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Competitive Training Influence on Golf Swing Kinematics

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Abstract. An attempt is made to estimate the influence of competitive training on the physical qualities development degree, manifested in changes of speed-power parameters of swing: carry, clubhead velocity and angular velocity of backspinning ball. A group of athletes at the training camp was under pilot study. The dedicated equipment recorded the kinematic parameters of the shot.

It is established that an intensive game training in the volume of 65 hours a week, with an intensity of 210 game activities a day in a competitive mode has a significant impact on the level of special physical and technical fitness in golf: carry increased by 9.2 %, stability of the ball movement by 24 %.

Keywords: golf simulator, competition, sports result, carry, velocity.

Research area: physical education.

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Влияние соревновательной подготовки на кинематические параметры свинга в гольфе

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Аннотация. Предпринята попытка оценки влияния соревновательной подготовки на степень развития физических качеств, проявляющихся в изменении скоростно-силовых параметров свинга: дальности удара, скорости головки клюшки и угловой скорости обратного вращения мяча. Проведено пилотное исследование группы спортсменов на учебно-тренировочном сборе. С использованием специального оборудования фиксировались кинематические параметры удара.

Установлено, что интенсивная игровая подготовка в объеме 65 часов в неделю, с интенсивностью 210 игровых действий в день в соревновательном режиме оказывает существенное влияние на уровень специальной физической и технической подготовленности в гольфе: дальность ударов возросла на 9,2 %, стабильность перемещения мяча на 24 %.

Ключевые слова: гольф-симулятор, соревнования, спортивный результат, дальность, скорость.

Научная специальность: 5.8.5 – теория и методика спорта.

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Introduction. Competitive (integral) training is known to be the most important part of sports training, combining in practice all types of training, including physical, theoretical, technical, tactical and psychological (Korolkov, 2016; Korol'kov, Anisimov, Andreev, Bereza, 2021). This type of training occupies a greater place in the structure of training workloads as the sports mastery develops. This is particularly evident in competitive sports, in which the volume of competitive training in the form of various competitions participation often exceeds 50–60 % of the total training loads volume at the stage of elite sports mastery (Korolkov, 2013; Savostin, Savostin, 2020).

At the same time, as shown in many studies, competitive results in golf are mainly determined by the level of special physical fitness (Cherkashina, Nin, Platonov, Ivanov, 2021; Strizhak, Korolkov, Strizhak, 2022; Cherkashin, Nin, 2020) for which speed and strength qualities, flexibility and agility are particularly important (Korolkov, 2016; Cherkashin, Nin, 2020; Korol'kov, Anisimov, Andreev, Bereza, 2021). manifested in the implementation of such coordination abilities as the sense of tempo, the ability to dose movements in direction and amplitude (Korolkov, 2016; Strizhak, Korolkov, Strizhak, 2022; Gryc, Zahálka, Malý, Hráský, Malá, 2019). At the same time, the degree of development of those physical qualities largely

determines the risk of injury (Korol'kov, 2013; Tszyan, Borokhin, Migalkin, 2022). In golf, kinematic variables of the trunk and pelvis are often associated with performance indexes (Khuyagbaatar, Purevsuren, Kim, 2019). Usually, studies on the relationship between physical fitness and athletic performance in golf address the direct question of how sport performance is related to the level of physical fitness (Cherkashina, Nin, Platonov, Ivanov, 2021; Savostin, Savostin, 2020; Cherkashin, Nin, 2020).

Research objectives. Our study attempts to address the reverse problem: how competitive training affects the physical qualities degree of development manifested in changes of the swing kinematic parameters (speed and power): the carry, clubhead velocity and angular velocity of backspinning ball.

Methods and organisation. To solve this problem, a group of nine athletes was under a pilot study, conducted in October 2022 at the training camp of the Krasny Yar (Krasnoyarsk) Specialised Olympic Reserve School. Participants of the study were preparing for a match with the team of RNGC SPB (Saint Petersburg) Golf Academy. Athletes participated in three daily training sessions: morning warm-up and three game practice sessions. The total volume of training activity made 9 hours a day, including aerobic exercises for 4 hours, number of game activities with submaximal power of 70 shots a day, number of activities with dosed amplitude made 140 shots a day and number of shots on the green equaled to 120. Also, during the training camp, 12 control games were played in the team event and on the shots count at the Strawberry Fields Golf Club.

At the beginning and at the end of the training camp, the athletes were tested at the Krasnoyarsk Golf Department using a GOLF-ZON Vision Premium golf simulator, during which each examinee performed a series of 7-iron shots. The following kinematic parameters were recorded: carry, dynamic loft, ball velocity, angular velocity of backspinning ball and clubhead velocity.

The results were processed using Excel Microsoft and Stadia 8.0/prof standard statistical packages. The statistical significance level for the null hypotheses was set to 0.05.

Results and discussion. The word swing in golf refers to an attempt to perform the required action, a strike. Whether a player tries to achieve a result with a strong swing or with a «swing strike» makes no difference to the ball. What is important to realise is that some type of swing action must take place in order to achieve the best results. The ball only reacts to the clubface, trajectory, centeredness, speed and approach angle, not how they are created. However, the word «swing» is in every instruction written regardless of the coach's style or the athletes' preference. The idea of «swing creation» should be part of any instructional plan. Swinging consists of two separate phases: (1) the preparation phase for the swing, before the main movement begins; (2) the actual swing itself. The main challenge for the coach is to teach the athlete the importance of three principles in preparing for the strike or swing: club grip, aiming, and stance (Ehlert, 2020).

Each athlete should be seen as a unique player, with individual natural talents, some weaknesses and most likely individual differences. The approach to coaching an athlete should involve finding the «best swing in golf». This finding can be facilitated by understanding the laws of ball flight, working with the swing principles that influence these laws and selecting appropriate preferences that will help achieve the desired results.

There is a best swing for each golfer, which includes the specific grip, alignment, stance and swing pattern that best suits (a) the player's ability, (b) their temperament, and (c) their physique. It is important to realise that the above three points are the key to the search, as the answers obtained will vary depending on individual characteristics.

There are five important steps that a golfer, with the help of a coach, should take to find their best swing: (1) to study the causes and relationships in determining golf strikes results; (2) to become familiar with the principles of golf shots and how strike changes affect results; (3) through experimentation, reflection, and with the help of a coach, more experienced playing partners, to select a style or technique that is compatible with the technique the athlete wants to master and can execute; (4) to de-

termine the physical ability and physicality of the athlete using their advantages and compensating for their disadvantages; (5) when preferences are chosen, one should dwell on them and practice strike techniques.

Proper weight shift can be taught if it is not natural. It is such a critical movement in golf that, if necessary, golfers must specifically practice it before acquiring a high level of skill. To practice, the student should take the 7-iron and first repeat the actions associated with the grip and stance performed (the grip and stance are very important; even professionals practice them repeatedly). Next, visualise the target line, the athlete should waggle and imitate with the club, trying to feel the right combination of body actions for a good weight shift back and forth. The most important is to shift the weight from the right foot to the left foot. If the golfer's opened up torso is positioned over the right foot, the golfer is ready for the most effective golfing motion by starting the take-away. The right heel comes off while weight is shifted to the left foot. There is a rotation of the torso and a lowering of the arms and hands to a position where they can make the maximum contribution to the strike. This change in weight position from the original position over the right foot to the position over the left foot is the basis of footwork in golf. The action comes from and through the right foot and leg. If the lower part of the right leg is not in a solid position, the powerful movement to the left will be deprived of some of its power. Once the desired torso position has been achieved, the inertia of the swing itself will drive the player forward into the final position. A good swing will always create a normal ending with the hands and arms over the left shoulder.

The trajectory of the club head during the swing describes an arc that is predominantly circular with a slight flattening at the bottom. Both the length and width of this arc affect the distance the ball can be forwarded and whether the ball will be struck at all. The width of the arc, like the radius of a circle, is measured from the center of the swing rotation to the end of the club head. If someone measures the velocity of the club head at a given swing and at the same time measures the velocity of the

club at the middle of the handle, they will find that the head is traveling faster than the point in the middle of the handle because it has more distance to cover. Assuming an equal force is applied, the velocity of the end of the lever will always be higher than the velocity of any other point on that lever. Thus, when a player shortens the length of the lever, they lose the potential velocity of the club head. If the athlete is unable to execute a swing without appearing stiff, the left arm may be bent during the swing, but the arm must return to a more extended position at the moment of contacting with the ball. Arc width not only affects speed but is also critical when the ball and the center of the clubface make contact. The player can compensate for shortening the leverage of the lead arm (left arm) by lowering the center of his swing. In addition, the player experiences a loss of distance even if hitting straight at the ball because the impact occurred with a shorter lever. The left arm extension within the strike should be the result of centrifugal force pulling it out. The result is a release within the swing with proper synchronisation that is free of muscle tension. Trying to keep the arm straight creates unwanted tension in the arms and shoulders. The most natural method coaches use to achieve extension at the stroke is to tell athletes that gravity and centrifugal force are working on them. If an athlete holds the club in their hands and then releases it, it hits the ground ... by gravity. If the athlete performs a swing with his arms and hands free of tension, the club tries to break free of the grip (centrifugal force), which causes the arms extension. With constantly repeated swings and with the help of gravity, centrifugal force and the center of the swing not shifted up until the strike, the athlete gains the ability to strike touching the grass with the club head. This is a natural consequence of the change in arc width (Hellström, 2009; Hébert-Losier, Wardell, 2021).

It should be remembered that most of a golfer's strength does not come from the legs. However, getting the lower body into a position in which torso strength can be used requires the involvement of the legs. This is why so many coaches emphasise the importance of good footwork.

One of the main indicators of physical and technical fitness is the carry which depends on the ball departure angle, the dynamic loft of the clubhead, the initial velocity of the ball and the angular velocity of its spinning. The initial velocity of the ball, in turn, is determined primarily by the velocity of the clubhead at the moment of hit and the elastic properties of the ball. A correlation analysis of the kinematic parameters measured on a golf simulator revealed the same parameters having the highest correlations with the carry, and a multiple regression expression was obtained:

$$L = -23.47 - 3.82 \cdot \alpha + 0.0219 \cdot \omega + 3.66 \cdot V,$$

where L – carry, m; α – loft, degrees; ω – angular velocity, base units; V – club head velocity, m/s.

The accuracy of this expression is ± 9.83 m ($\approx 10\%$ L) and the coefficient of determination equals to 0.95. That is, the variables on the right side of the resulting regression equation determine 95 % of the changes in the carry. Using Fisher's criterion, the validity of the hypothesis was established as follows: the regression model is adequate to the experimental data.

The obtained expression establishes quantitative relationships between the carry and the parameters of special physical fitness in the form of clubhead velocity and the parameters of technical fitness in the form of angular velocity of backspinning ball and the dynamic loft.

Differences in those swing kinematics before and after the training camp were determined using the sign test. The medians of the swing kinematic parameters having statistically significant differences are shown in the table below.

As it follows from the results obtained, the methods of intensive competitive training had a significant impact on the improvement of swing kinematic parameters. Particularly evident was the effect of changes in technical fitness: the angular velocity of backspinning ball increased (4.5 % of growth) and the initial velocity of the ball increased (7.1 % of growth). All of those changes resulted in an increase of 9.2 % in the carry (Fig. 1).

In addition to the carry increase the stability of the ball movement also increased: if before the training camp the quartile latitude of the carry was 24.9 m, then after the training it made 18.9 m.

Table 1. The medians of the swing kinematic parameters before and after the training camp holding

Moment of measurement /parameter	Carry, m	Angle α , degrees.	Ball velocity, m/s	Clubhead velocity, m/s	Angular velocity ω , base units.
Before training camp	103.2	17.3	36.7	28.9	4149
After training camp	112.7	18.6	39.3	29.9	4336

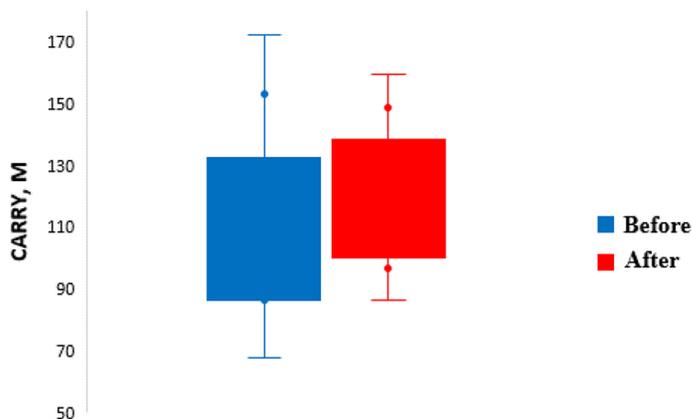


Fig. 1. Changes in the carry as a result of competitive training

Conclusion. The result of the conducted research established that intensive competitive training in the volume of 65 hours a week, with intensity of 210 playing actions a day in a competitive mode has a significant influence on the level of special physical and technical condition in golf: the carry increased by 9.2 %, the stability of ball movement increased by 24 %. The clubhead velocity, initial linear and angular velocity of the golf ball spinning also increased.

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