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ARISTO FUNCTIONAL BATTERY IN RHYTHMIC GYMNASTICS (AFBRG): RELIABILITY AND APPLICABILITY IN BASIC LEVEL GYMNAST CHILD

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ABSTRACT

Objective: To determine the test-retest reliability of the tests that make up the battery as well as to determine their normative values.

Method: 56 basic level rhythmic gymnasts between 7 and 11 years old participated. To identify the reliability of the ten battery tests (two of them bilateral), two evaluations were performed in each test. After one week the tests were carried out again to evaluate the test-retest reliability. The Intraclass Correlation Coefficient (ICC) was used for test- retest reliability. The discriminatory capacity of the tests, according to the different categories, was estimated using an ANOVA. If the assumptions of normality and homoscedasticity were not met, the Bland and Altman method was chosen to estimate reliability and the Mann Whitney U statistic for the discriminatory analysis between categories.

Results: The inter-rater reliability is high, presenting values higher than 0.95 in all tests except in the "stride" in relation to the "jump height". The ICC obtained indicated very good reproducibility (> 0.75) in the tests "Front-back splits to the right", "Front right and left leg raise and hold", and "Stride (dynamic flexibility)". Likewise, the presence of concordance between the records was presumed through the Bland and Altman method, in the tests "Throwing the ball and turning forward", "Front back splits to the left", "Bridge" and "Shoulder flexibility".

Conclusions: the final BFAGR battery consisting of six tests for the assessment of specific physical condition is reliable and applicable for gymnasts of these ages.

KEY WORDS

evaluation, child, rhythmic gymnastics, physical fitness.

INTRODUCTION

One of the main objectives of sports coaches is to find a simple, direct and scientifically accepted method of detection and selection of those young people who have the best qualities to become top-level athletes (1).

One of the main objectives of the ARISTO Project, of which this study forms part, has been to have a good programme for detecting young people with high sporting abilities by means of specific batteries, as well as to guarantee healthy sporting practice.

Rhythmic gymnastics is a sport with high physical and technical demands, which requires a high level of training (2). Therefore, it is a priority for gymnasts to have an optimal and healthy specific physical condition (FC) to cope with the requirements of a demanding sport.

Some authors highlight aerobic capacity, explosive strength, flexibility, balance, coordination and agility as the most important physical qualities of the sport (3,4). Vernetta et al. (5), indicate that it is a gymnastic sport with important physical demands involving explosive strength for the development of jumps, coordination, balance and agility for the development of throws and acrobatic skills and great flexibility throughout its execution.

Several studies talk about the importance of the gymnasts' CF for good results in competition (2,6). Therefore, it is important to know which qualities are inherent to this sport and which tests are used for their evaluation.

In the literature there are few specific tests that evaluate these physical qualities. Donti et al. (7) measured flexibility, strength, agility, balance and coordination in young gymnasts between 9 and 11 years of age, but they did not use a sport-specific test battery, but measured several general tests taken from various authors (8-10).

Therefore, due to the need for a standardised assessment of motor performance in RM, the International Gymnastics Federation (FIG) developed tests with body movements and technical elements of RM, to ensure a result close to the context of this sport (11). Similarly, there is now the FIG's developmental and high competition programme for GR age groups (12). However, many of the tests in these batteries are based on general

tests and most do not provide information on the reliability of the results recorded. As indicated by Batista et al. (13) the studies that have assessed some of the physical abilities in gymnasts are far from the reality of RM.

Therefore, this study addresses the last phase of the ARISTO project, which consists of the practical application and reliability of the Aristo Functional Battery in Rhythmic Gymnastics (BFAGR) designed for the evaluation of the specific CF of gymnasts in this discipline (5). The choice of the ten tests of this battery considered the specificity of the sport, taking into account the main characteristics of the sport (14).

The statistical procedure will allow us to show which tests are reliable and which are unreliable, thus establishing the definitive battery.

Hence, the objectives of this article were: a) to apply the battery to a representative sample to check the reliability of all its tests; and b) to obtain normative reference values for the different tests that make up the battery for the population practising this sport.

MATERIALS and METHODS

Participants

Fifty-six girls between 7 and 11 years of age from different clubs in Andalusia participated in GR at basic level. Table 1 shows the descriptive data of the sample. The inclusion criteria were: federated gymnasts between 7 and 11 years of age who regularly practised this sport. Gymnasts with any musculoskeletal pathology limiting their ability to perform the tests were excluded, as well as the lack of informed consent by the parent/legal guardian. All participated voluntarily, respecting the postulates of the Declaration of Helsinki 2013 according to the Organic Law on Data Protection with the approval of the Ethics Committee of the University of Granada number 723/CEIH/2018.

Table 1. Description of the sample. Mean (Standard deviation)

	Prebenjamin y Benjamin n = 26	Alevin n=30	Total N=56
Age (years)	8,27(,78)	10,53(,51)	9,48(1,31)
Body mass (kg)	27,23(5,26)	32,83 (5,69)	30,18(6,13)
Size (m)	1,30(,09)	1,41(,09)	1,36(,11)
BMI (Kg/m^2)	16,11(1,90)	16,34(1,49)	16,23(1,68)
Triceps Fold (mm)	7,62(2,83)	8,17(2,00)	7,91(2,42)

Subscapular Fold (mm)	10,27(2,29)	9,90(2,97)	10,07(2,65)
Waist Circumference (cm)	55,69(3,36)	57,33(3,02)	56,55(3,26)

BFAGR Test Battery

The BFAGR was designed and agreed by expert judgement with European Union members from three countries Bulgaria, Spain and Latvia. After discussion and consensus, a preliminary battery of ten tests was established to assess the following abilities: static balance, coordination, active shoulder girdle flexibility, passive, active and ballistic hip flexibility, dorsal trunk flexibility, abdominal and lumbar strength and jumping ability (5). The 10 tests can be seen in figure 1.

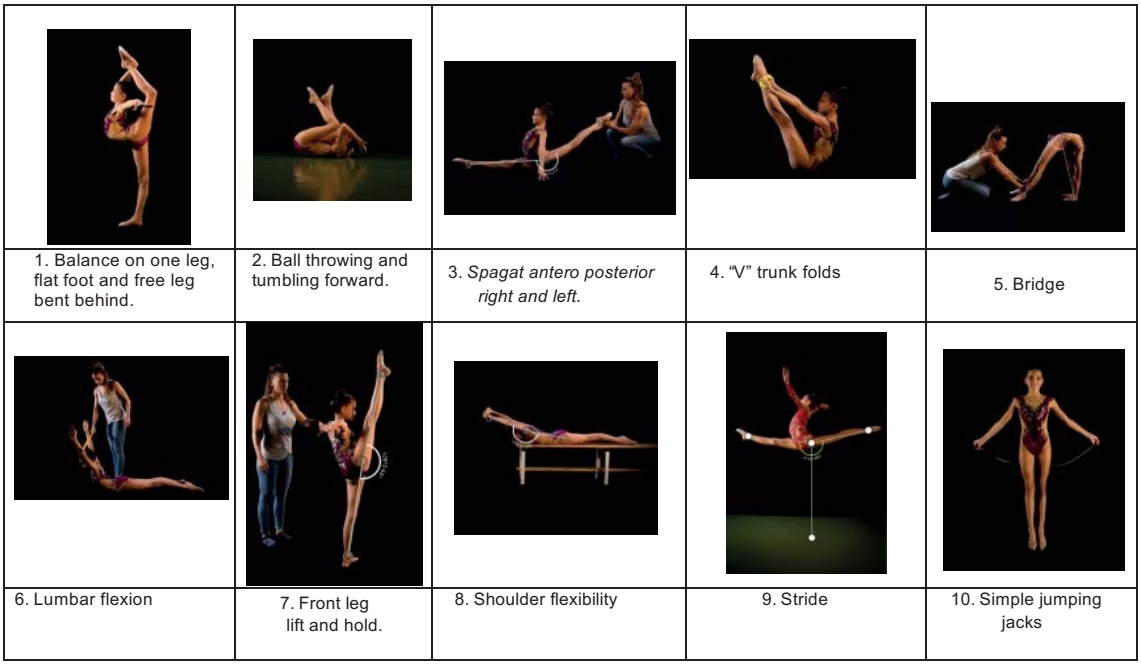

Figure 1. Preliminary field tests of the BFAGR

Procedure

Firstly, the cooperation of the FAG and the gymnasts' coaches and parents was requested, informing them of the objective of the study and the way in which the gymnasts would be measured. Subsequently, the research team travelled to the different provinces of Andalusia: Granada, Malaga, Seville and Huelva to carry out the measurements in the training rooms. Before the tests, the gymnasts performed their regular warm-up routine without taking into account the requirements of the BFAGR. Stations were set up for each of the tests and the gymnasts went through each station in groups (6-8 gymnasts) in the corresponding order of the tests described (fi gure 1). Before each test, the gymnasts received verbal instructions and video demonstrations of the test. A 5-10 minutes rest time was given between each of the tests and continuous motivation during the execution, respecting the recommendations applied to the gymnastic batteries (15, 16).

Statistical Analysis

Prior to the development of the inferential analysis, a descriptive analysis of the data relating to the different tests studied was carried out.

The analysis of inter-rater reliability between the two pre-test measures of raters 1 (pre-test E1) and 2 (pre-test E2), and the analysis of test-retest reliability (between the pre-test measure E1 and the retest), was calculated using the Intraclass Correlation Coefficient (ICC) statistic of absolute agreement, according to a random-effects model. For its calculation, the assumptions of homoscedasticity and normality were tested using the Levene and Shapiro-Wilk statistics respectively. The following values were considered for interpretation (Fleiss, 1986): low if CCI < 0.40; fair/good if CCI is between 0.41 and 0.75; very good if CCI > 0.75.

In the case of non-compliance with these assumptions, inter-rater reliability and test-retest reliability analysis was estimated using the method proposed by Bland and Altman (17). Given the absence in the literature of relevant reference limits of agreement for each of the tests analysed, the interval of 1.96 standard deviations (SD) around the mean of the differences was considered, thus including 95% of the observed differences.

Differences were considered statistically significant for p-values < ,05. Data analysis was performed with the Statistical Package for the Social Sciences (SPSS) for Windows® (version 25.0; SPSS Inc. Chicago, USA).

RESULTS

Table 2 shows the descriptive analysis of the values of the different tests carried out, recorded by the two assessors (Pre-test measures E1 and E2) and in the Retest measure.

Table 2. Descriptive analysis of Pre-test (Evaluators 1 and 2) and Retest measures for each of the tests carried out. Basic level

TESTS	Pre-test (E1)		Pre-test (E2)		Retest	
	N	Mean	N	Mean	N	Mean
Balance with back leg catch - Flat feet	53	21,92(14,42)	53	21,85(14,35)	42	26,13(15,99)
Ball throwing and tumbling forward.	32	46,94(13,96)	32	46,91(13,94)	25	45,76(12,48)
Spagat anteroposterior to right.	50	192,30 (13,49)	50	192,42(13,23)	50	191,36 (14,73)
Spagat anteroposterior to left.	50	183,50 (12,87)	50	183,46 (12,78)	50	182,67(12,48)
"V" trunk fold (30s)	51	14,67 (4,19)	51	14,65(4,13)	27	18,33(3,81)
Bridge (back angle)	51	60,82(8,76)	51	60,75 (8,65)	51	61,20(8,66)
Lumbar flexions 45º. (20s)	51	22,67(4,83)	51	22,57(4,77)	35	21,66(4,62)
Front right leg lift and hold	51	134,04(21,31)	51	134,18(21,05)	51	135,48(20,50)
Front left leg lift and hold	51	122,33(21,26)	51	122,25(21,11)	51	122,40(18,88)
Shoulder flexibility	51	196,35(21,57)	51	196,45(21,85)	51	196,51(21,55)
Stride (dynamic flexibility)	51	164,84(20,82)	51	164,76 (20,88)	51	165,04(21,09)
Stride (driving force)	51	84,08(8,20)	51	83,90(8,31)	38	84,11(9,31)
Single jump rope (30s)	51	51,24(12,20)	51	51,22(12,16)	39	54,19(12,12)

Data is shown as Mean (Standard deviation)

Analysis of inter-rater reliability

Prior to the test-retest reliability analysis, the reliability between the two measurements made by the assessors in each of the tests evaluated was determined.

The analysis based on the CCI for the two Pre-test measurements (E1 and E2), which observed homoscedasticity and normality, corresponding to the tests "Spagat antero-posterior right", "V trunk folds", "Lumbar flexions 45º", "Front leg raise and hold (right and left)" and "Stride (dynamic flexibility)" showed values, in all cases, above 0.95, with an excellent degree of agreement (Fleiss, 1986). Furthermore, in six of the seven remaining tests, the analysis using the method of Bland and Altman (17), allowed us to presume the presence of concordance between the records made by the two evaluators, observing a degree of coincidence (difference between the two measurements) without differences statistically different from zero, except in the case of the test "Stride (impulsion force)" $t(50) = 2.023$; $p = ,048$, being homogeneously distributed along the horizontal axis, and prevailing the absence of significant correlation between the variables represented. Moreover, in all of them, the limits of agreement at 95% were within zero.

Analysis of the reliability of the measures using the test-retest method.

The first measure (Test) was considered to be that corresponding to the Pretest of assessor one (Pretest-E1), with a second measure being taken for each of the tests after a period of one week (Retest).

The ICC was calculated for six of the twelve tests in which the assumptions of homoscedasticity and normality of the distributions of the Pretest-E1 and Retest measures were met, and for which inter-rater reliability was assumed in the previous analysis. The CCI obtained indicated a very good reproducibility of the two measures (> 0.75, Fleiss, 1986) in the tests "Spagat antero posterior to right", "Front right leg raise and hold", "Front left leg raise and hold" and "Stride (dynamic flexibility)". The analysis of variance associated with the CCI indicated the presence of bias in the tests "V 20s trunk folds" $F(1, 27) = 20.622$; $p < ,001$ and "45º lumbar flexion" $F(1, 35) = 27.651$; $p < ,001$, in which the two measures obtained (Pre-test E1 and Retest) showed significant differences (see table 3).

Of the eight resulting tests, analysed using the Bland and Altman method (see figure 1), four showed values of the difference between the Pre-test E1 and Retest measures statistically different from zero: "Balance with leg catch back - flat foot" $t(41) = -2.491$, $p = ,017$, "Trunk V-folds (20s)" $t(26) = -4.541$, $p < ,001$, "Lumbar flexions 45º" $t(34) = 5.258$, $p < ,001$ and "Simple rope jumps" $t(38) = -6.510$, $p < ,001$. In addition, it was observed that in none of the tests analysed was there a significant correlation between the variables represented.

Table 3. Intraclass Correlation Coefficient between the measurements recorded in the Pre-test E1 and Retest.

	ICC	95% Confidence interval		F (real value = 0) Sig.	*F*	N	gl	*p*
		Lower Limit	Upper Limit					
Spagat anteroposterior to right	,993	,988	,996	,000	,983	50	1	,326
"V" trunk fold 20s	,561	,057	,806	,000	20,622	27	1	,000
Lumbar flexions 45º	,923	,626	,973	,000	27,651	35	1	,000
Front right leg lift and hold	,995	,991	,997	,000	1,257	51	1	,268
Front left leg lift and hold	,996	,992	,998	,000	,406	51	1	,527
Stride (dynamic flexibility)	,994	,990	,997	,000	,371	51	1	,545

In general, it could be affirmed that the pairs of values (mean and difference between the Pre-test E1 and Retest measurements) were homogeneously distributed along the horizontal axis, with the circumstance that in all of them the limits of agreement at 95% have included the value of zero within them. Therefore, in view of the above considerations, it has also been possible to presume the presence of concordance between the records made in the Pre-test E1 and Retest measurements, through the Bland and Altman method (17), in the tests "Ball throw and forward roll", "Anteroposterior Spagat to the left", "Bridge (back angle)", "Shoulder flexibility" and "Stride (dynamic flexibility)".

Development of the scales

Table 4 shows the average value and standard deviation of the different tests according to the categories contemplated in the basic level of practice.

Prior to the development of the scale, the discriminatory capacity of the tests was analysed according to the different categories that make up each of the levels of practice, taking as a reference the values obtained in the Retest measure. Given the unequal behaviour of the tests in terms of discrimination between the two categories included in the basic level, it was decided to develop a single reference scale for both.

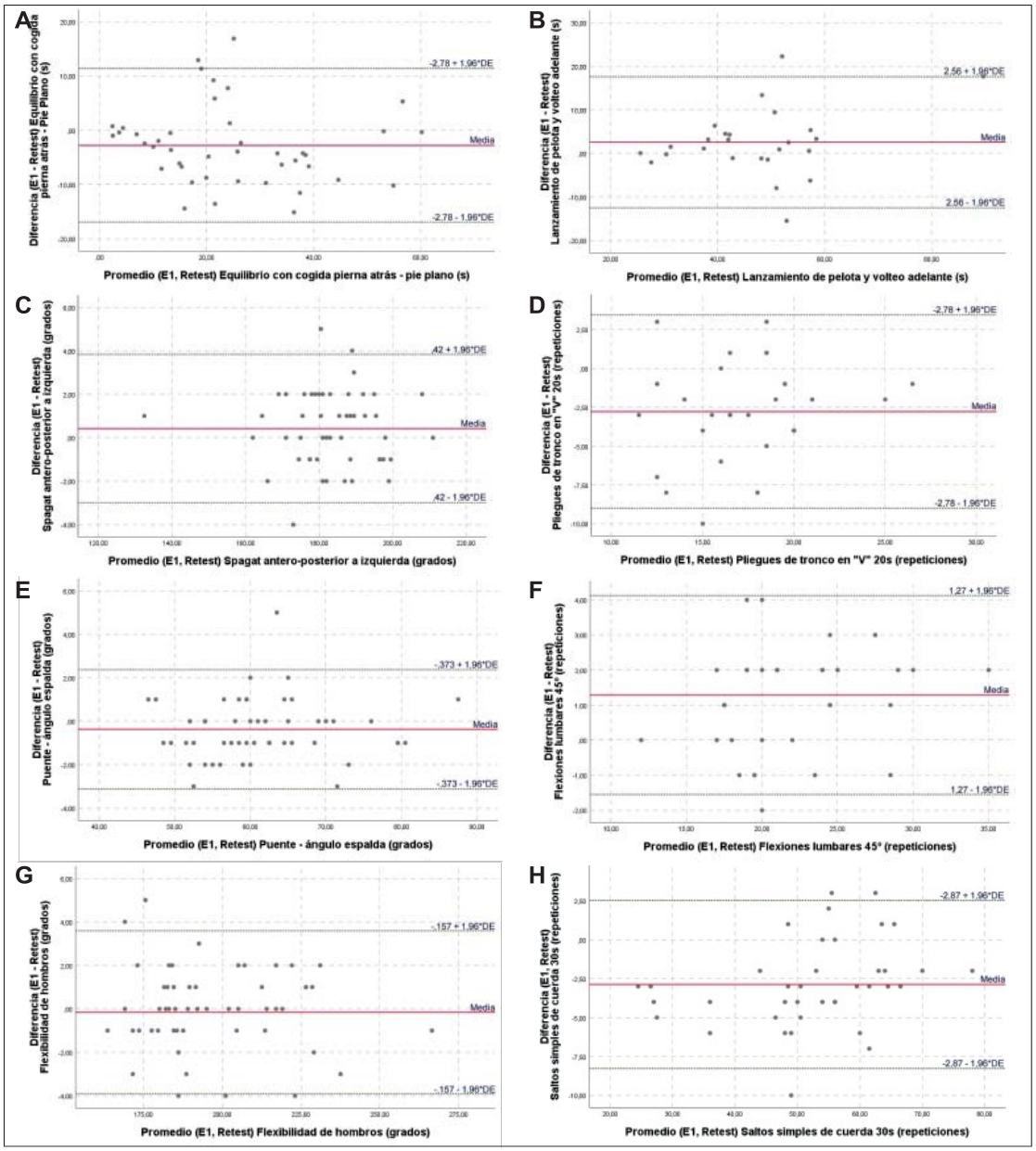

Figure 3. Differences in Pre-test E1 and Retest values in the tests (A) Back Leg Catch Balance - Flat Foot, (B) Ball Throw and Forward Roll, (C) Left Antero-Posterior Spagat, (D) Trunk V-Folds 20s, (E) Bridge (back angle), (F) Lumbar Flexion 45º, (G) Shoulder Flexibility, and (H) Single Jump Rope 30s. Bland and Altman method.

Table 4. Descriptive data (mean and standard deviation) of the tests that make up ARISTO, according to the different Basic Level categories. Measurement Retest.

TESTS		Prebenjamin y benjamin (n = 26)		Alevin (n = 30)	
		Pre-test E1	Retest	Pre-test E1	Retest
Ball throwing and tumbling forward	Mean	56,82	53,76	43,64	41,99
	SD	18,04	13,81	10,88	10,15
Spagat anteroposterior to right	Mean	188,68	188,5	195,14	194,89
	SD	11,73	10,78	14,29	13,8
Spagat anteroposterior to left	Mean	182,95	182,23	183,93	183,75
	SD	11,29	11,41	14,18	14,13
Bridge (back angle)	Mean	64,73	64,77	57,86	58,48
	SD	9,42	9,66	7,03	6,82
Front right leg lift and hold	Mean	127,05	127,32	139,34	139,72
	SD	17,99	17,88	22,38	21,83
Front left leg lift and hold	Mean	119,09	119,14	124,79	125,07
	SD	20,54	20,62	21,82	21,42
Shoulder Flexibility	Mean	187,59	187,55	203	203,31
	SD	17,8	16,99	22,07	22,4
Stride (dynamic flexibility)	Mean	155,41	155,59	172	172,21
	SD	18,63	19,32	19,76	19,78

Proposed scales

Two procedures have been followed to draw them up, depending on whether or not the distribution of the sample corresponding to the values of the different tests (Retest measure) maintains a normal behaviour.

In the first case, the arithmetic mean (50th percentile) and the standard deviation were considered as reference values for the construction of the scale. For this purpose, for each of the percentiles included, the z-value was determined in a standard normal distribution probability table. The test value corresponding to the indicated percentile is obtained by adding the product of z and the standard deviations to the average value.

In the second case, the percentiles corresponding to the direct scores were determined from the accumulated frequencies, considering the median (50th percentile) as the central tendency value (see Table 5).

Table 5. Scale of gymnastic tests at basic level (Direct scores)

Percentile	Ball throwing and tumbling forward (s)	Spagat anteroposterior to right (degrees)	Spagat anteroposteriorto left (degrees)	Bridges (degrees)	Front right leg lift and hold (degrees)	Front left leg lift and hold (degrees)	Shoulder Flexibility (degrees)	Stride (dynamic flexibility) (degrees)
99	16,73	226	--	41	183	166	267	214
97	22,29	219	208	45	174	158	251	205
95	25,23	216	206	47	169	153	234	200
90	29,76	210	198	50	162	147	228	192
85	32,82	207	196	52	157	142	222	187
80	35,25	204	192	54	153	138	217	183
75	37,34	201	190	55	149	135	214	179
70	39,21	199	189	57	146	132	205	176
65	40,95	197	187	58	143	130	204	173
60	42,60	195	185	59	141	127	196	170
55	44,19	193	183	60	138	125	191	168
50	45,76	191	182	61	135	122	189	165
45	47,33	190	181	62	133	120	188	162
40	48,92	188	180	63	130	118	186	160
35	50,57	186	179	65	128	115	184	157
30	52,30	184	178	66	125	113	183	154
25	54,17	181	176	67	122	110	182	151
20	56,26	179	175	68	118	107	180	147
15	58,69	176	173	70	114	103	174	143
10	61,75	172	168	72	109	98	172	138
05	66,28	167	162	75	102	91	170	130
03	69,23	164	155	77	97	87	167	125
01	74,79	157	132	81	88	78	164	116
N	25	50	50	51	51	51	51	51
Media	45,757	191,358	182,670	61,196	135,485	122,402	196,510	165,039
Mediana	43,370	192,000	182,000	60,000	137	121	189,000	169,000
DE	12,479	14,731	12,478	8,665	20,497	18,878	21,549	21,092

DISCUSSION

The main objective of the study was to test the reliability of a test battery designed to assess the physical abilities of rhythmic gymnasts with specific field tests, dispensing with generic CF tests that distance these athletes from their real context or the profile of their speciality.

The main findings show that the inter-rater reliability is high, with values of 0.95 in all the tests except for the "stride" in relation to the variable "jump height". This analysis aims to estimate to what extent the assessors agree in their measurements (18). In this study, it can be deduced that the level of concordance is high, coinciding in the evaluations of the different tests. Of the ten preliminary tests that make up the BFAGR, six are those that show reliability, leaving the final battery with six tests that measure coordination/agility, active and passive flexibility of the coxo-femoral joint, passive flexibility of the spine, and scapular-humeral joint (bridge) and active flexibility of the shoulder joint.

In relation to test-retest reliability, after analysis of the degree of agreement with the prestest of assessor 1 and the restest for the tests with normal distribution and those calculated using the method of Bland et al. (17), it can be concluded that the CCI is high in most of the tests except for the V-folds, lumbar flexion, balance with the leg behind and simple jumping rope, stride (impulsion force).

For the design of the final BFAGR, tests that did not provide inter-rater reliability or were unreliable in the test-rest were eliminated. Therefore, the final BFAGR test battery is composed of six tests of which two are bilateral (eight total tests), claiming that these specific tests of the final battery are reliable and applicable for rhythmic gymnasts.

The balance test did not demonstrate an acceptable level of reliability for inclusion in the final battery. Studies by Grigoroiu (19) and Gateva (20) indicate that static and dynamic balances are important factors in gymnastics routine performance. However, there is insufficient research data on balance stability in rhythmic gymnastics and the measurement of this ability remains a challenge for researchers. Sobera et al. (21)

conducted a study with the same balance used in the BFAGR, concluding that it should not be used for younger gymnasts. This could partly explain the unreliability of this test in these age groups. It is important to strengthen the intrinsic musculature of the foot, ankle and hip in order to carry it out.

The coordination-agility test shows reliability and is included in the final battery. Coordination is fundamental for highly technical sports such as RM, especially space-time coordination and hand-eye coordination, together with agility, all of which are necessary for the execution of body elements combined with the handling of the apparatus required for this discipline (22-24). On this ability, Vandopore et al. (25), conducted a longitudinal study with girl gymnasts, who completed a multidimensional measurement battery with anthropometric, physical, technical and coordinative tests to identify which characteristics are most related to performance in competition in these gymnasts. Two years later, the results of all these gymnasts in competition showed that anthropometric and physical characteristics were not sensitive enough to predict performance. However, the authors suggest that motor coordination tests may be valuable in the early identification of gymnasts, as their discriminative and predictive qualities may be sufficiently powerful for selection within a relatively homogeneous population of gymnasts exhibiting similar anthropometric and physical profiles.

The final BFAGR presents three tests to measure flexibility, two for passive flexibility (anterior-posterior spagat and bridge) and one for active flexibility (front leg raise). It should be noted that active and passive flexibility tests have always had a constant presence in the test batteries for the detection and selection of sports talent in gymnasts (26).

In relation to the passive flexibility of the coxofemoral joint, it is one of the essential tests (4, 27), being present in the majority of gymnastic sports and including one or several tests to measure it (4, 28-31). Likewise, passive flexibility of the spine is included in several elements of the scoring code, especially in body difficulties of greater value, which is why it is important to work on it from an early age (27). Despite the importance of this quality for rhythmic gymnasts, reaching maximum levels, the two test batteries found in the literature related to RM (4,30) do not propose a specific

test for it. However, it is one of the most widely used tests in male and female artistic gymnastics, the bridge being one of the main tests to be evaluated together with the spagat (28, 39, 32-34).

In relation to active flexibility, both the frontal leg raise test (right and left) and the shoulder flexibility test have demonstrated their high reliability and have been included in the definitive battery. As for the former, it is one of the most widely used specific tests in this sport, due to its proximity to the real conditions of execution of the body elements of this discipline. It is an exercise that is usually performed in training sessions and in competition choreographies, together with the spagat passive flexibility test (35). The reason for including its assessment on both sides lies in the importance of performing symmetrical work (right and left), as gymnasts generally repeat the same gesture with their dominant side, which predisposes them to acquire possible functional asymmetries, muscular imbalances or postural alterations and, as a consequence, the appearance of pain (35). As for the shoulder flexibility test, it should be noted that it is of great importance when manipulating the implements at an optimal distance from the body and performing the pre-acrobatic hand elements on the floor (7). In addition, it appears that high ranges of mobility in the shoulder and hip protect gymnasts from excessive loads on the spine during the performance of extreme postures (7).

Globally, active and passive flexibility tests are relevant factors to assess to differentiate gymnasts at various levels, noting that greater flexibility will allow gymnasts to perform higher value difficulties (36). Likewise, these tests have been used in artistic gymnastics batteries, where it is indicated that they are physical qualities that can be determinant in identifying a good sporting talent (28,29).

In general, they are tests that should be included and qualities to be developed, since the degree of technical and artistic perfection achieved by gymnasts in these sports is highly conditioned by the range of movement that they are able to develop in the execution of technical skills (37).

The "V trunk folds" test does not show reliability. However, this test is present in most of the specific batteries related to artistic gymnastics (15, 16, 28, 29, 29, 32, 38). In RM, this test has not generally been used to assess abdominal muscular endurance

strength. The only test found to assess this capacity is the so-called curl up test proposed by Batista et al. (13) and by Klentrou et al. (11) for the FIG's development and high competition programme for GR age groups (12), although they do not specify its reliability. The study by Batista et al. (13), included this test with young Portuguese gymnasts of two different levels (base and 1st division), indicating that it was not relevant or differentiating between the two groups. The test was performed in 30s and the maximum number of repetitions was counted as in our study. Although abdominal strength plays an important role in almost all the movements performed in rhythmic gymnastics and helps to maintain gymnastic posture in this sport, it does not seem to be a discriminating test for gymnasts in this discipline.

The lumbar flexion has also been excluded from the final battery as it did not show reliability. This test, which assesses the strength and endurance of the dorsal-lumbar trunk musculature, is included along with six other tests in a strength battery by the FIG for GR (11), but its reliability is not specified. However, Batista, et al. (13), included it with young Portuguese gymnasts, indicating that it is a test along with the jump rope (doubles) that most discriminates between groups of gymnasts according to their level of competition (base and 1st division), in favour of gymnasts of a higher level.

For the stride test (jump height), little reliability has been obtained for this variable, but this is not the case for the dynamic hip flexibility in spagat. Many studies found for the jump in gymnastics have been evaluated using the strength platform and bipodal support (39-45). Our study shows that the unipodal impulse, measuring the height of the jump, is not reliable for a test that aims to measure this ability.

On the other hand, the variable of dynamic hip flexibility measured in this stride test was reliable. This jump is basic in rhythmic gymnastics, and a good opening in this position is essential to obtain good sporting results (46, 47).

Grande et al. (48) looked for a tool to evaluate specific jumps in rhythmic gymnastics, in the swing phase, in the flight phase and in the damping phase. The tool could be good, but it had the problem of being too difficult to score. In order for a jump to be scored by the judges, soaring in height is essential to have a well-defined and fixed form (48). This is why jumping, and in particular good plyometric training, will improve

jumping (49-51). Hence, most of the test batteries in gymnastics evaluate the jumping power of both feet (4,29,30,32,52). In particular, in RM, most authors have limited themselves to analysing explosive strength only through vertical or horizontal jumping (39, 53, 54). However, due to the variety of jumps that include dynamic flexibility, it is important to be able to measure it with specific rhythmic gymnastics jump that is a valid and reliable test and easy to apply.

Finally, the simple jumping test is excluded from the definitive battery because it is not reliable. This test could a priori be a complete test in the practice of RM, since in addition to being a specific apparatus for this sport, its action involves postural stabilisation of both the upper and lower limbs; constant displacement of the centre of mass to guarantee the maintenance of balance; anticipation of movement when the rope approaches the ground and propulsive force through a motor action of the muscles of the upper and lower regions of the body (55). It is a test widely used in athletes in various disciplines for the development of coordination, dynamic balance, muscular strength, cardiovascular endurance, as well as the improvement of metabolic and cardiorespiratory function (56, 57). Hence its choice for assessing coordination and explosive leg strength. In GR, we have records of this test but with double jumps (13). In our study, it was discarded for this basic level because it was considered complicated, based on the study by Batista et al. (13), where several gymnasts had difficulties in its execution, with the lack of technique in this apparatus being the main cause of the low results, with many gymnasts performing more attempts than double jumps with rope.

For the normative reference values, a segmentation by categories (pre-benjamin, benjamin and alevín) was carried out to check whether there was discrimination between ages and tests measured, concluding that these tests do not discriminate between the different categories. Thus, the scales were carried out in accordance with the basic level globally, concluding that only the "Shoulder flexibility" test showed significant differences in the average ranges calculated for each of the levels analysed. This test, as indicated by Donti et al. (7), is of great transference in the technical performance of manipulation with apparatus, as well as in the pre-acrobatic elements

of hand support, hence the importance of the normative reference values on it, in order to adequately identify the deficits of the gymnasts in this ability.

On the other hand, obtaining the scale allows us to transform the direct scores obtained by the gymnasts in each of the tests into centiles. This centile value will indicate the percentage of the normative group in which the gymnast is in the evaluated test, establishing the normality in a margin of +-10 over this centile, being the 50th centile the normal. This means that the level that a gymnast may have will provide objective data on the physical quality where the gymnast is most deficient and can help in the development of a programme adapted to individual needs.

On a global level, considering that the physical capacities necessary for the GR at basic levels are mainly coordination and passive and active flexibility of the coxofemoral joint and shoulder (4, 46, 47, 58), as well as dynamic flexibility in jumping impulsion, the six tests of the final battery are of great significance. Ball throwing and forward rolls are related to coordination and agility, a determining quality at these basic ages (38, 59). The passive flexibility tests "splits or spagat to the right and left side and bridge are related to the flexibility of the lower limbs and the spine, respectively. The exercises "Front leg raise and shoulder flexibility" are related to the dynamic flexibility of two important body zones in this sport. Finally, the variable of the stride test concerning the dynamic flexibility of the hip in splits is of utmost importance for a large part of the jumps performed in GR with both single and double foot impulsion.

In conclusion, the reliability calculations confirm that six tests (two bilateral) of the preliminary battery are adequate. Consequently, the final BFAGR battery consisting of the six tests presented for the assessment of specific physical fitness can be considered reasonably reliable and applicable in gymnasts of this age group. Moreover, their normative reference values allow an objective knowledge of the gymnast's specific fitness level and the physical qualities that can be improved.

LIMITATIONS AND FUTURE PATHS

In terms of limitations, it is worth highlighting the lack of studies of this type with Spanish rhythmic gymnasts of this age group with which to compare our results, since

the existing studies were carried out with different test batteries and in many cases non-specific tests that lacked validity and reliability, and also the small number of gymnasts. Therefore, future studies should include larger samples, and a linear regression analysis should be carried out to determine which of the physical tests in this battery best predict sporting performance, taking into account the results in competition. However, it is positive to indicate that the tests selected and proposed have been strictly related to the most relevant physical capacities for the practice of RM. In this sense, the BFAGR presents good theoretical coherence and a specific relationship with the motor and functional profile of this discipline. Furthermore, given that one of the fundamental aspects to be taken into account in the choice of a particular assessment procedure is the ease of its application (16), it should be noted that the proposed test battery does not involve complicated or costly tests, nor does it require the training of trainers for its application.

As a practical application, until a larger study with a larger and randomly selected sample is available, it seems appropriate to use the results of the present study as normative reference data to assess the specific physical condition in the population of gymnasts of these ages.

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