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Original Research

Validity and Reliability of "Chaboki Afza" Researcher made Instrument

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ABSTRACT

Considering the need of most sports skills to perform fast actions, change of direction at an appropriate time, and necessity utilization of suitable agility tests for assessment, the purpose of this study was to determine the validity and reliability of the "Chaboki Afza" researcher-made device. In this experimental research, the model of the study was validation and reliability, and classified in applied research type. Following the design and construction of the agility booster device, for its validity and reliability, 10 young healthy volunteering to participate in this study. All tests were executed in the same conditions on both T and Illinois tests instruments and reference tests, by two examiners. To evaluate the validity of the researcher-made device, independent *t*-test was applied on the data recorded from the device-related test and the recorded data from the functional tests. Furthermore, to evaluate the reliability of instrument, the Inter-Intra Class Correlations (ICC) were used. Research results showed a significant correlation coefficient between the device test in all three replicates of the device and the Illinois field test (r = 0.66). While there was no significant correlation between T-test and the proposed instrument's tests (r = 0.23). The achieved results confirmed acceptable reliability of tests (within the examiner for consecutive repetitions of 0.93, 0.72 and 0.69, respectively and between the examiners 0.96) for Inter-Intra Class Correlation in these research measurements. Due to the results, Chaboki Afza can be recommended as an alternative or complementary device for evaluating agility field tests.

Keywords: Validity, Reliability, Agility

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INTRODUCTION

One of the important variables in the field of sports science is "agility" and its related concepts, that according to the different definitions of these concepts, so far, many performance exercises and tests have been used to evaluate and its effect on performance improvement in this field. Agility, on one hand, is not separate from the ability to explosive start, speed reduction, change direction and accelerating again while maintaining body control and minimal deceleration, and on the other hand, includes the ability to coordinate several professional sport tasks at the same time (1). In fact, agility involves "important neural adaptations" that are achieved over time and with great repetition. It seems that several factors effect agility and its related parameters, and it is prominent know them in measuring and how to use consistent exercises. However, in some ways, abilities related speed, agility, quickness, and accelerated performance are related to hereditary factors (1, 2). In recent years, the idea that these abilities are trainable has been confirmed. At the same time, it has been claimed that change of directions and agile reactions are developed through appropriate exercise (2). Numerous factors related to "perception and decision making" also affect the player's ability to react or speed, which ultimately affects agility (3).

Agility, the ability to change speed or direction quickly, is one of the most important factors for success in sports situations and is considered as one of the important characteristics of professional athletes (4, 5). In the literary background, two types of agility have been discussed: planned agility and reaction agility. Planned agility involves a path that requires physical action to change direction, and the person in question is already aware of this path and follows a predetermined path. Reactive and unplanned agility has a cognitive component (using the ability to recognize and react to external stimuli) (6). Reactive agility does not have a predetermined path and changes in a path are revealed. Often in the literary background of agility exercises, the time index in an agility path has been used as a measurement tool.

Spasik et al. used performance time to construct a perceptual-reactive capacity index (ratio of reactive path completion time divided by planned path completion time) (7). Some studies have analyzed the mechanics of motion when reacting to a stimulus to reduce directional changes (8, 9, 10). In order to understand biomechanical measurements that may be able to differentiate between planned and reactive agility performance, other studies sought to define biomechanical measurements to examine the ability of athletes and soldiers to change course in high-speed performance conditions (11, 12, 13).

The other method for the biomechanical quantification of human movements is the Inertial Measurement Unit (IMU), which extends the exercises and the environment under evaluation. IMUs are especially useful for assessing agility in open environments such as military training and field sports. An IMU limitation is the possibility of drift error due to the integration of raw acceleration or angular velocity's values over time. To solve this problem, accelerometer data can be combined with speed data in Coleman filters (14). McGinnis et al. performed a sacrum kinematic evaluation of the slalom track based on the IMU (15). The findings of these studies emphasize possible differences in planned and responsive agility exercises. These studies also provide the possibility of defining new kinematic measurements for agility performance and a range of measurement tools.

Today, several field tests such as T-test, Illinois-test, 505- test and (9*4)-test are used to evaluate agility and quickness, each of which faces limitations in measurement. First, there is a functional difference between the characteristics of speed and agility (16); therefore, tests involving the sprint section alone cannot measure agility and achieve high final speeds in these tracks, so invalidate their results for measuring agility (17). The second and most important factor is the number of changes of direction, or in other words, the reduction of acceleration and re-acceleration in the new direction, which is also limited in field tests, and it is better that according to specific sporting situations, tests for this purpose should be designed. Thus, the tests that have more of directional changes have completely different results than the tests with long path and no directional change (18). In this type of test, the subject usually has to respond to factors such as stimulus voice, light, and practically anything that simulates the actions of other players or special sport conditions which require a good view and knowledge of the environment, attention and necessary concentration. Finally, fast cognitive processing and timely and appropriate decision making, which is improved by mental exercises perhaps be one of the most effective factors in differentiating between professional athletes. Therefore, in the last decade, most experienced coaches and athletes have turned to agility and quickness exercises and use improved tests to measure (19). Although the measurement of the above factors requires more advanced equipment similar to conventional field tests, experts prefer to analyze the timing of the various components of the test to obtain more accurate information about the strengths and weaknesses of players than appropriate training, prescribe compensation for them. The change in the measurement of agility in the last decade indicates a change in the principles desired by experts (4). On the other hand, the factor of agility and quickness has been considered as an important factor more seriously (2).

The issue of how the difference between agility and quickness characteristics is better shown in individuals has led to the use of new tests in this area. In the meantime, the use of modern technologies makes it possible to examine the moving components more accurately with higher accuracy, and by collecting data related to the scheduling of moving components, post-test measurements can also be performed. By reviewing the theoretical foundations and changes in attitudes towards the concept of agility of the proposed tests, and identifying weaknesses and ambiguities, the purpose of this study is to investigate the possibility of measuring agility using a researcher-made device so that it can be used as a practical tool in sports science and cognitive mobility research to evaluate the degree of agility and associated micro factors. This device can accurately check the timing of moving components by recording the time of the person at a specific point or the time of movement on different points. Due to the importance of using a suitable measurement tool for various variables, including agility in evaluations and by reflecting on concepts and using technical knowledge, in this study, the validity and reliability of the researcher-made device "Chaboki Afza", was studied and evaluated as an alternative tool to existing methods.

TECHNICAL AND EXPERIMENTAL INFORMATION

In the past, several functional tests have been used to assess agility. Due to the field and limited measurement of concepts related to agility in these tests, the researcher-made device "Chaboki Afza" has been designed and built so that in addition to the possibility of measuring agility in the laboratories, it can be used as a practical tool according to the needs of people in different sports environments and even home use. This research was performed as an experimental research with the aim of validation and reliability of a researcher-made device for measuring agility. The research model is validation and reliability, and its type is applied. The statistical population and the statistical sample of the present study include the types of agility performance tests and in order to evaluate and compare the researcher-made device (validity and reliability), T-test and Illinois tests are used, so the device as an independent variable and different functional agility tests are considered as dependent variables. The instruments used in this study include a stopwatch and a researcher-made "Chaboki Afza" device. The stopwatch used has a high sensitivity that can measure time with an accuracy of one percent of the second. This device is used to record time in functional tests (T-test and Illinois test).

A. Design and manufacture of researcher-made device

The researcher-made device is a device with several sensitive points to the athlete's force, has a video feedback page and audio stimulus in which the motion protocol for evaluation by the examiner is defined through the main computer and executed by the athlete and the device. The researcher-made device consists of a plate with dimensions of about 1 x 1 meter and a weight of approximately 10 kg, peripheral sensors which apart 45 centimeters from the central one, plus an electronic hardware part and a software part (Figure 1). In general, the device is portable, which can record the movement times between the components on its responsive screen, and it can be used to estimate the timing of different parts of the execution of the movement pattern. For this purpose, ones are asked to perform a certain number of movements according to a specific pattern on the sensitive plate of the device. In this case, the location of the person's foot is shown in the system screen, and its time is recorded in the system.

The use of this device is very simple, because first the sensitive plate of the device is placed on the ground in the desired environment, and the necessary connections are established between the components (sensitive plate and computer) (hardware). Next, one should set up the device by turning on the computer (software). After booting the system and running the software related to the device and setting (by the instructor or therapist) the device will be ready to act; and using the start and stop button at the required time, it is possible to activate or deactivate the system. This device is designed and built with five force-sensitive points to evaluate and follow the desired protocol.

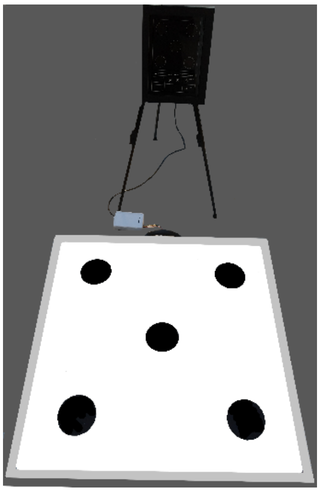

Figure 1. Chaboki Afza Instrument.

The device detects the presence or absence of force in sensitive areas through a plate with pressure-sensitive sensors and sends the presence or absence of a person through the interface circuits for proper processing and feedback and registration to the CPU. For used device, this section included a personal computer, in which received data is stored and evaluated. For the display part, a computer monitor was used, which, while depict the desired information, was also used to apply visual feedback. The MATLAB Graphical User Interface (GUI) has been used to facilitate the communication, storage, and operation of the required data and operation of the device (Figure 2).

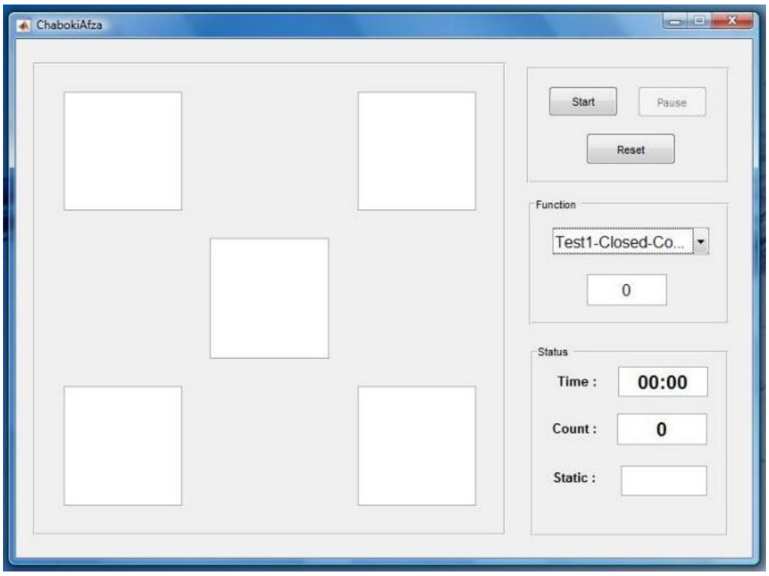

Figure 2. Graphical user interface on a researcher-made device.

B. Data collection

Ten subjects to perform studies related to the validity and reliability of the study, voluntarily with an average age of 15.4 years, mean weight of 54 kg, average height of 167 cm (Table1), without any affective diseases (injury and any history of lower limb surgery, Pain and swelling in the ankle and knee joints and having hearing and balance problems) participated in the studied variables. First, the purpose of using the device and how to perform the tests were explained to the subjects. A demographic information questionnaire, including information (height, weight, age, gender, sports history) and consent to participate in the test was used.

Table1. Description of demographic variables.

	Mean	Standard Deviation
Hight(centimeter)	166.4	13.97
Weight(kilogeram)	54.19	16.62
Age(year)	16.7	7.9

Subjects were asked to warm up 10 minutes (including soft running and light stretching) to prepare for the test while reducing the likelihood of injury. After announcing the readiness of the subject for each type of tests, a total of one test with each device and one of the field tests were performed. The tests were performed by two examiners in six days and at the same hours. The first examiner measured three types of tests on the first day of the subjects. On the second and third day, the identical tests of the first day were repeated at the same time. The other examiner was asked to repeat the same tests once on the fourth day and repeat them on the fifth and sixth days for all subjects without knowing the results of the primary examiner. The time was measured and after the completion of each test, the required time and information were recorded.

For each type of field test, the path was determined and the time spent by the subject was recorded for him. In the design tests for the device, the subject moved according to the required pattern and the number of movements of the person in a specific time was recorded for him. Each test was repeated for three times, and the average of repeated steps was used to perform statistical calculations. At least three minutes of rest time was provided between the two attempts, and likewise; five minutes of rest time was considered between the two types of tests. At the end of the tests, they were asked to maintain the necessary preparation for future tests by proper cooling (recovery phase).

The tests used in this study included T test, Illinois and a device test. To test the device, since the exact location of the subjects' feet was indicated on the researcher - made device, the subjects placed their feet completely on the designated areas during the tests. The minimum test time, the main variable for the study and comparison in this study, was calculated. The following continuous pattern (Figure 3) was selected for evaluation by the device, and its steps were repeated:

1- Front (1), middle (3), side (neutral position) with right foot
2- Back (4), middle (3), side (neutral position) with right foot
3- Front (2), middle (3), side (neutral position) with left foot
4- Back, (5) middle (3), side (neutral position) with left foot

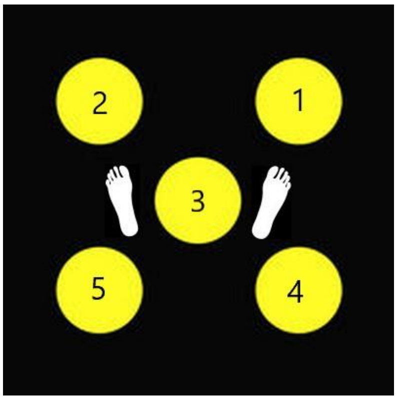

Figure 3. Movement pattern in device test.

In this assessment, feet are placed in the initial position (two feet at a distance of about 10 cm on both sides of the middle sensor). Since the start time of data collection and timing in the device is announced to the subject by the beep; after the stages and the end of the test is announced to the subject by the beep sound as well, the examiner's involvement in the measurement is minimized. The test designed with the "Chaboki Afza" device consisted of 45 movements according to a special pattern with maximum speed on the predetermined points on the sensitive plate of the device, the result of which can be seen simultaneously on the screen of the device.

T-test and Illinois field tests were performed according to the validated patterns of the subjects. The T-test, which is so named because of its path shape, requires four changes of direction. The athlete moves forward from the starting line 10 meters, then moves five meters sideways to the conical barrier to the left of the central conical barrier, next moves ten meters sideways to the right of the central conical barrier, once the other moves from the right conical barrier to the central conical barrier and later backwards towards the starting line (Figure 4.a). The Illinois Agility Test is also a time-consuming exercise that involves running a spiral between four conical obstacles (Figure 4. b).

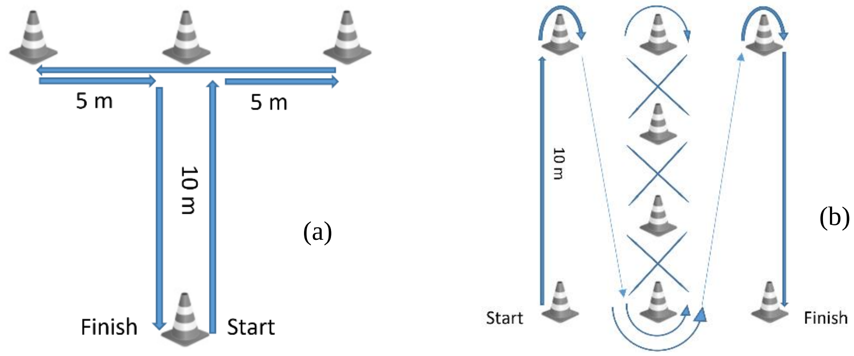

Figure 4. Planned agility routes: a. T-test, b. Illinois Agility Test.

In this study, due to the continuous supervision of the examiner on the test process, the accuracy of the measured data was easily checked. In addition, due to the nature of the variable being measured (time), there is no need to filter and normalize the data. And the results could be used directly for statistical analysis.

In order to check the validity of the device, the collected data were compared and analyzed using t-test. Furthermore, the internal consistency coefficient (ICC) was used to check the reliability, so that the data of the primary examiner for three consecutive days were used to check the reproducibility (reliability within the examiner), and the data of the first and second examiner were compared to check the reliability between the examiners. All statistical analyzes were analyzed by SPSS 22 software.

RESULTS

To check the reliability and validity of the device, various tests were taken several times from all subjects through comparing different tests as follows. The tests were performed in six days. Each subject participated in three types of tests per day, of which two types of tests were conducted in the field and one type using the device, and with three repetitions, nine tests per day were taken from the subjects. In order to analyze the data, in addition to providing statistical indicators such as mean and standard deviation (Table2), Kolmogorov-Smirnov test was used to check the normality of data distribution, ICC correlation test and t-test. Based on the collected information, the mean time of T-test and device test were close to each other. However, the coefficient of variation for the device test was higher, indicating better segregation between individuals.

Table2. Mean and standard deviation of variable time of T-test, Illinois and device test in seconds.

Test	Mean(s)	Standard Deviation(s)	Maximum(s)	Minimum(s)
T test	12.39	0.76	13.32	11.11

Illinoise	19.03	1.52	21.91	17.45
Device test	9.65	1.91	14.45	7.17

Based on the results of Kolmogorov-Smirnov test (Table3), it can be said with 95% confidence that all variables have a normal distribution and the data for all variables are at the level of 0.05 normal (significance level is greater than 0.05). Therefore, parametric statistical tests were used for statistical analysis.

Table3. One-Sample Kolmogorov-Smirnov Test

		T_mean	Ilinoise_mean	Device_mean
N		10	10	10
Normal Parameters	Mean	13.2570	19.8130	9.7300
	Std. Deviation	2.27563	2.45414	1.72254
Most Extreme Differences	Absolute	.280	.197	.184
	Positive	.280	.197	.184
	Negative	-.173	-.168	-.136
Test Statistic		.280	.197	.184
Asymp. Sig. (2-tailed)		.025	.020	.020

In evaluating the validity of the agility device, there was a significant correlation between the tests performed (T-test, Illinois test, device test) at the level ($\alpha = 0.05$) between the T-test and Illinois, as well as between the Illinois test and the researcher-made device test (Table4), while the results of statistical test showed a low correlation between T-test and device test.

Table4. Correlation coefficient between tests performed (T-test, Illinois and device test)

Pair	Correlation coefficient	Significance level
T test and Illinoise	0.73	0.015
T test and Device test	0.23	0.517
Illinoise and Device test	0.66	0.036

The reliability of the device was evaluated in two parts: the reliability of the agility measurement and the agreement between the measurements using the ICC test. For the device test, the ICC value between the first and second examiner was 0.96 and the ICC value for consecutive repetitions was 0.93, 0.72 and 0.69 for the first examiner and 0.75, 0.37 and 0.55 for the second examiner, respectively (Tables 5 and6). To evaluate the reliability within the examiner, the results confirm the high reliability of the tests performed within the examiners. According to the results of the research, it can be stated that the internal reliability of the subject is acceptable for testing the device. Regarding the reliability of the device test between two examiners using ICC statistical method, the results also confirm the reliability between the two examiners.

Table5. Correlation test results and agreement within the tester for device testing

	Examiner 1 Test 1	Examiner 1 Test 2	Examiner 1 Test 3	Examiner 2 Test 1	Examiner 2 Test 2	Examiner 2 Test 3
Examiner 1 Test 1	1	0.93	0.72	0.64	0.72	0.58
Examiner 1 Test 2		1	0.69	0.75	0.78	0.46
Examiner 1 Test 3			1	0.61	0.67	0.84
Examiner 2 Test 1				1	0.75	0.37
Examiner 2 Test 2					1	0.55

Examiner 2 Test 3	1

Table6. Agreement between the tester to test the device

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	0.73	0.53	0.90	25.85	9	72	0.000
Average Measures	0.96	0.91	0.98	25.85	9	72	0.000

DISCUSSION

Following the design and construction of the agility device, the aim of this study was to evaluate validity and reliability of researcher-made device. Most common tests for measuring agility are based on walking a certain distance at the maximum speed. The path of this movement has several path changes and is usually completely pre-designed, which also requires a large space to perform. On the other hand, changes in the definitions and concepts of agility in the last decade have led coaches and exercise designers to design and use tests that resemble real-world situations in the sport in question. Therefore, the idea of designing and manufacturing a suitable tool for various agility tests with the listed features was considered.

One of the unique features of the “Chaboki Afza” is the possibility of designing various agility tests that are required for different sports activities in the laboratory and in sports fields. The possibility of designing new agility tests allows coaches to assess effectively the conditions and abilities of players and allows this device to be used as a laboratory set to evaluate a variety of field tests. It also can be used to find talent in various sports. At the same time, with the designed device, it is possible to measure the change of direction in different directions. Portability, the need for less space, reduction and, in other words, elimination of the human factor in the measurement, the ability to use tools indoors and outdoors, being domestic, availability of post-production services, its construction price compared to similar equipment can be mentioned as other merits of this device.

The statistical results showed a high correlation between T-test and Illinois test, which can be an explanation for the claim that these two tests, despite the difference in implementation stages, evaluate the same characteristics. The low correlation value of T-test with the test of the studied device indicates the difference in the measured characteristics. Nevertheless, the good correlation between the Illinois test and the device test is the reason for some of the commonalities measured in these two tests.

On the other hand, the number of changes of direction is also important. The number of directional changes in field tests is limited and, in the Illinois, test this accelerated change of directions is more than the T-test. Therefore, a good correlation can be attributed to the device test and the Illinois test.

In evaluating the validity of the device, the measurement of the results obtained from the device was compared with the results of two common agility tests (a field called T-test and Illinois). The results obtained from different tests show that the components of these tests have a high effect on the results. The T-test consists of a straight path to high speed and only a few changes of directions, while the Illinois test, in addition to direct paths to acceleration and high speed, has several paths to change successive directions, and finally the test designed for device only has consistent changes of direction and does not have any fast running during the test. Comparing the T-test and Illinois test, due to their unique characteristics, the results showed that these two tests evaluate the same characteristics, which from this perspective of one of the two tests depending on the conditions. Environment can be used for what its designers claim (agility measurement). In reviewing the research background, the results of previous researchers also confirmed the correlation between the results of T-test and Illinois (19, 20 and 21), while the results of these two tests in comparison with the results obtained from the device mentioned in this study showed that in T-test which the number of changes of direction was very limited, but the results of the Illinois test showed a significant correlation (0.66) with the device test, which was a non-feedback but a more directional change test.

In evaluating the reliability of the researcher-made device, it was considered from two dimensions, within the examiner and between the examiners, using the internal consistency coefficient (ICC) method. The data of the first examiner for three consecutive days were used to check the reproducibility (reliability within the

examiner) and high values were obtained for the repetitive measurements of the primary examiner. The comparison of the data of the first and second examiner was also used to evaluate the reliability between the examiners, which showed a high correlation (0.96) between the results of the two examiners. The reason for the high reliability results among examiners for the test can be related to the non-interference of the examiners in the test. Devices similar to the researcher-made device that has time-series data output, allow researchers to obtain more details of a person's movements after the test time. On the other hand, accurate measurement of the desired parameters without human intervention reduces the incidence of error and ultimately increases the validity of the measurement.
Timing of distinct parts of the movement of persons through this device is less expensive compared to conventional video equipment, and it can be synchronized another equipment such as electromyography or accelerometers, so it can be a good alternative to overpriced equipment, considered photography. The various arrangements of the sensors also make it possible to use this device to measure or practice different skills in different sports. In addition, the possibility of analyzing the various components of the movement on this device, makes it a suitable tool for rehabilitation and measuring corrective movements. Since it is possible to connect different type of sensors such as piezo, resistance and infrared in the present device, it is possible to detect the beginning and end of movements or the distance between two movements as well. Furthermore, the number of sensors is not limited, so it is potential to measure in three-dimensional space and in unlike directions. Therefore, it is possible to design new tests related to agility.

CONCLUSION

According to the results of this study, which showed the acceptable validity and reliability of the researcher-made device for assessing agility, it can be used because of its capabilities for different tests taken by similar devices and Can be recommended as an alternative and more practical device for evaluating various types of agility field tests.

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چکیده فارسی

اعتبار و پایایی سنجی دستگاه محقق ساخته "چابکی افزا"

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با توجه به نیاز اغلب مهارتهای ورزشی به انجام حرکات سریع، تغییر جهت در زمان مناسب ، و ضرورت بهره گیری از آزمونی مناسب برای ارزیابی، هدف این پژوهش اعتبارو پایایی سنجی دستگاه محقق ساخته "چابکی افزا" بود. در این پژوهش آزمایشگاهی، مدل تحقیق، اعتباریابی و پایایی سنجی و نوع آن کاربردی بود. متعاقب طراحی و ساخت دستگاه "چابکی افزا"، برای اعتبار و پایایی آن، ۱۰ فرد سالم جوان داوطلب شرکت در تحقیق، به عنوان آزمودنی استفاده شد. آزمون‌ها در شرایط یکسان روی دستگاه محقق ساخته و آزمون‌های مرجع(ایلیونز و تی) توسط دو آزمونگرانجام شد. برای بررسی اعتبار دستگاه محقق ساخته، اطلاعات ثبت شده از آزمون مربوط به دستگاه با اطلاعات ثبت شده از آزمون‌های عملکردی، از تست تی مستقل، و به منظور بررسی پایایی دستگاه از ضریب همسانی درونی (ICC) استفاده شد. نتایج تحقیق، ضریب همبستگی معناداری بین آزمون دستگاه در هر سه تکراربین دستگاه محقق ساخته و آزمون میدانی ایلینویز (R=0.66) را نشان داد، در حالی که این ارتباط بین آزمون تی و آزمون با دستگاه چابکی افزا را نشان نداد(R=0.23). نتایج بدست آمده موید پایایی قابل قبول (درون آزمونگر برای تکرارهای پشت سر هم نیز به ترتیب ۰,۹۳، ۰,۷۲ و ۰,۶۹ و بین آزمونگر ۰,۹۶) آزمون های درون و بین آزمونگر آزمونگر در آزمون های انجام شده با دستگاه چابکی افزا بود. با توجه به نتایج تحقیق، "چابکی افزا" می‌تواند به عنوان دستگاهی جایگزین و یا تکمیل کننده، برای ارزیابی آزمون‌های میدانی چابکی توصیه گردد.

واژه‌های کلیدی: اعتباریابی، پایایی‌سنجی، چابکی.