls by ±5.04 cm (Table 1).

The comparison of the thigh circumference parameters of the control group, there is also an obvious difference between the left and right thigh: in the upper third, the left thigh of young men is bigger by ±8.06 cm, the girls by ±7.05 cm, than the right, in the middle third, the circumference on the left of both gender is bigger on
the left by ±3.02 cm than on the right, the thigh circumference in the lower third on the left is greater by ±1.05 cm in boys and ±3.02 cm in girls (Table 2).

A comparison of the thigh circumference in dynamics after a year, in football students of the main group, reveals an obvious difference with an increase in high parameters: in the upper third, on the right in boys and girls by ±1.5 cm; on the left in boys and girls by ±4.02 cm; in the middle third by ±4.5 cm in both genders on the right and by ±4.02 cm on the left; in the lower third by ±1.5 cm on the right in boys and ±3.02 cm in girls, on the left in both genders by ±4.02 cm (Table 1).

By comparing the circumference between the right and left thigh in the main group, there is a difference, because in the upper third, the right of girls and boys is ±1.5 cm more than the left; in the middle third from the left, boys have more by ±9.03 cm, girls by ±8.5 cm; in the lower third on the right, boys have more ±4.5 cm, girls ±4.0 cm (Table 1).

A comparison of thigh circumference in dynamics after a year, in students of the control group, does not reveal a significant difference with an increase in high parameters: in the upper third on the right and on the left in boys and girls, there is almost no change, in the middle third by ±1.05 cm in both genders on the right and on the left, in the lower third by ±2.01 cm to the right in girls (Table 2).

By comparing the circumference between the right and left thighs in the control group, there is a difference, as the values on the left are higher than on the right: in the upper third, girls and boys have ±9.03 cm more; in the middle third by ±7.05 cm; in the lower right third of boys and girls it is more by ±1.05 cm (Table 2).

The average body weight of students of the main group was 67.58 ± 3.02 kg, where 69.20 ± 3.02 kg for boys and 63.56 ± 3.02 kg for girls; The students body weight in the control group was 66.57 ± 3.02 kg, where 77.04 ± 3.02 kg for boys and 56.10 ± 3.02 kg for girls.

The average height of students of the main group is 177.87±2.03 cm, of where 176.52±2.03 cm for boys and 172.51±2.03 cm for girls. The height of students of the control group is 172.25 ± 2.03 cm, of where 179.47 ± 2.03 cm for boys and 164.26 ± 2.03 cm for girls.

Discussion
Given that the thigh muscles include three groups of muscles: anterior, posterior and adductors. The most prominent of these muscle groups are the front muscles, which are made up of the four muscles that make up the quadriceps, and the rear muscles. These muscles are the powerhouse of the body and provide short bursts of energy that allow players to sprint or maintain a steady run while playing. [23]. Developing these muscles will make the player faster and also give more power to kick.

There are almost no works devoted specifically to the research of high circumference parameters of football students for the purpose of sports selection and sports orientation.

Table 1. The comparison of thigh circumference dynamics of football students of the main group

<table>
<thead>
<tr>
<th>Year</th>
<th>In the upper third</th>
<th>In the middle third</th>
<th>In the lower third</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>right</td>
<td>left</td>
<td>right</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>g</td>
<td>b</td>
</tr>
<tr>
<td>2021</td>
<td>54.29±2.01</td>
<td>51.26±2.06</td>
<td>50.09±2.03</td>
</tr>
<tr>
<td></td>
<td>±2.01</td>
<td>±2.06</td>
<td>±2.03</td>
</tr>
<tr>
<td>2022</td>
<td>55.86±2.03</td>
<td>52.83±2.01</td>
<td>54.46±2.04</td>
</tr>
<tr>
<td></td>
<td>±2.03</td>
<td>±2.01</td>
<td>±2.04</td>
</tr>
</tbody>
</table>

"b" - boys; “g” – girls

Table 2 The comparison of thigh circumference dynamics of football students of the control group

<table>
<thead>
<tr>
<th>Year</th>
<th>In the upper third</th>
<th>In the middle third</th>
<th>In the lower third</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>right</td>
<td>left</td>
<td>right</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>g</td>
<td>b</td>
</tr>
<tr>
<td>2021</td>
<td>44.27±2.01</td>
<td>42.20±2.04</td>
<td>52.67±2.05</td>
</tr>
<tr>
<td></td>
<td>±2.01</td>
<td>±2.04</td>
<td>±2.05</td>
</tr>
<tr>
<td>2022</td>
<td>44.90±2.04</td>
<td>42.30±2.03</td>
<td>53.47±2.05</td>
</tr>
<tr>
<td></td>
<td>±2.04</td>
<td>±2.03</td>
<td>±2.05</td>
</tr>
</tbody>
</table>

"b" - boys; “g” – girls
Luts Yu.P. and co-authors studied athletes of various qualifications (orienteering, triathlon, sports walking, athletics), of the first mature age, coming to the conclusion that the morphofunctional indicators of the body are one of the important keys to high performance in sports. Taking into account the features of the composition of the body and functional indicators of breathing is necessary for the optimal construction of the training and competition period of athletes, as well as the fact that the morpho-functional indicators of the composition of the body of the examined persons differ between individual groups of athletes depending on their qualifications. Highly qualified athletes, compared to athletes of other qualifications and amateurs, have the lowest body weight, the highest percentage of fat-free body mass, the lowest body fat content, the highest water content, and the highest mass of the mineral component of the skeleton. Amateurs are characterized by the highest body weight, the lowest lean body mass, the highest body fat content, the lowest water content, and the mass of the mineral component of the skeleton compared to athletes with a high and average maximum oxygen consumption. Athletes with an average level of maximum oxygen consumption are characterized by intermediate values of the specified parameters compared to other groups [24].

Summing up, it can be concluded that our research is relevant, as it was established that football students (who during the year systematically played football and also engaged in physical education, according to the program of their specialty, in contrast to the students of the control group, who had little physical load according to the program of their specialty and additionally did not do sports), there is an increase in hip circumference in all dimensions, especially in the upper third on the left, in the middle third and in the lower third on the left in boys and girls. A study of the dynamics of students in the control group shows that there is almost no increase in hip circumference.

So, for the purpose of selecting promising students to play football, mathematical models for predicting the parameters of football players (hip circumference in the upper third, in the middle and in the lower third) were derived.

Model for predicting thigh circumference in the upper third (right):
\[ Cpr=\beta_1 + \beta_2 + 0.493w - 0.135h, \]
where \( Cpr \) — thigh circumference in the upper third (right), \( w \) — body weight, \( h \) — height, \( \beta_1= (49.735 \text{ for girls and 44.489 for boys}) \), \( \beta_2= (-5.215 \text{ for the control group; -1.391 for the football group}) \). The coefficient of determination is 99.7%; on the left: \( Cpl=\beta_1 + \beta_2 + 0.465w \), where \( Cpl \) is the circumference of the thigh in the upper third (left), \( w \) is body weight, \( \beta_1= (25.736 \text{ for girls and 20.147 for boys}) \), \( \beta_2= (-4.497 \text{ for the control group; 0.254 for the football group}) \). The coefficient of determination is 99.7%.

Model for predicting the circumference of the thigh in the middle (right):
\[ Cmr=\beta_1 + \beta_2 + 0.460w - 0.183h \]
where \( Cmr \) is the thigh circumference in the middle (right), \( w \) is body weight, his height; \( \beta_1= (52.567 \text{ for girls and 48.930 for boys}) \), \( \beta_2= (-3.944 \text{ for the control group; -2.235 for the football group}) \); on the left: \( Cml=\beta_1 + \beta_2 + 0.449w \), where \( Cml \) is the thigh circumference in the middle (left), \( w \) is body weight; \( \beta_1= (20.716 \text{ for girls and 20.943 for boys}) \), \( \beta_2= (-4.977 \text{ for the control group; 0.254 for the football group}) \).

Model for predicting the circumference of the thigh in the lower third (right):
\[ Cdr=\beta_1 + \beta_2 + 0.418w, \]
where \( Cdr \) is distal thigh circumference (right), \( w \) is body weight, \( \beta_1= (25.560 \text{ for girls and 20.165 for boys}) \), \( \beta_2= (-4.497 \text{ for the control group; 0.039 for the soccer group}) \); on the left: \( Cdl=\beta_1 + \beta_2 + 0.387w \), where \( Cdl \) is the thigh circumference in the lower third (left), \( w \) is body weight; \( \beta_1= (24.638 \text{ for girls and 18.523 for boys}) \), \( \beta_2= (-0.051 \text{ for the control group; 0.379 for the football group}) \).

Significant predictors for predicting upper third thigh circumference (right) are gender, sport, height and weight, and for predicting upper third thigh circumference (left) are gender, sport and body weight.

Significant predictors for predicting thigh circumference in the middle third are gender, sport, height, and weight on the right, and gender, sport, and body weight on the left.

Significant predictors for predicting the circumference of the thigh in the lower third are gender, sport and body weight.

So, there is a need for further study of anatomical parameters for specific sports, followed by the derivation of a prediction model for these parameters to ensure optimal monitoring and interpretation of anatomical characteristics in athletes. In our opinion, it is the further study of the anatomical parameters of student-athletes that will allow us to more correctly solve the problems of selection and sports orientation.

Conclusions
1. The comparison of the thigh circumference parameters of football students of the main group between boys and girls in the primary study, found the difference between the indicators, since in all measurements the indicators of the boys are higher than those of the girls (±3.02 cm), especially for the hip circumference in the lower right third ±5.04 cm.
2. By comparing the thigh circumference parameters of the main group on the right and on the left, has established that the circumference of the upper third of boys and girls on the right is bigger by ± 4.02 cm than on the left, the circumference of the thigh in the middle third of the left of girls and boys is bigger by ± 10.01 cm, the circumference in the lower third is bigger on the right for boys by ±7.05 cm, for girls by ±5.04 cm.
3. A comparison of thigh circumference in dynamics after a year in football students reveals an obvious difference with an increase in hip parameters: in the upper third, on the right in boys and girls by ±1.5 cm, on the left in boys and girls by ±4.02 cm; in the middle third by ±4.5 cm in both genders on the right and ±4.0 cm on the left; in the lower third by ±1.5 cm on the right in boys and ±3.02 cm in girls, on the left in both genders by ±4.02 cm.

4. According to the comparison of the circumference there is a difference between the right and left thigh in the main group, because in the upper third, the right of girls and boys is ±1.5 cm more than the left; in the middle third on the right, boys have more by ±9.01 cm, girls by ±8.5 cm; in the lower third on the right, boys have more by ±4.5 cm, girls have more by ±4.02 cm.

5. Model for predicting thigh circumference in the upper third (right): Cpr=β1 + β2 + 0.493w – 0.135h, left: Cpl=β1 + β2 + 0.465w. Model for predicting hip circumference in the middle (right): Cmr=β1 + β2 + 0.460w – 0.183h, left: Cml=β1 + β2 + 0.449w. Model for predicting thigh circumference in the lower third (right): Cdr=β1 + β2 + 0.418w, left: Cdl=β1 + β2 + 0.387w.

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Received: 12.06.2023
Revised: 21.06.2023
Accepted: 27.06.2023