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The effectiveness of kettlebell exercises in the aspects of special efficiency training in American football

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C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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abstract

Background The aim of the study was to investigate the effectiveness of kettlebell exercises in the aspect of shaping the special efficiency characteristics required by American football players.

Material/Methods The kettlebells training group (n = 12) and the American football group (n = 12), who used training typical of their discipline, were subjected to a fitness test in US football, consisting of a 40-yard run speed test, an agility test in two shuttle runs, a jumping test in Counter Movement Jump (CMJ), and a power and strength endurance tests.

Results In tests of speed, agility, jumping and power, there were no significant differences between footballers and kettlebell exercisers, while strength endurance testing (benchpress with 100 kg) and one special agility test (two shuttle runs) showed that training with kettlebells develops these qualities of physical fitness significantly worse than standard football practice ($p < 0.05$).

Conclusions Kettlebell training can be beneficial for shaping most characteristics of the special efficiency needed in American football but it is not able to completely replace the traditional football strength training program, based on exercises with barbells.

Key words kettlebells, special efficiency, American football

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INTRODUCTION

The question of the effectiveness of exercises, referred to in the training methodology (auxiliary), specific to the sport, with phases of movement and elements of classic and non-specific (preparatory) exercise techniques which are intended to develop the physical fitness characteristics of preferred in the sport has not been resolved [1, 2, 3, 4]. Despite many observations in the field of sports practice and publications on similarities and differences in the impact of these exercises on the development of athletes' sports form, the number of supporters and opponents of their use is similar [5, 6, 7, 8, 9]. The universality of interactions of many successful exercises in different periods of development of sport methodology is usually verified by training practice, and some of them are no longer used while others find a permanent place in the methodology of many disciplines, and there are some that come back periodically with the fashion and demands for so-called "modern" types of physical activity.

One of the types of physical activity that has been "rediscovered" in recent years, primarily due to the dynamic development of muscle strength and its derivatives, under the name of "CrossFit" is exercising with a use of kettlebells [11, 12, 13]. The history of kettlebell exercises dates back to ancient Greece, although its popularity peaked at the beginning of the 18th century, when it had spread from Western Europe to Russia and was used there as a basic training device [11, 14, 15]. Regardless of the nature of this activity as a discipline, other athletes and coaches have tried to incorporate kettlebell trainings into their own training programs, due to the expected versatile effects that can outweigh the effects of bar exercises [12, 16, 17, 18]. The reason for the effectiveness of this training was seen in the specific structure of the weight, which significantly allows to increase the range of motion during the exercise, as well as force the workout of stabilizing muscles [12, 15, 17]. It is believed that training with weights also increases strength, elasticity and resistance to shoulder injuries, because the forces that affect the musculoskeletal system during ballistic exercises, strengthen the joints of the shoulder [12, 15, 19].

The precursor of research on the effectiveness of training with weights, the propagator of methodology and the most famous and creative trainer of this sport was I.W. Woropajew. In his numerous studies, he pointed to the superiority of the effects of training with weights, even to the prevalent and well-known "military" training in the Soviet Union at the time [16]. The effects of workouts with weights were also investigated by other authors, who pointed to a high correlation between the number of weight lifts and the results of strength tests in rod and parallel handrails, overall strength in the 1000 m run, and the ability to maintain body balance [14, 16].

Nowadays, the similarity of the effects of exercise with weights and the effects of weight lifting training is evident, due to the possibility of developing athleticism and strength, as well as changes in body composition [20, 21]. There is also a possibility of positive effects in terms of increasing strength and endurance in weight lifting and powerlifting, after exercising with weights as non-specific training measures [20, 22].

The advantages of training with weights are also appreciated by American footballers, because the character of the work of the muscles used in the game. This is especially true in exercises with weights of the so-called "slow and fast

negative phases" associated with eccentric and concentric muscle work, used in a fast and slow pace. Several studies on the effectiveness of exercise in the aforementioned regimens indicate that rapid-phase hypertensive groups exhibit significant increases in muscle strength and hypertrophy in Type IIb fast-wave fibers [2, 6, 20].

Despite the long history but variable popularity of exercises with kettlebells, the current scientific evidence lacks a systematic advancement of knowledge on the effects and practical applications of this kind of training. As part of the enhancement of knowledge, it is natural to examine the effectiveness of these exercises in shaping of the fitness features required by American football players.

In the context of the main objective, there is also an application goal, which explores the possibility of replacing modern football training with a traditional kettlebell exercise system.

MATERIAL AND METHODS

The study was conducted in two groups of amateur athletes (n = 24) whose physical preparation is based largely on training with kettlebells. Among the first group were amateurs of mixed martial arts and CrossFit practitioners (n = 12), who for the purposes of the experiment were called "kettlebellers" due to the historical name of this sport. The other group consisted of twelve American football team amateurs who at the time played in the top division of the Polish American Football League, who were called "footballers" for the purposes of the experiment. A diet monitored by a dietitian whose protein content per kilogram of body weight per day was up to 2g was used. All respondents signed declarations that they would not radically change their diet or use pharmacological substances. According to the requirements of the Helsinki Declaration, the participants were informed about the purpose of the research, the methodology of the procedure, the possibility of resignation at any stage of their implementation and written consent to participate in the experiments. Prior to the experiment, the group did not differ significantly in age, body weight, body height, training period (t-Student for independent trials, $p < 0.05$) (Tab.1).

Table. 1. characteristics of the examined groups

Group	Age (years)	Mass (kg)	Height (cm)	Training (years)
I kettlebellers n = 12	21.2 ±1.2	89.83 ±9.62	180.5 ±4.38	4.9 ±0.2
II footballers n = 12	20.6 ±1.1	92.83 ±5.32	182.58 ±4.32	4.1 ±0.4

For a period of eight months, group I - kettlebellers was trained with kettlebells, usually with four training units per week (Monday, Tuesday, Wednesday, Friday) from 17:00 to 19:00. Training was based on Woropayev's methodology, and his basic assumptions and examples are presented below [16].

One of the most important innovations introduced to the training with kettlebells by Woropayev was the variation in the pace of exercise. He recommended exercise snatch and clean and jerk usually in average rate. It is believed that this results in an increase in traffic control and a decrease in the energy expenditure incurred during the exercise. The lifting rate should also be synchronized with

the rhythm of breathing as it allows you to maintain high exercise capacity over a longer period of time and to achieve better results. The authors' suggested rate ranges and number of cycles per minute are presented in Table 2.

Table 2. Summary of the rate ranges and the number of cycles per minute

Pace	Fast (F)	Average (Av)	Slow (S)
Press	2.0 /27	3.0/19	4.0/14
Alternate press	2.0/25-30	2.5/20-25	3.0/15-17
Clean and jerk	2.0/27	3.0/19	4.0/14
Snatch	2.5/20-25	3.5/16-18	4.0/14-15
Both hands snatch	2.0/27	2.5/23	3.0/19
SLKCH (Snatch with lowering kettlebell to the chest)	2.5/23	3.0/19	3.5/16

Demonstration scheme of the microcycle used by group I - kettlebellers is shown in Table 3. The record of the type (17.5 kg × 80% × 2Av) refers to the maximum number of repetitions a competitor can perform (in this case 80% of this number), with a weight of a given mass (17.5 kg), in two series and at medium tempo.

Table 3. Model training microcycle of the competitor from group I – kettlebellers

1st training	1. Alternate lifting – 17.5 kg × 60% × 2Av, 24 kg × 70% × 2Av, 24 kg × 70% × 2F 2. Snatch above knees – Av 17.5 kg × 40%, 32 kg × 50% × 3 3. Snatch – 17.5 kg × 40%Av, 24 kg × 50% × 2F, 32 kg × 40% × 2F 4. Triceps parallel bar dips with weights – 10–15 kg × 100% 5. Double kettlebells press at the same time – F17.5 kg × 50% × 2, 24 kg × 60%, 32 kg × 70% × 2, 32 kg × 50% × 2 6. Climbing a rope – 4 reps 7. Run – 10 minute 8. Supplementary exercises
2nd training	1. Every rep snatch with changing hand – 17.5 kg × 60%Av, 24kg × 70% × 2F, 32 kg × 80%Av, 32 kg × 90%F, 32 kg ×80%F 2. Double kettlebells clean at the same time – Av17.5 kg × 70%, 24 kg × 70%, 36 kg × 70% × 4 3. Press – F17.5 kg × 70% × 2, 24 kg × 70% × 2, 32 kg × 60% × 4 4. "Raising harnesses on shoulders" – 5–10 kg × 14–18 reps × 4 5. Kettlebells snatch – F17.5 kg 80%, 32 kg × 90% × 3 6. Cross-country – 15 minutes 7. Supplementary exercises
3rd training	1. Forehead level press – Av17.5 kg × 50% × 2, 32 kg × 50% × 2 2. Two kettlebells jerk at the same time – 17.5 kg × 70%Av, 24 kg × 70%S, 28 kg × 70%Av, 32 kg × 60% ×2S 3. Kettlebells pull-up standing – 28–36 kg × 10–14 reps – 5–7 series 4. Sitting double kettlebells press (at the same time) – 17.5 kg × 80%, 24 kg ×80%, 32 kg ×80% ×4 5. Cross-country – 20 minutes 6. Supplementary exercises
4th training	1. Kettlebells snatch – 17.5 kg × 50%Av, 24 kg × 60%Av, 24 kg × 60% × 2F, 32kg × 60%Av, 32 kg × 60%F, 2. Double kettlebells jerk (at the same time) – 17.5 kg × 70%Av, 24 kg × 70%F, 32 kg × 60% × 2F, 36 kg × 40% × 2F 3. Good morning – 40–50kg × 6–8 reps × 4 4. Snatch squats – 60 kg ×15 reps × 2, 70 kg × 10 reps × 3 5. Basketball – 20 minutes 6. Supplementary exercises

F –fast rate; Av –average rate; S –slow rate

A group of footballers spent eight months using a modified workbook, based on the Nebraska University Physical Fitness Training Protocol [5]. Basic exercises and their dosage are shown on the example of a 4 week mesocycle, in which the series are separated by a slash, and the repetitions written in numbers. The slang names of the traditional football preparation exercises (also used with weights), referring to bowing and twisting, snatch, clean, press, squats, were recorded in the original English version [5, 13, 20] (Table 4).

Table 4. Example of mesocycle training for American football players modified by the authors

Selection of exercises and training days	Microcycle 1	Microcycle 2	Microcycle 3	Microcycle 4
Monday and Thursday				
Snatch squat	5/5	5/5	5/5	5/5
Rack clean	5/5	5/5	5/5	5/5
Power Press	10/10	5/5/5	5/5	5/5
Trunk twist or Jammer rotation Crunch		10/10	10/10	10/10
Tuesday and Friday				
Squats	10/10	10/10	10/10	10/10
Good morning	10/10	10/10	10/10	10/10
Bench Press	10/10	10/10	10/10	10/10
Jammer Press	10/10	10/10	10/10	10/10
Lat pulldown	10/10	10/10	10/10	10/10
Triceps extension	10/10	10/10	10/10	10/10
Barbell curl	10/10	10/10	10/10	10/10
Neck machine	10/10	10/10	10/10	10/10

REGISTRATION AND CALCULATION OF WORKLOADS

Workloads are counted daily, individually for each competitor, based on an analysis of exercises and their dosage, recorded in training logs.

TEST METHODS

Before and after the eight-month training cycle, all subjects did a fitness test in American football [5, 13, 20]. The test is a system tool used to check the level of motor performance characteristics that are useful for the functionality of field athletes. It should be noted that the essence of the tests included in it does not always correspond to the definitions of motor fitness characteristics used in the Polish sport theory. The battery consists of six fitness tests:

1. 40-yard run – as a speed test. A sprint run of forty yards, which starts with a high starting position.

2. Running through the arch – as an agility test. This task is characteristic of American football and it is used here to test the ability to quickly change the direction of the run. Three bollards are placed in the test: the first one on the starting line, the second one five yards perpendicular to the starting line, the third one on the line with the second bollard five yards away. The second and third bollard were on a line parallel to the starting line. The participant starts with the run from the start line to the second bollard, and then returns to the first bollard. After crossing the starting line, the participant goes to the second bollard, and then the third one and returns to the starting line (Fig. 1).

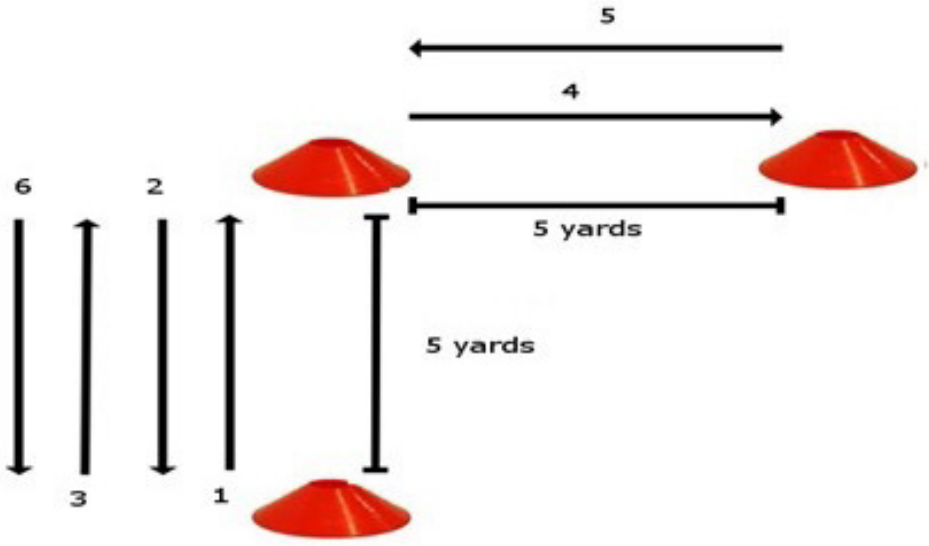

Fig. 1. Running through the arch (source: own elaboration)

3. Shuttle running – as a second agility test. Three bollards are aligned in one line, keeping five yards between them. The player is positioned in the middle of the bollard, then runs to the extreme bollard to his left, passes and runs to the extreme right bollard and returns to the starting position (Fig. 2).

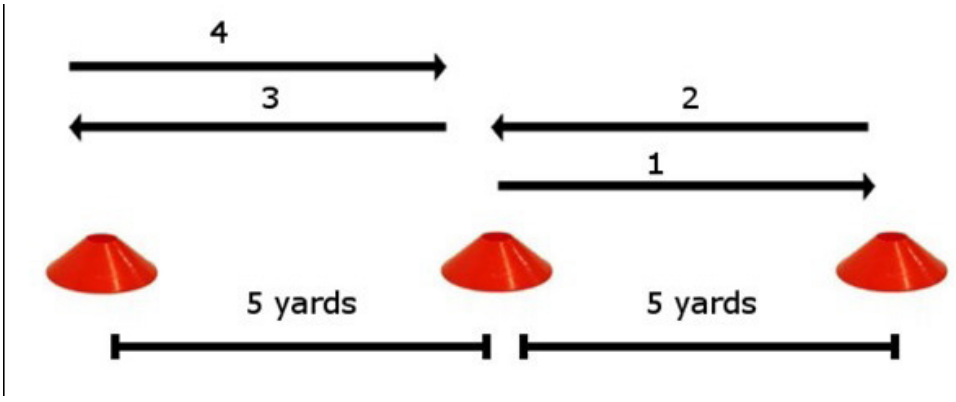

Fig. 2. Shuttle running (source – own elaboration)

4. Counter Movement Jump (CMJ) – test for jump height. The athlete stands at the wall where the scoreboard is located. He sits sideways, lifting up his hand, specifying his reach from the place. He then performs a jump with an arm swing, on the spot, marking the maximum range in the jump on the board. The referee notes the difference between the range from the spot and the range from the jump.

5. Long jump with space – as a power test. The player performs a swing and long jump. Measurement is made to the fulcrum closest to the line of take-off. An attempt is considered unsuccessful if the competitor fails to maintain balance after landing.

6. Benchpress with 100 kg – as a test of endurance strength. The player starts lifting on the judge's command and then at his own pace he makes the maximum number of repetitions. The judge counts only repetitions made in

the full range of motion, draws attention to the back of the shoulders and buttocks on the bench and feet on the ground.

All trials, apart from benchpresses, were carried out on tartan and in indoor shoes. Usually they are carried out on grasslands and in specialized footwear.

STATISTICAL PROCEDURES

The results were analysed using STATISTICA™ (v.5.5, StatSoft, USA) and t-Student for dependent groups ($p < 0.05$). The significance of the differences between the mean values of the analysed variables in subsequent studies was determined by the analysis of variance for repeated measurements (Anova). The significance of change in individual repetitions (difference in average values from both groups in the 1st and the 2nd measurements – the Wilcoxon test) and the significance of group-dependent increases (interaction between group and repetition – the Mann-Whitney test) were determined ($p < 0.05$).

RESULTS

The 40-yard run speed test results show that the average time taken in this test for both groups was 5.05 ±0.09s. There was no significant difference between the achievements of both groups. Similarly, in both the CMJ and the long jump tests there were no significant differences between the groups.

On the other hand, different results were obtained in two agility tests. The results of one of the agility tests, the arch run, did not show a significant difference between the two groups. However, the results of the other agility test, the shuttle running, which is more related to the conditions of an American football game, show that group I – kettlebellers got significantly worse results than group II – footballers ($p < 0.05$) (Fig. 3).

In an attempt to lift 100 kilograms on a benchpress, which was to test endurance strength, the players showed significantly more repetitions than the kettlebellers – on average 8.92 ±5.71. A diagnosis of this sample and the reliability of the obtained results, in the context of their strength determination in both groups, require additional explanations and interpretations (Fig. 4).

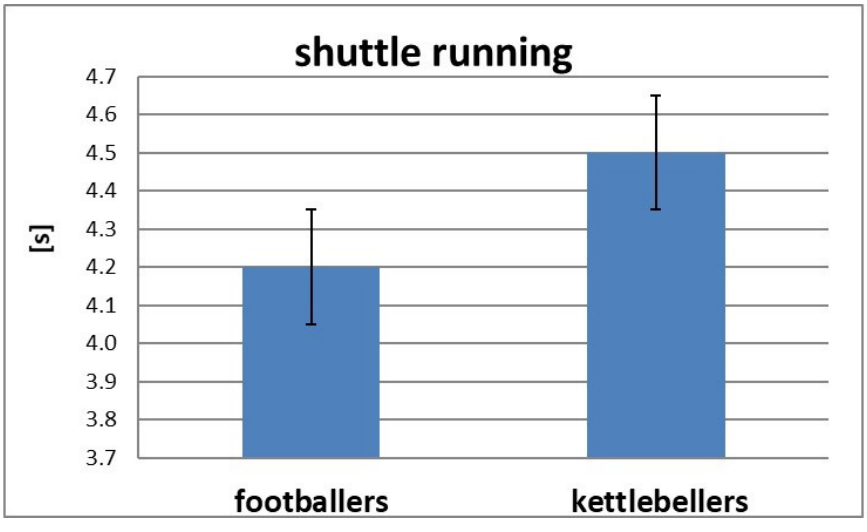

Fig. 3. Results in the agility test – shuttle running ($p < 0.05$)

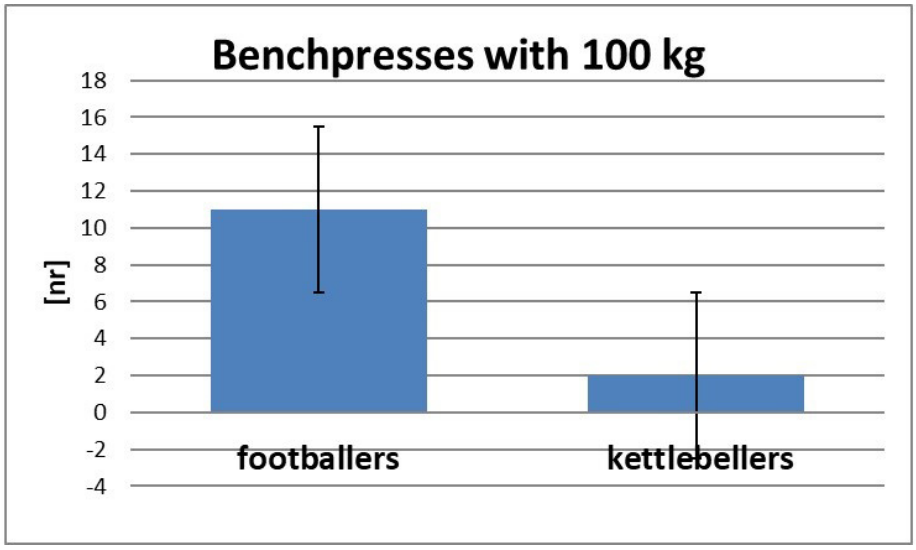

Fig. 4. Results in the benchpress with 100 kg – the endurance strength test ($p < 0.05$)

DISCUSSION

It seems that by using ball weights we can develop special fitness just as efficiently as the current systems of exercise used by American footballers. This is indicated by the results of four of the six exercise tests in which there were no significant differences between the groups. These include: running for forty yards, running through the arch, CMJ and long jump with space. A 40-yard run indicates that football training and kettlebell training are equally effective at shaping the speed level. Although the training of kettlebellers does not generally favour cross-country skiing, in order to develop speed they perform exercises poliarticular in speed tempo [12,16]. In subsequent training stages, the time of exercise with weights was gradually reduced, and the use of fast tempo, according to Woropayev, improves sprint running [16]. Hence, it seems that training with kettlebell used in this form can be an alternative way to develop speed in American football.

In the jump test, which was performed according to the CMJ (Counter Movement Jump) method, both groups achieved the same result. In training with kettlebells, in exercises of the type: layout as kettlebell, one-handed snatch, manoeuvre movements are made, and thus the technique of rebound is developed indirectly. During exercise tests at the California Sports Exercise and Fitness Center, it has been shown that exercise with kettlebell improves jumping as well as weightlifting training and other "resistance exercises" [22].

In the power test – long jump from the spot, the kettlebellers also achieved as good results as the American footballers. Training with kettlebells is very effective in developing the power that was tested in our experiment by means of a long jump [2, 3, 17]. When performing the swing with the kettlebell, the flexors, trunk and thigh extensors in the hip joints are most involved, and their level of training is decisive for achieving high scores in this trial [10]. It seems that in the abovementioned regularities one can see the causes of the similar increase in the results in both groups.

In the run along the arch, the kettlebellers were as good as the footballers, although it is arguably the most complex agility test. In American football, most of the developing exercises shaping agility are based on a similar pattern, while a group of kettlebellers first encountered this test during the first study. Kettlebellers probably owe their results to very good body balance [12, 20]. Exercise with kettlebells engages postural muscles, acting in a similar way to proprioceptive training, thereby significantly improving balance [14, 20]. However, in another swing test – the shuttle running (Fig. 3) in the kettlebellers obtained significantly worse results than footballers. It seems that exercises with kettlebells can have a positive effect on the development of the features that footballers need for longer periods of time in low body positions, but they do not do so well in the event of sudden changes in the position or direction of movement. Differences in the results obtained in both trials are puzzling and require further investigation, as perhaps the reasons for the differences should be seen in the difference in the pattern of movements in both trials, misleadingly called the agility tests.

In the number of benchpresses of 100 kilograms, the group of footballers reached a significant advantage over the group of kettlebellers (Fig. 4). It seems that in this case training with weights with relatively small masses could not, for eight months, lead to such a dramatic increase in strength that it would allow repeatedly lifting 100 kilograms. Besides, training with kettlebells does not involve the chest muscles in a manner similar to lifting a barbell, while some studies indicate that weightlifting training is more effective than training with kettlebells [22]. Prior to the experiment, most of the kettlebellers were not able to lift the bar once and, therefore, the average result of 3 lifts obtained in a macrocycle study should be considered a training success. A recent study carried out at the Lesgaft Physical Culture Institute (1986) showed a positive effect of training with kettlebells on building strength. However, the results obtained were due to the use of less stressed exercises and referred to the pulls on the bar and the pushrods on the parallel rails [14]. It has been repeatedly proven that strength training with kettlebells as a complementary element can be useful in weightlifting and powerlifting [23, 24, 25].

CONCLUSIONS

1. Training with kettlebells can have a positive influence on shaping most physical features needed in American football.

2. Training with kettlebells cannot completely replace the traditional football strength training program, but it is a good complement to it.

3. The endurance strength test (benchpress with 100 kg) due to the difficulty of the attempt and personal differences (standard deviation) does not seem indicative.

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