
Measuring Instruments for Assessing the Explosive Power of the Lower Limbs in Volleyball Players

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Abstract: The most accurate data for measuring the explosive power of the lower extremities are provided by modern measuring instruments and apparatus for measuring the maximum isometric force of the leg extensors with associated hardware and software, tensiometric probe inside the foot platform, force reader with PC such as Quattro Jump, Ergo Jump, Myotest. Given that explosive power is one of the essential abilities in volleyball, which contributes to the vertical jump of volleyball players, this research would aim to present and assess the validity of these measuring instruments. The method of work is to collect relevant literature in the period from 2007 to 2021 and analyze them. The results showed practicality, efficiency, the economy in transport, validity, reliability, as well as the static correlation of tested variables. The research included nine original scientific papers, which satisfied the research problems and could provide an answer to the set goal. With the help of the found research, we can freely say that the application of measuring instruments for estimating the explosive power of the lower extremities in recreation and sports is in expansion and an increasingly common ally of coaches in initial measurement, tracking form, and designing training sessions.

Keywords: Quattro Jump, Ergo Jump, Myotest, Volleyball, Strength, Explosiveness

1. Introduction

The basic methodological orientation of all sciences that deal with a man is an interdisciplinary approach to the study of personality. According to Malack [11], anthropological status means the following human abilities and characteristics: morphological characteristics (growth and development), functional abilities (structure and function of individual organs and organ systems), motor abilities (solving motor tasks), biomechanical characteristics (knowledge of structural components of the human body eg bones, joints, muscles), how the physical laws of movement govern this structure (mechanics), cognitive abilities (reception, processing, and transmission of information),

conative characteristics (modalities of human behavior) and sociological characteristics (position of an individual in a group and group relationships).

The explosive strength of the lower limbs is the most important aspect from the point of view of physical training, on which each coach of a volleyball team, irrespective of the age or level of training of that team, tends to focus. This explosive power is an essential part of many specific abilities of volleyball players, which allows them to perform actions with the high and necessary power, at the right moment [4].

Volleyball is a polystructural, acyclic complex activity, a collective sports game that places numerous requirements on

players, defined by the rules and structure of the game. Through the phase of organization of defense and attack, there is an exchange of points that are characterized by high-intensity activities with periods of short rest. It is considered an anaerobic sport with metabolic energy requirements satisfied by a predominantly phosphocreatine system [7]. Dynamic strength is dominant in volleyball because this sport is saturated with jumps and rapid changes of direction, and to gain an advantage over the opponent, all the elements that make it possible, strive to perform in the jump [18].

Reflective abilities are classified into a latent space of explosive power of the jump type, which is characterized by a fast and elastic reaction from the ground. The efficiency of movement is especially dependent on the explosive power, which appears in various situations in which it is necessary to develop the maximum force in the shortest possible time. The explosive power of the jump type is an important motor ability necessary for success in a large number of sports, primarily in sports games [20].

In research Dal Pupo velocity and maximum force were the main determinants of height and power in the two types of vertical jumps. However, explosive force (RFD and TMF) was also important for power production in vertical jumps. Runners had a better vertical jump performance than volleyball players [2].

One of the most successful transformations of horizontal speed into a vertical component with one leg is one of the key characteristics of movement patterns in volleyball and similar motor structures, there are rare moments in the game when athletes are in contact with the ground and the possibility of using both legs or arms. Athletes have been shown to show different results in agility tests when it comes to moving in one direction or another [14].

Explosive power represents the ability of the neuromuscular system to mobilize functional potential to achieve increased values in the shortest possible time. In sports games, this type of strength has an extremely important impact on achieving maximum performance [5]. It is important to note that the research [3, 17], show that the regular curriculum of physical education for the fifth grade of primary school has a positive effect on the explosive strength of the legs, coordination and speed of alternative movements, as well as that students who regularly attended physical education classes attended a volleyball class based on play and elements, they made significant progress in complete explosive power, speed of alternative movements, and coordination [1].

Several methods can be used to determine the height of the vertical jump and the explosive power of the lower extremities: traditional methods such as the distance between the marks, the pc-system for motion analysis, the force platform, and the contact platform. The most extensive method is the contact platform, because this device is cheap, compared to the force platform, requires less training to operate than a pc-system for motion analysis, while the results are current and provide good reliability between measures [13]. The mechanism of the contact platform

consists of a mat located inside the metal bars. The height of the jump is determined by the flight time, which is measured by the time in which the system detects any interruptions in the contact between the metal bars [19].

To primary determinant of quality performance in volleyball belongs as well high-quality sports training, just like in other sports, which builds on development of techniques of individual sport activities, whether on development of physical ability with intention to dynamic and explosive characteristics. Those are in the game reflected mainly in hitter's and blocker's jumps, quick starts, movements and falls [21].

2. Method

The following electronic databases were used to collect data on measuring instruments used to assess the explosive power of the lower extremities in volleyball: PubMed / Medline, PEDro, DOAJ, SCIndex, Google Scholar, as well as journals in the field of sports science and relevant literature that could respond to the task at hand.

The search of works was done in the period from 2007 to 2021. The following keywords were used in the database research: Quattro Jump, Ergo Jump, Myotest, volleyball, strength, explosiveness.

The found research titles, abstracts, and full texts were then read and analyzed. For the research to be accepted for the final analysis, it had to meet two criteria: the first criterion refers to the specific selection of the measuring instrument, while the second criterion is the implementation of the analysis of works in the selected period. The researches that met the set criteria were then analyzed and presented based on the following parameters: reference (first letter of the author and year of research publication, the sample of respondents, the applied instrument of tested value, finally, research results).

In Table 1, a review of the collected and analyzed papers, we have listed the content of the authorship, the holder of the paper, and the year of publication are listed, the co-authors are listed in the references. Basic information on the number of respondents, age categories, and gender within the sample of respondents, measuring instrument, as well as research results, are provided. In the section marked as a measuring instrument, the keywords from the title, ie the problem of work, are extracted. The research results section presents the authors' results and partial conclusions.

3. Research Results

The procedure for collecting, analyzing, and eliminating the found works is given in Figure 1. Based on the keywords, 168 works were identified. The number of studies that were immediately excluded based on titles and duplicate papers is 75, while 49 papers were included in the analysis based on abstract and full text. The further analysis excluded 35 papers based on several criteria: abstract, because it was systematic review research, as well as the absence of a control group in

research, review research and topics was not fully adequate. The remaining 9 works met the set criteria, which are:

published in the period from 2007 to 2021, are shown in Table 1.

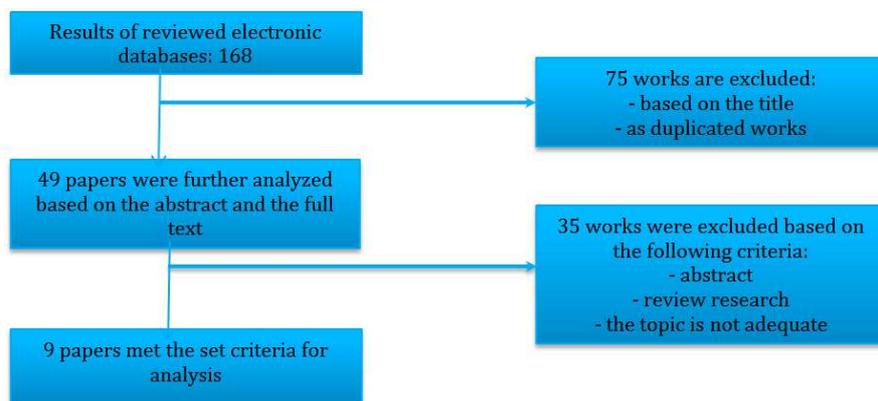


Figure 1. Procedure for collecting, analyzing, and eliminating found works.

Table 1. Shows the studies that show the validity and reliability of measuring instruments for assessing the explosive power of the lower extremities in volleyball players.

First author and year of publication	Sample of respondents			Research results
	NUMBER	GENDER	INSTRUMENT	
Sattler, T, Hadzic, V, Dervisevic, E, & Markovic, G. (2015)	253	M / F	OptoJump	The optojump device is valid, reliable, and easy to operate. It can be used for various protocols. There are some differences when comparing results with other instruments. Preliminary results show a significant correlation between this system and Ergojump for Squat Jump (SJ) and the Reactivity test. There was a difference of almost 9% in favor of Myotest. The contact platform measures the flight time while Myotest only measures the acceleration of the body's center of gravity during the ground contact phase.
Markovic, K., Herodek, K. (2011)	6	M	Myotest, Ergo Jump	In the comparison between the tests, statistically significant differences in measurements were noticed, where the Ergo Jump system proved to be a reliable and accurate measuring instrument for estimating the explosive power of volleyball players.
Jefferson E. H, Gonçalves L. N, Arruda, M, Augusto D, C. (2007)	10	M	Ergo Jump	The results showed statistically significant differences and showed that Quatro Jump is a precise and precise method for estimating flight time when the force platform is not available. Quatro Jump showed good convergent validity.
Dal Pupo, J., Detanico, D., Dos Santos, SG (2012)	12	M	Four Jump	Myotest provided insight into the measurement of lower limb muscle contraction abilities (flexibility, stiffness, or stiffness), reactivity, and lower extremity muscle coordination properties, and proved to be practical and reliable.
Schmida, L., Rozim, R., Bendíková, E. (2014)	14	M	Myotest	A Myotest device was used to estimate the explosive power. Respondents performed two vertical jumps, the Jump Against Movement (CMJ) and the Squat Jump (SJ). The sample of variables processed by the Myotest device consisted of Height (expressed in cm); Power (expressed in W / kg); Force (expressed in N / kg) and speed (expressed in cm / s). Respondents wore a belt around their hips, on which a "Myotest" wireless device was placed (securely fastened to the belt). All subjects performed three vertical jumps (CMJ), where Myotest proved to be extremely reliable and practical to apply.
Krističević, T., Krakan, I., Baić, M. (2016)	54	F	Myotest	The research was conducted with the Explosive Power Diagnostic Platform Quattro Jump 9290BA (Kistler, Winterthur, Switzerland) which was used to assess jumping performance during squat jumps, reverse jumps, and 45-second continuous jumps. The results show that Quattro Jump is extremely reliable and is an effective tool for assessing the explosiveness of the lower extremities.
Jandova, S., Janura, M. (2019)	17	F	Four Jump	It was found that the observed variables do not deviate statistically significantly from the normal distribution and that Quatro Jump is one of the most commonly used measuring instruments for estimating the explosive power of the lower extremities, which confirms its reliability.
Rešetar, T., Marinović, M., Ivanković, M. (2021)	24	F	Four Jump	To process the results of this research, the software of the Optojump Next System device was used, which enables the creation of a database and the calculation of dynamic strength, elasticity, and average muscle strength, which confirmed its validity and practical application.
Graur, C., Făgăraș, S. (2013)	22	F	Opto Jump	

4. Discussion

This paper presents measuring instruments and some tests for assessing the explosive power of the lower extremities in volleyball as one of the decisive factors for success. The vertical jump is usually estimated, with or without load on platforms and force measurement software.

The discussion includes ten original papers showing the applicability of measuring instruments for assessing the explosive power of the lower extremities in volleyball, as well as their validity, economy, reliability, and practical applicability, and about 400 respondents of both sexes.

This paper aims to present and indicate through data from the literature, scientific papers, and experience measuring instruments as diagnostic methods for assessing the explosive power of the lower extremities of volleyball players, as well as their application, validity, reliability, and economy.

Through the research from Table 1, it has been proven that the performance of the vertical jump (VJ) is an important element for successful volleyball practice, as well as that there are obvious differences between men and women when conducting testing.

The first row of the table contains research data conducted on a sample of 253 respondents, 113 males, and 140 females. The respondents were professional volleyball players of the first and second Slovenian leagues. 4 types (VJ) of vertical jump were used as a protocol. The height of these 4 different types of vertical jump was tested using the Optojump system (Microgate, Bolzano, Italy): SJ, CMJ, BJ, and AJ. An optojump is a dual-beam optical device that measures contact and flight time during a series of jumps (or single jumps). Flight time (tair) was used to calculate the height of the body's center of gravity [16]. The device proved to be very reliable, accurate, and valid for use.

The second, fifth, and sixth rows of the table contain data from a survey conducted on a sample of 74 volleyball players. These studies aim to evaluate the validity of Myotest for vertical jump assessment. Plyometric training induced significant improvements in SJ and CMJ [8]. The research also included a comparison of two measuring systems for measuring vertical movement during a squat jump (SJ) and a reactivity test - Myotest and Ergojump. Subjects performed six vertical jumps (with as little bending in the knees as possible). The achieved jump height measured by Myotest and Ergojump did not show a significant difference, while the values of the jump height are slightly higher with Myotest if compared to the results obtained with Ergojump. The difference was approximately 3 cm, which represents a relative average difference of about 9.5% [12]. Myotest provided a measurement of the contractile abilities of the muscles of the lower limbs.

The third line contains research data conducted on a sample of 10 volleyball players from the Volleyball Federation of Sao Paolo who had an average of six years of experience in volleyball coaching. A contact mat connected to the Ergo Jump digital timer was used to measure the

resistance of the explosive power. Subjects had four sets of 15 seconds of continuous vertical jumps with a recovery interval of 10 seconds between each series. The results showed a high level of reliability in testing, as well as retesting of vertical jumps where the Ergo Jump system proved to be a reliable tool for testing the explosive power of the lower extremities in volleyball players [10].

The fourth, seventh, eighth and ninth lines contain data from a survey conducted on 12 young volleyball players and 41 female volleyball players. It was found that the observed variables do not deviate statistically significantly from the normal distribution and that Quattro Jump [15]. The measurement procedure was performed by experienced meters through a tensiometric mobile platform for tests SJ, CMJ, and CMJa (Quattro Jump, Kistler, Switzerland), where it was found that the observed variables do not deviate statistically significantly from the normal distribution and that Quattro Jump is one of the most commonly used measuring instruments for estimating explosive power, which confirms its reliability and validity.

The last row of the table contains data from a study conducted on 22 volleyball players, where they calculated elasticity, dynamic and muscular strength through the Opto Jump System, which confirms the fact that strength training and plyometrics are necessary for volleyball players, and that Opto Jump is a reliable system for measuring the explosiveness of the lower extremities in volleyball.

5. Conclusion

Reviewing the relevant literature, we conclude that modern measuring instruments for assessing the explosive power of the lower extremities in volleyball players Quattro Jump, Ergo Jump, Myotest are extremely reliable and valid, as well as have certain differences when comparing results.

These measuring instruments for estimating the explosive power of the lower extremities are increasingly used in practice to determine the initial state of the subjects and have the most valid, reliable, and accurate information about the tested characteristics, which also facilitates the research approach. Through the insight and measurement of the contraction abilities of the muscles of the lower extremities, the measurement of the flight of the subjects as well as the acceleration of the center of gravity of the body, these measuring instruments are increasingly used.

The fitness industry is expanding, so diagnostics will be more accessible and applicable in the future, as we can see that there are more and more instruments that are affordable and practical in actual testing conditions.

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