# Influence of special physical preparedness of athletes on biomechanical characteristics of performing basic exercises in acrobatic rock'n'roll

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**Purpose:** to reveal the effect of special physical preparedness of athletes on the biomechanical characteristics of the performance of the kick-step component of the main course in acrobatic rock'n'roll.

**Material & Methods:** following research methods were used: theoretical analysis and generalization of data from special scientific and methodological literature; pedagogical observation; biomechanical computer analysis; video of the final of the category Juvenile of the Ukrainian championship (2017) from acrobatic rock'n'roll.

**Results:** a biomechanical analysis of the performance of the kick-step component of the main course; the amplitude of the performance of the kick-step component of the main move of the Juvenile category in acrobatic rock'n'roll.

**Conclusion:** the level of special physical preparedness of the Juvenile category athletes is determined; based on the biomechanical analysis of the performance of kick-step athletes in the main course, changes in the angle of the knee and hip joints of the legs at the beginning, middle and end of the competition program.

**Keywords:** main move, kick-step, athletes, acrobatic rock'n'roll, juvenile category, biomechanical characteristics (analysis), special physical readiness.

## Introduction

Increasingly, the popularity of acrobatic rock'n'roll in the world is growing. Recently, the countries of the continents of Asia and South America joined the development of this sport [12]. Admirers of acrobatic rock and roll: amateurs, professionals dream to be in the Charter of the Olympic movement. The World Confederation of Rock'n'Roll and the national federations of acrobatic rock and roll countries are making efforts to bring the requirements for the execution of competitive programs in line with mathematical statistics to determine the best sports couples not only in the basic class category (M-class), but also categories "B-class", "juniors", "juveniles" [4; 5; 7; 8]. Based on the WRRC Regulation [12] and its requirements, it is determined that one of the main components in the performance of the competitive program is the special physical fitness of the athletes [5; 6; 9; 11]. The special physical fitness of the juvenile category is based on the basic exercises, which include the main move (kick-ball-chench, kick-step + kick-step [10]).

The analysis of scientific and methodological literature revealed the lack of consideration of the issue in this direction and highlighted the problems of the special physical fitness of the Juvenile category in acrobatic rock and roll, which determined the relevance of this study.

**Relationship of research with scientific programs, plans, themes.** The work is carried out in accordance with the Consolidated Plan of Research in the Field of Physical Culture and Sports for 2016–2020. On the topic: "Psycho-sensory regulation of motor activity of athletes of situational sports" (№ 0116U008943).

**Purpose of the study:** to reveal influence of special physi-cal readiness of sportsmen on biomechanical characteristics of performance of base exercises in an acrobatic rock'n'roll.

*Objectives of the study:*

1. To study sources of special scientific and methodological literature on the research problem.

2. Determine the biomechanical characteristics of the implementation of the kik-step component of the main course in acrobatic rock and roll.

3. Determine the level of special physical fitness and its influence on changes in the parameters of the knee and hip joints in the implementation of the main step kick-step component in the continuation of the competition program.

## Material and Methods of the research

Research methods: theoretical analysis and generalization of data from special scientific and methodological literature, video shooting, biomechanical computer analysis, methods of mathematical statistics. The study involved 14 sportsmen (7 sports pairs of the Juvenile category) of the finals of the Ukrainian Championship in acrobatic rock and roll of 2017.

## Results of the research and their discussion

The essence of the study is to determine the biomechanical characteristics of the performance of the component of kick-step exercises, the main course of the left and right foot part-ner, the partner of the sports pair of acrobatic rock and roll in the beginning, in the middle and at the end of the competition program. The biomechanical computer analysis of the finalists of the Ukrainian championship in acrobatic rock and

roll showed the problems of performing the basic exercises of acrobatic rock and roll by the Juvenile category (the preliminary basic training stage). Changes in the amplitude of the *kick-step* component of the basic exercise "Main course" in the beginning, in the middle, and at the end of the competitive program of sports pairs gives us a description of the level of special physical fitness of athletes at this stage of preparation. The graphics of the component of the basic acrobatic rock and roll exercise by the partners and partners of the sports pairs are almost identical, according to this; we consider it expedient to show the results of the study of one sports pair of the Juvenile category (Figures 1–6).
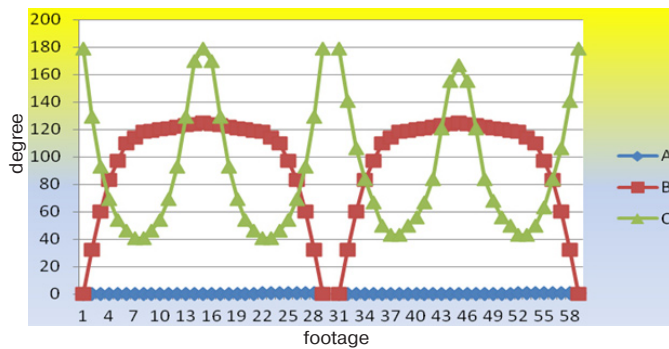


**Figure 1.** **Changes in the parameters of the knee and hip joint angle of the male partner's left and right legs in the performance of the kick-step of the main course at the beginning of the competition program:**
*A – t (time) one footage = 0,022 s;*
*B – parameters of the angle of the hip joint of the left leg at the time of changing the parameters of the angle of the knee joint (footage 1–28), the parameters of the angle of the hip joint of the right leg at the time of changing the parameters of the angle of the knee joint (footage 30–58);*
*C – trajectory of changing the parameters of the angle of the knee joint of the left leg (footage 1–28), right leg (footage 30–58).*

Reflected in Fig. 1 biomechanical characteristics (changes in the angle of the hip and knee joints at the beginning of the competition program) show the percentage to the maximum opening of the knee joint angle of the left leg 100% ($\varphi_{l.l.}$ – 180°); right leg 92,7% ($\varphi_{r.l.}$ – 167°). The percentage of the opening level of the angle of the hip joint of the left leg is 69,4% ($\varphi_{l.l.}$ – 125°), right leg is 68.8% ($\varphi_{r.l.}$ –124°). One of the main parameters of the performance of the kick-step component is the initial (first) phase of the knee joint angle change. During the raising of the thigh, the angle of the hip joint changes in the direction of increase, and the angle of the knee joint decreases. Raising the hip of the leg goes to the optimal height (individual performance) in the first phase. In the second phase, the angle of the knee joint is increased to the optimum opening. From the parameters of changing the angle of the knee joint in the second phase of both legs depends on the evaluation of the performance of the athlete's components and the whole of the main course. In Figure 1 shows the minimum parameters of the angles of the knee joints of the left (41°) and right (43°) legs. In this case, we have such calculations of the path (*S*) of the CM legs (shin, foot) segments along the segment:

$$S_{l.l.}=3,14·r·139/180; S_{r.l.}=3,14·r·124/180.$$

The execution time of the kick-step component of the exercise "main move" is constant and equal to 0.618 seconds (t = 0,618 s). So, we obtained two equal time intervals for changing the parameters of the angle of the knee joint (t=0,309 s). For equal parts of the time of the kick-step and right-foot

component, the biomechanical characteristics of the CM of the legs (shin, foot), the speed (V), acceleration (a) depend directly on the path characteristic (S). According to this calculation, the characteristics of the path (S) of the CM leg links, we observe that when the component is executed by the right foot, the partner of the sports pair applies a less effort (F) than in the left-foot performance of the component. The authors, P. Kizim, N. Bateeva (2017) [10], indicate that the energy characteristics of the legs of the athlete in the performance of the kick component depend on the mechanical work and kinetic energy. In this case, the energy expenditure of the male and female partner, of the sports pair for the performance of the kick-step component, is directly proportional to the biomechanical characteristics of the left and right legs, the energy costs of the internal friction of the musculoskeletal system by the male partner, the female partner, and the energy costs of the male partner's body, the partner in the environment [1; 2; 3].
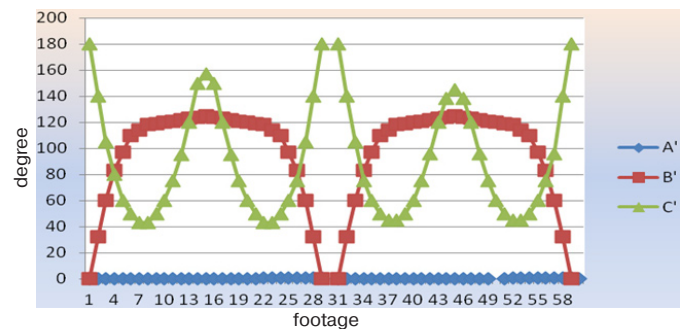


**Figure 2.** **Changes in the parameters of the knee and hip joint angle of the male partner's left and right legs in the performance of the kick-step of the main course at the middle of the competition program:**
*A' – t (time) one footage = 0,022 s;*
*B' – parameters of the angle of the hip joint of the left leg at the time of changing the parameters of the angle of the knee joint (footage 1–28), the parameters of the angle of the hip joint of the right leg at the time of changing the parameters of the angle of the knee joint (footage 30–58);*
*C' – trajectory of changing the parameters of the angle of the knee joint of the left leg (footage 1–28), right leg (footage 30–58).*

The biomechanical analysis of the performance of the kick-step component (Fig. 2) showed the following results: the percentage to the maximum opening of the knee joint angle of the left foot 87,2% ($\varphi_{l.f.}$ – 157°); right leg 80,5% ($\varphi_{r.f.}$ – 145°); percentage to the maximum opening of the knee joint angle of the left leg is 69,4% ($\varphi_{l.f.}$ – 125°), right leg is 68,8% ($\varphi_{l.f.}$ – 124°); minimum parameters of the knee joint angles of the left (43˚) and right (45˚) legs. In this case, we have such calculations of the characteristics of the path (S) of the CM legs (shin, foot) segments along the segment:

$$S_{l.f.}=3,14·r·114/180; S_{r.f.}=3,14·r·100/180.$$

On the basis of the obtained calculation of the characteristics of the path (S), we observe that the partner of the sports pair applies a greater effort (F) to the performance of the component with the left foot than doing the component with the right foot.

The biomechanical analysis of the performance of the kick-step component (Fig. 2) showed the following results: the percentage to the maximum opening of the knee joint angle of the left foot 83,3% ($\varphi_{l.l.}$ – 150°); right leg 78,8% ($\varphi_{r.l.}$ – 142°); percentage to the maximum opening of the knee joint angle
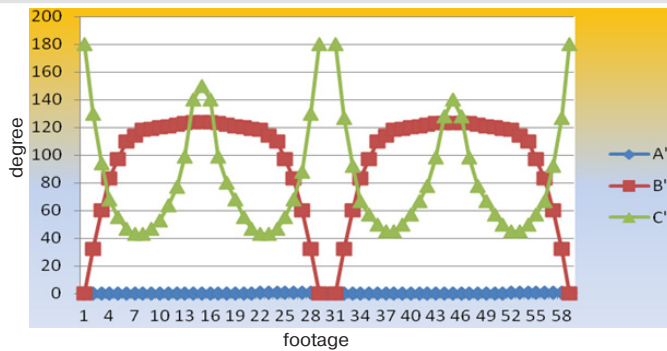
**Figure 3.** Changes in the parameters of the knee and hip joint angle of the male partner's left and right legs in the performance of the kick-step of the main course at the end of the competition program:

*A"* – *t (time) one footage = 0,022 s;*
*B"* – *parameters of the angle of the hip joint of the left leg at the time of changing the parameters of the angle of the knee joint (footage 1–28), the parameters of the angle of the hip joint of the right leg at the time of changing the parameters of the angle of the knee joint (footage 30–58);*
*C* – *trajectory of changing the parameters of the angle of the knee joint of the left leg (footage 1–28), right leg (footage 30–58).*

of the left leg is 68,8% ($\varphi_{l.l.}$ – 124°), right leg is 68,3% ($\varphi_{r.l.}$ – 123°); minimum parameters of the angles of the knee joints are left (43°) and right (45°) legs. In this case, we have the following calculations of the characteristics of the path (S) of the CM units of the foot (legs, feet) by segment minimal parameters of the angles of the knee joints of the left (43 ) and right (45 ) legs. In this case, we have such calculations of the characteristics of the path (S) of the CM units of the foot (legs, feet) by segment:

$$S_{l.l.}=3,14 \cdot r \cdot 107/180; \; S_{r.l.}=3,14 \cdot r \cdot 97/180.$$

From the calculation of the path characteristic (S), it is seen that for the component to be executed with the left foot, the partner of the sports pair applies a greater effort (F) than to the component with the right foot.

According to the calculations of the biomechanical characteristics of the male partner's performance of the sports pair of the kick-step component during the competitive program, their numerical value dominates in the direction of lowering the parameters. In percentage terms such results are shown:

– maximum opening of the knee joint angle of the left foot 100% ($\varphi_{l.l.}$ – 180°), 87% ($\varphi_{l.l.}$ – 157°), 83,3% ($\varphi_{l.l.}$ – 150°); right leg 92,7% ($\varphi_{r.l.}$ – 167°), 80,5% ($\varphi_{.l.}$ – 145°), 78,8% ($\varphi_{r.l.}$ – 142°).

Decrease in parameters of the knee joint angle of the male partner's left leg occurred on 16,7% ($\varphi_{l.l.}$ – 30°).

Decrease in parameters of the knee joint angle of the male partner's right leg occurred on 17,7% ($\varphi_{r.l.}$ – 25°).

Compared with the kick-step execution model, according to the WRRC Rules, the decrease in the parameters of the knee joint angle of the right leg of the male partner occurred on 21,1% ($\varphi_{r.l.}$ – 38°).

Biomechanical analysis of the performance of the kick-step component of the female partner sports pair (Figure 4)
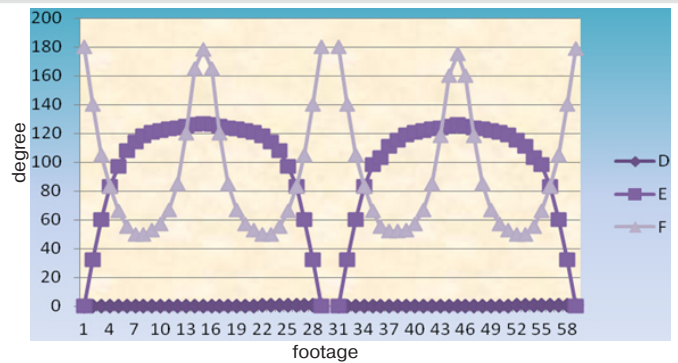


**Figure 4.** Changes in the parameters of the knee and hip joint angle of the female partner's left and right legs in the performance of the kick-step of the main course at the beginning of the competition program:

*D* – *t (time) one footage = 0,022 s;*
*E* – *parameters of the angle of the hip joint of the left leg at the time of changing the parameters of the angle of the knee joint (footage 1–28), the parameters of the angle of the hip joint of the right leg at the time of changing the parameters of the angle of the knee joint (footage 30–58);*
*F* – *trajectory of changing the parameters of the angle of the knee joint of the left leg (footage 1–28), right leg (footage 30–58).*

showed the following results: percentage of the maximum opening angle of the knee joints of the right leg 98,8% ($\varphi_{r.l.}$ – 178°); left leg 97,2% ($\varphi_{l.l.}$ – 175°); the percentage of the opening of the right angle of the hip joint of the right foot is 70,5% ($\varphi_{r.l.}$ – 127°), left leg is 70,0% ($\varphi_{l.l.}$ – 126°); minimum knee joint angles of the right (50°) and left (52°) feet. In this case, we have such calculations of the characteristics of the path (S) of the CM legs (shin, foot) segments along the segment:

$$S_{r.l.}=3,14 \cdot r \cdot 128/180, \; S_{l.l.}=3,14 \cdot r \cdot 123/180.$$

According to the calculation of the path characteristic (S), it is observed that for the component to be executed by the right foot, the female partner of the sports pair applies a greater effort (F) than to performing the component with the left foot.
Biomechanical analysis of the performance of the kick-step component of the female partner sports pair (Figure 5)
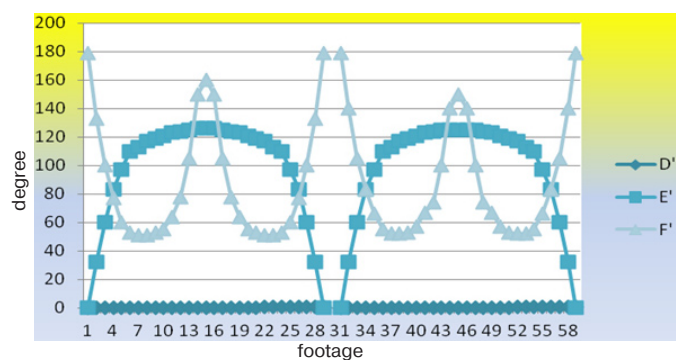


**Figure 5.** Changes in the parameters of the knee and hip joint angle of the female partner's left and right legs in the performance of the kick-step of the main course at the middle of the competition program:

*D'* – *t (time) one footage = 0,022 s;*
*E'* – *parameters of the angle of the hip joint of the left leg at the time of changing the parameters of the angle of the knee joint (footage 1–28), the parameters of the angle of the hip joint of the right leg at the time of changing the parameters of the angle of the knee joint (footage 30–58);*
*F'* – *trajectory of changing the parameters of the angle of the knee joint of the left leg (footage 1–28), right leg (footage 30–58).*

showed the following results: percentage of the maximum opening angle of the knee joints of the right leg 88,8% ($\varphi_{r.l.}$ – 160°); left leg 83,3% ($\varphi_{l.l.}$ – 150°); the percentage of the opening of the right angle of the hip joint of the right foot is 70,0% ($\varphi_{r.l.}$ – 126°), left leg is 69,4% ($\varphi_{.l.}$ – 125°); minimum knee joint angles of the right (51°) and left (52°) feet. In this case, we have such calculations of the characteristics of the path (S) of the CM legs (shin, foot) segments along the segment:

$$S_{r.l.} = 3,14 \cdot r \cdot 109/180, \quad S_{l.l.} = 3,14 \cdot r \cdot 98/180.$$

According to the calculation of the path characteristic (S), it is observed that for the component to be executed by the right foot, the female partner of the sports pair applies a greater effort (F) than to performing the component with the left foot.
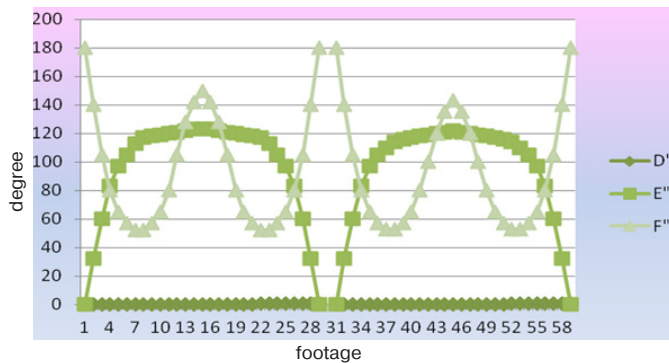


**Figure 6. Changes in the parameters of the knee and hip joint angle of the female partner's left and right legs in the performance of the kick-step of the main course at the end of the competition program:**
*D" – t (time) one footage = 0,022 s;*
*E" – parameters of the angle of the hip joint of the left leg at the time of changing the parameters of the angle of the knee joint (footage 1–28), the parameters of the angle of the hip joint of the right leg at the time of changing the parameters of the angle of the knee joint (footage 30–58);*
*F" – trajectory of changing the parameters of the angle of the knee joint of the left leg (footage 1–28), right leg (footage 30–58).*

Biomechanical analysis of the performance of the kick-step component of the female partner sports pair (Figure 6) showed the following results: percentage of the maximum opening angle of the knee joints of the right leg 83,3% ($\varphi_{r.l.}$ – 150°); left leg 79,4% ($\varphi_{rl.l.}$ – 143°); the percentage of the opening of the right angle of the hip joint of the right foot is 68,3% ($\varphi_{rr.l.}$ – 123°), left leg is 67,7% ($\varphi_{rl.l.}$ – 122°); minimum knee joint angles of the right (52°) and left (53°) feet. In this case, we have such calculations of the characteristics of the path (S) of the CM legs (shin, foot) segments along the segment:

$$S_{r.l.} = 3,14 \cdot r \cdot 98/180, \quad S_{l.l.} = 3,14 \cdot r \cdot 90/180.$$

According to the calculation of the path characteristic (S), it is observed that for the component to be executed by the right foot, the female partner of the sports pair applies a greater effort (F) than to performing the component with the left foot.

According to the calculations of the biomechanical characteristics of the female partner's performance of the sports pair of the kick-step component during the competitive program, their numerical value dominates in the direction of lowering the parameters. In percentage terms such results are shown:

– maximum opening of the knee joint angle of the right foot

98,8% ($\varphi_{rr.l.}$ – 178°), 88,8% ($\varphi_{rr.l.}$ – 160°), 83,3% ($\varphi_{rr.l.}$ – 150°); left foot 97,2% ($\varphi_{rl.l.}$ – 175°), 83,3% ($\varphi_{rl.l.}$ – 150°), 79,4% ($\varphi_{rl.l.}$ – 143°).

Decrease in parameters of the knee joint angle of the female partner's right leg occurred on 15,7% ($\varphi_{rr.l.}$ – 28°).

Decrease in parameters of the knee joint angle of the female partner's left leg occurred on 18,3% ($\varphi_{rl.l.}$ – 32°).

Compared with the kick-step execution model, according to the WRRC Rules, the decrease in the parameters of the knee joint angle of the right leg of the female partner occurred on 16,6% ($\varphi_{rr.l.}$ – 30°); decrease in the parameters of the knee joint angle of the left leg of the female partner occurred on 20,5% ($\varphi_{rl.l.}$ – 37°).

In this study, a decrease in the amplitude of the performance of the kick-step component by the male partner and female partner in the middle and at the end of the competition program is revealed in comparison with its beginning (Figure 7).
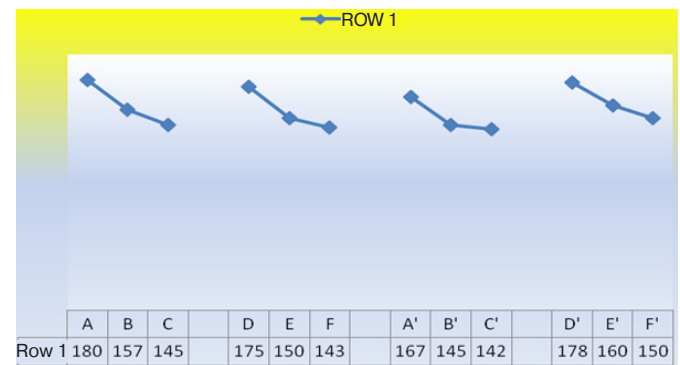


| | A | B | C | | D | E | F | | A' | B' | C' | | D' | E' | F' |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Row 1 | 180 | 157 | 145 | | 175 | 150 | 143 | | 167 | 145 | 142 | | 178 | 160 | 150 |

**Figure 7. Parameters of the angles of the knee joints of the male partner and female partner:**
*A – parameters of the angles of the knee joints left leg of the male partner at the beginning of the competition program; B – parameters of the angles of the knee joints left leg of the male partner at the middle of the competition program; C – parameters of the angles of the knee joints left leg of the male partner at the end of the competition program; D – parameters of the angles of the knee joints right leg of the male partner at the middle of the competition program; F – parameters of the angles of the knee joints right leg of the male partner at the end of the competition program; A' – parameters of the angles of the knee joints left leg of the female partner at the beginning of the competition program; B' – parameters of the angles of the knee joints left leg of the female partner at the middle of the competition program; C' – parameters of the angles of the knee joints left leg of the female partner at the end of the competition program; D' – parameters of the angles of the knee joints right leg of the female partner at the beginning of the competition program; E' – parameters of the angles of the knee joints right leg of the female partner at the middle of the competition program; F' – parameters of the angles of the knee joints right leg of the female partner at the end of the competition program.*

The curve of the performance characteristics of the kick-step component of the base exercise, the main move shows a decrease in the parameters of the angles of the knee joints of athletes of the sports pair during the competition program.

Investigation of the performance of the kick-step component revealed the dependence of the increment of the applied forces ($dF$) with the increase of the knee joint extension angle ($d\varphi$) on the degree of fatigue of athletes of the sports pair at the beginning, in the middle and at the end of the competition

program.

## Conclusions

The biomechanical analysis of the basic exercises performed by the Juvenile category in acrobatic rock'n'roll allowed us to state that there is a problem in the training process in the preparation of this category of athletes. Obtained results of biomechanical characteristics indicate the level of functional preparedness of athletes. In this case, at the stage of preliminary basic training in acrobatic rock'n'roll, the dominant functional training is the special physical preparedness of a partner and a partner of a sports couple. The dependence of the increment of the applied forces ($dF$) with the increase of the knee joint extension angle ($d\varphi$) on the degree of fatigue of the athletes of the sports pair at the beginning, in the middle and at the end of the competition program determined their level of special physical readiness and its influence on changes in the parameters of the knee and hip joint angles in performing the kick-step component of the main stroke.

**Prospects for further research** are to find ways to apply the basics of biomechanics in this direction, using the methodological recommendations and determining the preparedness of rock'n'roll athletes at the stage of preliminary basic training.

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