THE OPTIMAL LOAD FOR ACHIEVE MAXIMUM OUTPUT POWER – BENCH PRESS FOR TRAINED FOOTBALLER

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SUMMARY
The collective ball games, explosively driven events and many other sports, it is necessary in certain situations produce the maximum amount of mechanical work in the shortest possible time. This means that it is necessary to achieve maximum mechanical output power (hereafter P\textsubscript{opt}), which can be regarded as the most important factor in sports performance. P\textsubscript{opt} is dependent on the external load, which acts against a force of movement. The main aim of this paper is to identify the maximum weight load (% 1 RM - repetition maximum), with which the sample reaches the maximum mechanical output power (% P\textsubscript{opt}) in the bench press exercise. The research group was 15 probands of highly trained soccer players. Using experimental methods and measurements was 3D kinematic and dynamic motion analysis. The group performed strength tests, in which the P\textsubscript{max} was measured with 0, 10, 30, 50, 70, 90 and 100\% 1RM. Of the results obtained and the necessary data were then edited in programs Qualisys Track Manager, 3D and Visual Basic / RT. During the measurement results are recorded separately and can help to determine the optimal load for strength training.

INTRODUCTION
Mechanical output power is dependent on the external load, which acts against a force of movement (Hill, 1938). A. V. Hill first examined the relationship between muscle power and load. Based on his experiments, which first gave the isolated frog muscles, determine the optimum ratio of muscle strength (F\textsubscript{opt}) and maximal muscle strength (F\textsubscript{max}) to achieve maximum muscle performance during concentric contraction P\textsubscript{opt} value F\textsubscript{opt} / F\textsubscript{max} = 0.31. The optimum value of power is one third the maximum isometric muscle force at maximum power. Kaneko et al. (1983) states that the strength training with loads that maximizes muscle performance helps to the development of mechanical muscle performance in flexion at the elbow joint. The optimal load for maximum mechanical output power during specific exercises of upper extremities investigated by Wilkie (1950), Baker, Nance and Moore (2001a), Cormie, McCaulley, Triplett and McBride (2007b), however, the authors present very different values of the optimal load. In individual studies appear in the optimal load ranging from 0 to 80\% 1RM. Investigations are carried out using methods that simplify the measuring method so that the results may not be valid. Unlike previous methods FitroDyne Premium, which is preoccupied with this issue before and the current method of 3D analysis QUALISYS, we show that the method is able to capture QUALISYS dumbbell movement in all axes x, y and z. Unlike earlier methods (Cormie et al., 2007) we are able to get the speed of gravity of the upper limbs and load tested person, and not only monitor the speed of movement dumbbells. Other advantages of the present method is that it is not necessary to use Schmidt's engine, which restricts movements in the sagittal and left to right direction, but everything will be done in free space without undue friction, so the results are logically valid. Many scientists, doctors, sports trainers, etc., deals with the monitoring of individual muscles, muscle fibers in various joints, in determining the dependence of the mechanical muscle performance. However, very little is known about dependence of mechanical stress on the muscle performance of specific exercises that are used in strength training.

METHODS
The method of experiment consisted of manipulating the load weight (independent variable) in the bench press exercise. We observed the maximum mechanical output power which was dependent variable. This involved a homogeneous group of 15 professionally trained soccer players. The average age of test subjects was (26.1 ± 3.87) years, range 19-33 years, mean body height (183.3 ± 6.73) m in the range from 1.70 to 1.96 m and the average body weight (78.8 ± 7.17) kg in the range of 65-91 kg. The main equipment used included kinematic and dynamic motion analysis. Like other institutions, we used 3D analysis QUALISYS. This method is specific in that the reference of the camera body is dependent on each other. This device provides the kinematic data very quickly and with precision. The body is attached to his body about 25 fluorescent points, which are sensed by cameras. Qualisys Assistance Program, we can handle the computer model, which we determine exactly where the center of gravity of the body while lifting weights in the bench press. When measuring the weight load P\textsubscript{max}, with which test subjects performed exercises systematically increased from 0, 10, 30, 50, 70 and 90\% of their actual 1RM. With each load was calculated as follows stroke executed with maximum speed. Between each stroke was at least 3 minutes interval. With each load measurement was performed three times for each person tested. To find the optimal load we used the regression function, which will satisfactorily explain the measured power.
dependence of the load. Closeness of the relationship between regression model and the measured data, we estimate the coefficient of determination (R2).

RESULTS AND DISCUSSION
When a relationship between the ratio of mechanical power output (% $P_{mm}$) and the weight load (% 1RM) for bench press exercises were used quadratic regression equation (Fig. 1). For this exercise has been achieved in a group of $P_{mm}$ test subjects, the relative percentage of 52% by weight of the burden of a recurrent high. The outcome of this equation, we came to the exact calculation of the maximum mechanical output power. The formula was based on the achieved coefficient of determination $R^2 = 0.858$.

![Figure 1: The relationship between the ratio of mechanical power output (% $P_{mm}$) and the weight load (% 1RM) lifted during bench press exercises. Circles represent observed data. The full curve represents the quadratic regression model.](image)

The importance of this study is to determine how to measure the maximum mechanical muscle output using 3D analysis QUALISYS. Determination of measurement method based on analysis of physical quantities, which can measure the 3D analysis QUALISYS during the exercise. One of the main reasons this work is to verify the validity and reliability of measurement of mechanical power output, using the latest techniques (3D analysis) to achieve accurate results for the performance of one of the recurrent maximum (1RM). The validity of measurement of the maximum mechanical output power we conducted an analysis using 3D Qualisys. This method achieves more accurate results due to the fact that compared to previous methods (Cormie et al., 2007). Reliability is estimated in the classical theory of testing with the coefficient of reliability, which is the proportion of true variance to observed variance. It should be noted that, in light load weight has been tested in people maximum instantaneous output power produced mainly in the first half of the range of motion, while the heavier load weight is the maximum instantaneous output of muscle power has shifted in the second half of the range of motion. The muscles then take up in different phases of movement which is closely associated with weight lifting load. These factors may be an important component in the creation of training. The force which each person tested has evolved as a reaction has been measured using dynamometer power washers platforms. Power was then calculated as the product of speed and power. Performance is expressed as a function depending on the relative distance (range of motion).

CONCLUSIONS
The overall results obtained, we can identify the relative weight of the load is achieved by trained soccer players $P_{mm}$. By exercising maximum bench press was a mechanical muscle output power achieved in a group of test subjects, with a relative weight percentage of 52% 1RM load. The value of the load would be the optimal training load for no ballistics in which we try to give maximum energy in the shortest possible time.

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REFERENCES