MODERN TESTS AND TECHNOLOGIES FOR MEASURING THE MOTOR QUALITY AGILITY

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ABSTRACT
Measurement in sports is part of the athlete's or student's control. It is associated with obtaining data (results), usually represented by numerical values. In turn, agility is a complex motor quality; to obtain objective data for it, modern technical means should be utilized.
The current theoretical study aims to identify the most frequently used, highly informative tests for assessing motor quality "agility" over the past five years in the global SCOPUS and Web of Science databases. The scientific methods used are information research on the problem, document analysis, theoretical analysis, and synthesis. he results of the study establish that two main groups of tests are primarily used when measuring agility:
The first group relates to changing direction and speed, with examples being: the Illinois Agility Test, T-test, 505 test, Zig-zag test, and others.
The second group relates to reactive agility—the most popular are tests involving sudden decision-making. In this type of test, various photo or light contact sensors, sound transducers, monitors, and time gate systems are used and placed in a precisely defined manner.
In conclusion, the use of modern technologies assists in the more accurate measurement of the motor quality of agility. All this leads to a more objective assessment, which helps coaches or teachers optimize the training process.

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INTRODUCTION

One of the most significant challenges in contemporary sports training is controlling and optimizing sports preparation in highly qualified athletes (Dasheva, 2015) and determining the motor capacity of students from grades I to XII.

Measurement is an extremely important and necessary process for tracking the development of students in the context of physical education, or for the athlete in the context of high sports mastery.

Essentially, the control system in sports encompasses three subject areas: measurement, evaluation, and optimization. The main function of the measurement subsystem is to generate information about the current state of factors related to the athlete's sports performance. This information is necessary for planning training interventions (methods, means, volumes, durations, repetitions, intensity, etc.), i.e., for regulatory purposes. Without such information, regulation, and consequently management, it is impossible (Brogli, 2012).

Currently, there is no consensus among the sports science community on a clear definition of agility. Agility has classically been defined as the ability to change direction rapidly (Bloomfield et al., 1994; Clarke, 1959; Mathews, 1973), but also as the ability to change direction rapidly and accurately (Barrow & McGee, 1971; Johnson & Nelson, 1969). In more recent publications, some authors have defined agility to include whole-body changes of direction, as well as rapid movement and direction changes of limbs (Baechle, 1994; Draper & Lancaster, 1985). Another viewpoint, presented by Zhelyazkov et al., defines agility as the body's ability to coordinate individual movements and actions in terms of time, space, and effort, adequately responding to the motor task (Zhelyazkov et al., 2020).

Everything said so far gives us reason to believe that agility is a complex motor quality. To obtain more objective data, modern technical means should be used for its measurement.

In sports games, combined exercises have been created to measure agility, where the indicator is the time taken to perform the entire complex. However, the precision of execution is not measured here, which introduces some error into the overall test assessment (Bachev, 2017).

Young, James, and Montgomery (2002) outlined a comprehensive definition of agility as it relates to running sports such as football codes. The researchers addressed the multifaceted influences involved in agility performance. In particular, the authors outlined that there are two main components of agility: change of direction, speed, and perceptual and decision-making factors (Young et al., 2002).
All of this gives us reason to state that we have two main groups of tests that can be used to monitor the motor quality of agility: Change of Direction Speed (CODS) and Reactive Agility Tests (RATs).
Over time, the applied examples and theoretical generalizations that have been formed logically have become enriched and evolved, which has determined the content of the current study (Zlatev & Bachev, 2019).

Aim and Objectives
The current theoretical study aims to identify the most frequently used, highly informative tests for assessing motor quality "agility" over the past five years in the global SCOPUS and Web of Science databases.

Objectives:
1. To research information sources on the problem related to the measurement of the motor quality of agility.
2. To present the most popular and highly informative tests from the Change of Direction Speed (CODS) group.
3. To present the most popular and highly informative tests from the Reactive Agility Tests (RATs) group.

METHODOLOGY
The scientific methods used are: literature review on the problem, document analysis, prediction, theoretical analysis, and synthesis.
Literature review plays a key role in the in-depth consideration of a given problem. In our article, we consider the problem of controlling the motor quality of agility. When we talk about motor qualities, the best approach to control is through highly informative tests that meet the criteria of informativeness, reliability, validity, standardization, and objectivity.

Data search criteria
An electronic data search was used, utilizing the Web of Science and Scopus databases, to collect systematic literature on tests for changing direction and speed and tests for reactive agility.
The words we used to search the indicated databases in our research are: reliability and validity of the motor quality of agility. The criteria for selecting articles were that they were in English and not older than 2020.

Extraction of data
A preliminary electronic search on the Web of Science and Scopus databases resulted in 227 articles. The articles focusing on sports problems from 2020 to the present, including the reliability and validity of agility tests, number 120, of which 119 are in English. Based on the processed results, we identified the most popular agility tests from 2020 to 2025. The obtained data are presented in the results section in Tables 1 and 2.

RESULTS
Based on the studied information sources, we have established that two main groups of tests are primarily used in sports practice to assess the motor quality of agility: CODS and RATs. This is confirmed by the study by Young et al. (2002)—"Is muscle power related to running speed with changes of direction?"—and further developed in 2006 by Sheppard and Young, in the article "Agility Literature Review: Classifications, Training and Testing." In it, the authors describe in detail that agility is considered in two main directions and the tests for its measurement are focused on: Change of direction speed (CODS) and Reactive agility tests (RATs).
Table 1 presents some of the most popular and highly informative tests from the Change of Direction Speed (CODS) group, published between 2020 and 2025, as identified in the Web of Science and Scopus databases.

Table 1. *Most frequently cited or applied agility tests related to the assessment of the reliability and validity of motor agility in the 2020–2025 period (Change of Direction Speed – CODS group)*

№	Name of the Test and Author(s)	Number of Articles (2020–2025)
1	***T*-Test** – Semenick (1990)	35
2	**Illinois Agility Test** – Cureton (1951)	18
3	**505 Agility Test** – Draper & Lancaster (1985)	8
4	**Hexagon Agility Test** – Arnot (1984)	6
5	**Pro-Agility Test** – Harmann et al. (2008)	5
6	**L-Run (Schematic Illustration)** – Webb & Lander (1983)	4
7	**Southeast Missouri (SEMO) Agility Test / Zig-Zag Test** – Kirby (1971)	3
8	**Arrowhead Agility Drill** – Rago et al. (2020)	3

Table 1 presents the most frequently used agility tests from the CODS group. The specified tests, a total of 82 in number, are reliable and valid. They are widely used in sports practice. The first reason for this is that no specialized equipment is required; cones, a tape measure, a chronometer, or a timing system are typically used. They also take little time to conduct - no more than 30 seconds. Based on the literature studied, these tests can be used to control the motor quality of agility in football, volleyball, basketball, boxing and kickboxing, squash, tennis, etc. Everything said so far gives us reason to believe that the specified tests are the most effective ones used in the last 5 years.

The other group of tests for controlling motor quality agility is from the RATS group. They use modern technology and are used mostly in professional sports. Some of the most used tests in the period 2020-2025 in the databases from Web of Science and Scopus are presented in Table 2.

Table 2. *Most frequently cited or applied reactive agility tests related to the assessment of the reliability and validity of motor agility in the 2020–2025 period (Reactive Agility Tests – RATs group)*

№	Name of the Test and Author(s)	Number of Articles (2020–2025)
1	**LIRAT (Light Stimulus Reactive Agility Test)** – Lockie et al. (2014); Spasić et al. (2015); Rauter et al. (2018); Pojskic et al. (2018)	8
2	**LRAT (Live Tester Reactive Agility Test)** – Sheppard et al. (2006)	3
3	**VRAT (Video Stimulus Reactive Agility Test)** – Henry et al. (2013)	2
4	**LSRAT (Life-Size Stimulus Reactive Agility Test)** – Trecroci et al. (2019)	1

In the first case, in the LIRAT tests, the authors presented in Table 2 show different arrangements and positioning of measurement systems using the same equipment.

In the databases from Web of Science and Scopus for the past 5 years, 14 scientific articles are related to reactive agility tests. The mentioned articles present the criteria for the informativeness of the tests, the necessary equipment for the implementation of the test, as well as the sports in which the study was conducted. In the RATs group, various equipment sets are used - time measuring systems, cameras, light or sound sensors, which are associated with making a sudden decision. These systems are significantly more expensive in comparison with the necessary equipment for the tests from the CODS group, which is why they are used mainly in elite sports.

Unlike CODS tests, which can only measure overall recorded time, some RATs can also measure decision-making/reaction time and movement time. Movement time is defined as the total time required to complete a test, which is the time taken from when the tester initiates the test and starts timing, until the participant triggers the timing beam on both sides of the tester (Gabbett & Benton, 2009). Decision/response time, on the other hand, is defined as the time it takes for an athlete to react and make a decision to run either to the left or right in response to a stimulus (Clark et al., 2010).

DISCUSSION

Based on the results obtained and the studied information sources, it is reasonably concluded that tests for assessing the motor quality of agility are divided into two groups: CODS (Change of Direction Speed) and RATs (Reactive Agility Tests).

CODS tests have found wider application in school physical education and youth sports. The reason for this is that they do not require specialized and expensive equipment; often, stopwatches are used to measure time. Less frequently in physical education and young sport, one might observe the use of a timing gate system, which allows for more accurate and objective time measurement. Tests of this type are used in various test batteries, such as Eurofit or Alphafit.

In professional sports, CODS tests are less frequently used, while RATs are significantly more implemented. The number of reactive agility tests used in scientific research has increased considerably over the last five years. There are many reasons for this: new technologies provide a wealth of information; many parameters can be measured as a function of time, easily saved, and exported. All of this allows for a tremendous amount of analysis by coaches. Not least important is the accuracy of measurement and the fact that some RATs can measure not only the test execution time but also the reaction time.

A number of scientific studies confirm that RATs can differentiate between an athlete's skill level—professional, semi-professional, or amateur. Once again, highly skilled players performed much better in RAT, which may be attributed to their excellent response movement ability. It is worth noting from the study that highly skilled athletes (elites) demonstrated better reaction time than moderately skilled athletes (sub-elites) and less skilled athletes (amateurs) due to their ability to predict the direction of movement expected by their opponents, and the ability to predict their change of direction to complete the sprint part of the test at a faster speed (Nor Saafri et al., 2024).

Nor Saafri et al. (2024) present a hierarchy of agility testing instruments, as shown in Figure 1.

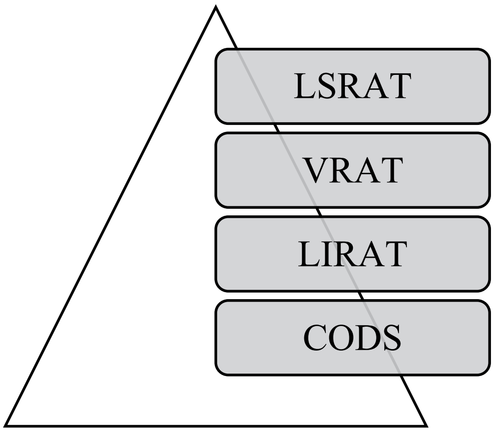

Figure 1. *Hierarchy of agility testing instruments*

From Figure 1, it is clear that the basis for the control of the motor quality of agility are the tests from the CODS group. The reason for this is that the fundamental components of agility are placed here - acceleration, braking, sharp change of direction, moving forward, backward, sideways. All this is related to the development of agility. After acquiring the basic components of agility, one moves on to a higher level - tests from the RATs group. According to the components used, only light or sound sensors can be employed. Time measurement systems can also be added, as well as video cameras and specialized monitors, which are essential for making an informed decision, as projected. These equipment sets are presented as LIRAT, VRAT, and LSRAT. Here, it is already important to note that the athlete must make a decision as quickly and adequately as possible, that is, respond to some unknown stimulus.

CONCLUSION

For controlling the motor quality of agility, the best approach is motor tests. They should be highly informative and easy to apply. After researching literary sources from the world's databases, including Web of Science and Scopus, it was found that two types of tests are primarily used to control agility: tests related to changing direction and tests related to reactive agility. The tests from the CODS group are used mainly in physical education and youth sports. The tests from the RATs group are primarily used in professional sports to assess the skills of athletes, whether professional, semi-professional, or amateur. The use of modern technologies helps in the more accurate measurement of motor quality and agility. All this leads to a more objective assessment, which helps coaches or teachers optimize the training process.

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