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Original Article

Diagnosis and trend in the acquisition of gymnastic and acrobatic skills in high school

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Abstract:
The teaching of sports skills present in most physical education programs in Secondary Education, including gymnastic and acrobatic skills, provides multiple benefits to students in training such as the development of postural control, the improvement of stability skills, general coordination, fundamental movement skills, as well as locomotor and object control skills, among others. In this line, the aim of this study was to analyze, the level achieved by Spanish first-year university students of Physical Activity and Sport Sciences in executing two basic acrobatic skills after their previous stages of training. Therefore, in this research a cross-sectional descriptive and retrospective study was developed, where through an initial evaluation of 675 first-course university students distributed over eight academic years (from the academic year 2010-2011 to the academic year 2017-2018 included), the trend of the level of execution of two basic acrobatic skills acquired was determined. The results demonstrated an insufficient level of technical achievement and physical deficiencies. The stability and body orientation of students performing basic skill were lacking, and the most deficient muscle actions were those associated with the folding and deployment of the legs, and the absence of arm–trunk–leg alignment was also observed. This study determined that in the stages of previous training, the contents associated with basic gymnastic and acrobatic skills could be underdeveloped in the curricula of physical education. These findings reflect the need to reinforce both the specific initial training and in-service training of physical education teachers to guarantee effective acquisition of motor learning and, specifically, of basic gymnastic skills.
Keywords: students- gymnastics competence - motor control - physical education.

Introduction

The teaching programs in the physical education (PE) curriculum in secondary education focus on developing and acquiring, among other competencies, sports skills (Proios, 2019). PE should progressively facilitate the integration of motor tasks of different levels of complexity from early ages to adolescence, as well as the attitudes and emotions associated with motor behavior, thus allowing individual to develop appropriately and comprehensively through the contents of the subject format established in the Organic Law of Educational (Organic Law, 3/2020).

The educational systems of countries such as England, Germany, and Spain clearly (directly or indirectly) integrate gymnastic content into the official educational curricula (Robinson et al., 2020; Sloan, 2007). It is essential that experience and motor practice arise so that they last over time (Magill & Anderson, 2017; Payne & Isaacs, 2017; Schmidt & Lee, 2019), and in the case of the gymnastics field, practice is priority (Delaš et al., 2008). Complex skills include controlling and synchronizing multiple body parts, and they require considerable practice to be executed well (Schmidt & Lee, 2019). Studies of authors such as, Payne and Isaacs (2017), and Schmidt and Lee (2019), determined that effectiveness in a skill depends primarily on practice, where learning and the number of successful practice trials are positively related. Such learning can therefore be given because of experience and practice.

Gymnastic practice allows one to develop postural control, involving stability and orientation skills, as well as locomotive skills and the control of objects, in addition to it being important in terms of individual development (Rudd et al., 2015). According to García et al. (2011), the regular practice of gymnastics in children contributes to improving postural control in bipedal positions, especially in children between the ages of 5 and 7 years old, hence the importance of initiating the development of these skills at early ages. The practice of gymnastic and acrobatic skills at an early age creates opportunities for practitioners to acquire a background of the situations of rotation, body investment, and body sustainability using all body segments.

The development of such tasks awakens participants' sensory perception, resulting in a greater acquisition of spatial orientation and stabilization resources (Rudd et al., 2015). Therefore, the continued practice of gymnastic skills can contribute to the development of the postural control system, which is necessary for the development of the motor family. Another study by Rudd et al. (2017), showed that the implementation of a

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children's gymnastics program led to significant improvements in overall coordination, fundamental movement skills, and the physical self-concept as compared with students who continued the standard PE program. However, society and generations of children today have lower levels of basic motor skills and lower levels of competence in movement, as noted in various studies, such as that conducted by Hardy et al. (2013) and that by Tester et al. (2014), as well as a low level of development in their physical condition, which, along with motor impairment, may affect the health of the younger population (Lima et al., 2019). In this line, gymnastic skills are mostly complex and are especially difficult for low-skilled or inexperienced students, such as elementary or high school students, whose previous experiences in these disciplines are scarce (Ávalos & Vernetta, 2020).

The emergence of difficulties in learning gymnastic activities in the primary and secondary stages is associated with problems such as a lack of initial training of PE teachers, the inadequate methodology used, fears or lack of previous experience, or negative gymnastic experiences of students (Ávalos et al., 2015). Another factor that can have an influence is that gymnastic skills require a certain amount of training and preparation time, and according to the time available in the school year, it becomes difficult to teach. Despite this, it is essential to note the myriad contributions that the development of these skills make at the cognitive, physical, and social interaction levels (Lucas et al., 2019).

Thus, there are many factors that can influence motor learning and, in this case, learning gymnastics skills. Among them, we can cite key aspects associated with PE teachers, as mentioned above, such as the teacher training (Breslin et al., 2012), the selection of strategy, approach and method (Logan et al., 2015; Miller et al., 2016), communication, verbal information and/or the feedback offered to the potential learner (Potdevin et al., 2018), and the properties and variety of practice (Drost & Todorovich, 2017; Kok et al., 2020). On the other hand, the aspects associated with students can also be decisive in the learning process, such as motivation and a predisposition towards practice, the initial level of skills, errors in the learning process, body control, memory, and feedback received in the learning process (Kangalgil & Özgül, 2018; Magill & Anderson, 2017).

Within the factors associated with students, it is important to measure knowledge retention after a learning period to provide information about the acquisition (or not) of motor skills (Schmidt & Lee, 2019). Consequently, the identification of difficulties, successes, and errors, through evaluation is of great importance within the teaching process (Asún et al., 2020). In doing so, we provide information on whether the time spent on practical school education training in relation to learning gymnastic and acrobatic sports skills is necessary and adequate or conversely insufficient and in need of methodological readjustment. Although there are studies associated with the gymnastic field that are highly linked to sports performance (Taboada-Iglesia et al., 2020; Vernetta et al., 2018; Junior et al., 2021) we hardly find studies that analyze the gymnastic motor competence developed and achieved in educational stages.

In conclusion, the objective of this study was to identify and analyze, over eight academic years, the level achieved by university students of first-course Physical Activity and Sport Sciences (PAS) in executing two basic acrobatic skills after their previous stages of training.

Materials and methods

The retrospective study presented is quantitative, with a descriptive approach and a cross-sectional design.

Participants

The exhibition, selected for convenience and availability, was initially composed of 837 students enrolled from the academic year 2010/2011 to the academic year 2017/2018 in the subject *Gymnastic and Artistic Skills* belonging to the first course of the degree of PAS at the University of Alicante (Spain). Finally, 675 of these students (500 men; 175 women) aged 18–34 years old, with a mean age of 20.2, participated in the study voluntarily.

Instruments

The instruments designed and used for the diagnostic evaluation of skills were a video camera and two observation templates (Table 1 and Table 2). To check the internal reliability of the proposed instruments, the Cronbach alpha coefficient was calculated for each skill with the following results: cartwheel alpha= 0.71 and handstand alpha=0.85. In the academic year 2010–2011, the teacher of the subject together with two experts from the gymnastic field designed two templates for the realization of the diagnostic evaluation of two basic acrobatics: cartwheel and handstand (Estapé, 2002; Vernetta et al., 2000).

The templates describe the different technical phases and specify the assignment of a numeric value according to the importance of the phases of the movement, this being the total value of the 10-point acrobatic element. Furthermore, the overall achievement level of the skills was established: outstanding (9–10 points); remarkable (7–8 points); well (6 points); sufficient (5 points); insufficient (3–4 points); deficient (1–2 points); very poor (0 points); and did not perform (NP) the acrobatic movement.

Table 1. Description of the technical phases to be evaluated in the execution of the cartwheels.

Phases	
1.	Wide step forward: Starting from the extended and front upright position (0.2 point), a wide step forward is performed (0.4 point), followed by a remote hand support with respect to the forward foot (0.4 point). Total: 1 point.
2.	Alternative hand support: The hand corresponding to the forward foot is first placed before the other one (1 point). The delayed leg is thrown upwards until the inverted position is reached by keeping the arm–trunk angle open (1 point). Total: 2 points.
3.	Legs open and straight down the vertical axis: An inversion is made with open (1.5 point) and straight legs (1.5 point), carrying the body fully extended over the hand support in a passing balance (90^o turn) (1 point). Total: 4 points.
4.	Alternative foot support: Both arms are alternately impulse to facilitate the incorporation of the body (1 point), the foot corresponding to the delayed leg reaching the ground first in the initial phase of movement (1 point). Total: 2 points.
5.	Ends standing and with arms extended: Ends upright with one foot in front of the other, with a trunk extension and arms extended in front at a 180^o angle (0.5 point). Ends counterclockwise to the starting position (0.5 point). Total: 1 point.
6.	Did not perform the move: Unable to execute any of the phases mentioned above. He/she did not perform the skill. 0 points.

Table 2. Description of the technical phases to be evaluated in the execution of the handstand.

Phases	
1.	Hand support away from the forward foot: Starting from the upright position, the practitioner performs a wide step forward (0.5 point), followed by a remote hand support with respect to the forward foot (0.5 point). Total: 1 point.
2.	Hand support on the ground: A simultaneous hands support is performed away from the forward foot (0.5 point) and with an approximate separation of the width of the performer's shoulders (0.5 point). Total: 1 point.
3.	Open arm–trunk angles: Extended body alignment of the arm and trunk segments is observed. Total: 2 points.
4.	Straight arm–trunk–leg line: Extended body alignment of the arm, trunk (1 point), and leg segments is observed (1 point). Total: 2 points.
5.	Maintains the 2" position without aid: Once the inverted support is reached, the center of gravity is maintained over the hand support for at least 2 seconds (1 point) without misaligning the angulation reached (2 point). Total: 3 points.
6.	Reception of alternative legs. From the inverted position, the legs are lowered alternately and without sudden movements (0.5 point). The upright position is reached with one foot forward with respect to the other and with the arms in straight extension (0.5 point). Total: 1 point.
7.	He/she did not make the move. Unable to perform any of the phases mentioned above. He/she did not perform the skill. 0 Points.

Procedure

Students in the initial session of the mentioned subject took a technical execution test where they had two attempts to perform the corresponding stunts while being assessed for technical execution. Students were informed that the data from the initial evaluation could be used for research purposes. Informed consent was obtained, following the guidelines of the data protection law, and the approval of the Ethics Committee of the University of Alicante (UA-2020-08-29).

The protocol carried out during the eight academic years was analyzed as follows:

- Students were informed about the need to carry out a diagnostic test, the content of the test, and its recording procedure.
- Ten minutes of specific warm-up prior to the test.
- Individual evaluation of the technical test.
- The evaluation was carried out by the teacher of the subject in situ with the recording of the test, and the evaluation was recorded in the templates.
- Review and subsequent evaluation of the recordings of the technical test by the professor of the subject and by two professors specializing in gymnastics.

Statistical analysis

Descriptive statistics (mean, SD, and contingency tables) were calculated. The normality and homogeneity were tested with the Kolmogorov–Smirnov test, which showed that the sample did not follow normality. To establish the differences of the means, the Kruskal–Wallis was used for related samples, and Mann–Whitney's U test was used between the academic years. The $\chi 2$ test was used to evaluate the association between the level of achievement of gymnastic skills and previous experience. For all statistical tests, a probability level of $p < 0.05$ denotes statistical significance. Statistical analyzes were performed with SPSS® (v26.0; IBM®, Armonk, NY, USA).

Results

The first variable we analyzed was the students' previous experience with content related to gymnastic and acrobatic skills. Our data showed that of the total sample, 37.9% of the students had no previous experience and 62.1% stated that they had worked on this content.

Findings Corresponding to Cartwheels

The general analysis of the data on cartwheel performance shows an insufficient mean trend (m= 4.61, SD= 2.754). When segregating the data according to academic year and analyzing them with the Kruskal–Wallis test, we found that there are significant differences (K=16.604, $p < .020$) between academic years. These differences were found in the academic years of 2010/11 and 2013/14 (U= 2909.00, $p < .006$), 2010/11 and 2014/15 (U= 2854.50, $p < .003$), 2013/14 and 2016/17 (U=2931, $p < .009$) 2013/14 and 2017/18 (U= 2652, $p < .024$), 2014/15 and 2016/17 (U= 2943, $p < .010$), and 2014/15 and 2017/18 (U= 2656.00, $p < .025$).

In the level of achievement in the execution of the cartwheel (Table 3), a very low percentage of students executed the skill (37.1%) throughout the eight academic years. On the contrary, there was a very high trend of students who did not execute the acrobatic skill analyzed in an adequate way (55.6%), in addition to a small percentage that did not execute it (6.9%). When analyzing previous experience and the level of achievement, we found that 65.1% of the students who say they have previous experience and 58.6% of those who did not obtain an average insufficient score (less than 5). No association was found between previous experience and motor competence achievement according to the X^2 test.

Table 3. Cartwheel: level of achievement according to academic years and temporary total.

Level of achievement	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	Total
Did not perform skill	5.7	3.8	0.0	2.3	1.1	14.9	17.2	10.5	6.9
Very poor	4.6	7.6	4.7	3.4	4.6	1.1	1.1	2.6	3.7
Deficient	16.1	12.7	14.1	12.6	10.3	8.0	11.5	14.5	12.4
Insufficient	51.7	38	43.5	37.9	40.2	32.2	32.1	40.8	39.5
Sufficient	4.6	15.2	4.7	1.1	6.9	13.8	19.5	6.6	9
Well	2.3	5.1	5.9	1.1	2.3	0.0	2.3	0.0	2.4
Remarkable	6.9	10.1	4.7	28.7	21.8	19.5	9.2	21.1	15.2
Outstanding	8	7.6	22.3	12.6	12.6	10.3	6.9	3.9	10.5

Table 4, we can see that in phase one (broad forward step), in general, the average percentage of the correct execution was low (15.3%), and only in two academic years did this percentage increase.

Phase two (alternative hand support) was executed correctly by a high percentage of students (88%). In phase three, which is the main phase of movement (carrying open and straight legs along the vertical axis), we see that the technical range was low (27.2%). In contrast, in phase four (alternative foot support), most students (72.8%) performed this correctly. Finally, phase five (standing end and arm extension) was properly implemented by a minimal percentage of students (14.1%). There was also a small group of students who did not perform the skill (6.9%). Finally, all phases of the movement, except for phases two and four, were performed improperly by more than half of the participants.

Table 4. Cartwheel: analysis of technical execution depending on phases of movement.

Academic years	Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Did not perform
	√(%)	X(%)	√(%)	X(%)	√(%)	X(%)	√(%)	X(%)	√(%)	X(%)	(%)
2010/11	15.0	79.3	87.4	6.9	14.9	79.3	74.7	19.5	9.2	85.1	5.7
2011/12	27.8	68.4	88.6	7.6	17.7	78.5	74.7	21.5	8.9	87.3	3.8
2012/13	14.1	85.9	95.3	4.7	32.9	67.1	60.0	40.0	36.5	63.5	0.0
2013/14	10.3	87.4	93.1	4.6	42.5	55.2	80.5	17.2	6.9	90.8	2.3
2014/15	19.5	79.3	92.0	6.9	36.8	62.1	81.6	17.2	10.3	88.5	1.1
2015/16	8.1	77.0	83.9	1.1	29.9	55.2	75.9	9.2	18.4	66.7	14.9
2016/17	16.1	66.7	78.2	4.6	18.4	64.4	63.2	19.5	23.0	59.8	17.2
2017/18	11.8	77.6	85.5	3.9	25.0	64.5	72.4	17.1	0.0	89.5	10.5
Total	15.3	77.7	88.0	5.03	27.2	65.7	72.8	20.1	14.1	78.9	6.9

√(%): correct; X(%): wrong.

Findings Corresponding to Handstand

The overall data on the performance of the handstand show an overall poor mean trend (m= 3.16, SD= 2.738). When analyzing the data with the Kruskal–Wallis test, we found that there are significant differences (K=20.711, $p <.004$) between the academic years. These differences were found in the academic years 2010/11 and 2013/14 (U= 2867.500, $p < .063$), 2010/11 and 2014/15 (U= 2466.500, $p < .002$), 2011/12 and 2014/15 (U=2466. 500, $p < .002$) 2012/13 and 2014/15 (U= 2758.500, $p < .003$), 2014/15 and 2016/17 (U= 3031.500, $p < .022$), and 2014/15 and 2017/18 (U= 2565.000, $p < .013$).

In classifying the level of achievement in the execution of the handstand (Table 5), we observed that over the period analyzed, a very low percentage of the students executed the skill with more than five points out

of ten (26.29%). On the other hand, throughout the eight academic years, a large proportion of students (61.18%) did not exceed five points, i.e., they did not reach the minimum level of achievement of the basic handstand skill: students were at an insufficient level (22.9%), at a poor level (34.3%), and at a very poor level (3.98%). It was even noted that 12.3% of students did not execute the skill. When we analyzed previous experience and the level of achievement of the handstand, we found that 60.9% of the students who reported having previous experience and 73% of those who did not obtain an insufficient score (less than 5). When analyzing the data with the X^2 test, significant differences were found (X^2= 22.817(10), p <.011).

Table 5. Handstand: level of achievement according to academic years and temporary total.

Level of achievement	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	Total
Did not perform skill	11.5	7.6	0.0	13.8	11.5	21.8	11.5	21.1	12.3
Very Poor	11.5	8.9	4.7	1.1	2.3	2.3	1.1	0.0	3.98
Deficient	27.5	43.1	73	29.9	25.3	24.1	33.3	18.4	34.3
Insufficient	31	17.7	4.7	25.2	19.5	20.7	35.6	29	22.9
Sufficient	10.3	3.8	0.0	2.3	1.1	8.0	5.7	27.6	7.35
Well	6.9	8.9	4.7	5.7	4.6	9.2	3.4	0.0	5.42
Remarkable	0.0	8.9	0.0	10.3	18.4	8.0	3.4	3.9	6.61
Outstanding	1.1	1.3	12.9	11.4	17.2	5.7	5.7	0.0	6.91

Analyzing the results obtained in the execution of handstand acrobatics by phases of movement (Table 6), we observed that phase one (support of hands away from the forward foot) was executed correctly by students infrequently (27.1%), with the 2017/18 academic year demonstrating the highest percentage of students performing the movement properly (55.3%), and the 2016/17 academic year representing the lowest percentage (5.7%). Phase two (support of hands with a separation of shoulder width) was performed correctly by a high percentage of the students (76.9%), as was phase six (alternative leg reception), which refers to movement recovery (50%). With respect to phase three (open-trunk arm angle), it was performed by almost half of all students (41.8%). However, the adequacy percentages decreased in phase four (arm–trunk–leg line) (16%) for the 2014/15 academic year, which had the highest percentage of students who correctly performed the skill (31%); on the contrary, for the 2017/18 academic year, a minimal percentage (2.6%) of students performed this part of the movement. For phase five (keeping the invested position 2" unaided), the proportion of students performing the skill correctly was small (13%); at this phase students, of the 2014/15 academic year obtain the best results (29.9%), and the low percentage of achievement (2.6%) of the 2017/18 academic year was repeated. There was a small number of students (12.3%) who did not execute the movement. It should be noted that phases one, four, and five were performed incorrectly by a very large proportion of students.

Table 6. Handstand: analysis of technical execution according to the phases of movement.

Academic years	Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Phase 6		Did not perform
	√	X	√	X	√	X	√	X	√	X	√	X	
2010/11	31.0	57.5	41.4	47.1	47.1	41.4	13.8	74.7	3.4	85.1	39.1	49.4	11.5
2011/12	34.2	58.2	75.9	16.5	21.5	70.9	20.3	72.2	8.9	83.5	51.9	40.5	7.6
2012/13	12.9	87.1	95.3	4.7	22.4	77.6	17.6	82.4	12.9	87.1	55.3	44.7	0.0
2013/14	20.7	65.5	81.6	4.6	47.1	39.1	24.1	62.1	20.7	65.5	57.5	28.7	13.8
2014/15	39.1	49.4	86.2	2.3	57.5	31.0	31.0	57.5	29.9	58.6	49.4	39.1	11.5
2015/16	18.4	59.8	70.1	8.0	48.3	29.9	18.4	59.8	16.1	62.1	43.7	34.5	21.8
2016/17	5.7	82.8	87.4	1.1	51.7	36.8	17.2	71.3	10.3	78.2	43.7	44.8	11.5
2017/18	55.3	23.7	77.6	1.3	39.5	39.5	2.6	76.3	2.6	76.3	64.5	14.5	21.1
Total	27.1	60.5	76.9	10.7	41.8	45.7	16.0	69.5	13.1	74.5	50.6	37.0	12.3

√(%): correct; X(%): wrong.

Discussion

The aim of this study was to identify and analyze the gymnastics competence of first-course PAS students prior to their university training, for which an initial evaluation process was carried out from eight academic years.

Our findings suggest that students in their pre-university training stages did not reach a sufficiently high level of achievement in performing basic skills with relative autonomy and technical success. In the evaluated cases (cartwheels and handstand), students did not achieve more than 60% in these skills, with the inadequacy in the handstand skill being more pronounced. This study reflects the evidence that, today, there is a low level of motor competence in children and adolescents (Hardy et al., 2013; Tester et al., 2014; Duncan et al., 2020), even though the acrobatic skills evaluated are deemed basic skills that can be developed naturally and through early play (Navarro, 2009). On the other hand, as we mentioned above, gymnastics skills are complex and most of them require a high level of neuromuscular coordination for their execution and need practice time and experience to be acquired (Schmidt & Lee, 2019). Gymnastics in general could be a tool for improving the motor

proficiency of children and adolescents, as evidenced by various studies (Karachle et al., 2017; Yilmaz & Sicim-Sevim, 2018), but require a lasting approach over time. In relation to the analysis of the results according to the different academic years, it should be noted that even though there are significant differences between some of the academic years analyzed, the achievements in six of the eight years are deficient and insufficient. Despite a high percentage of participants (over 60%) reporting previous gymnastics experience, they did not reach sufficient levels of proficiency in the two skills studied. In the case of the handstand, students with no previous experience had significantly lower results in the level of achievement, as this acrobatic skill requires greater postural control, balance, and technical knowledge. Thus, the technical foundation depends on physical and coordinative capacities (Cherepov et al., 2019).

These findings can be attributed to the fact that this content has not been developed continuously and effectively throughout school education, since, in this case, previous experience has not been sufficient for the acquisition of the learning of these contents. Continuity in practice seems to have been scarce, since the learning of basic acrobatics has not been consolidated, a fundamental aspect for hard learning (Payne & Isaacs, 2017). These results are in accordance with the findings of previously mentioned studies (Ávalos et al., 2015), where it is concluded that PE teachers spend little time developing this type of content. These facts, in addition to being linked to the lack of hours of PE in schools, two hours of PE a week in the case of Spain (Organic Law 3/2020), may be related to the low levels achieved by students.

When analyzing skills in college students according to their movement phases, a high proportion of deficiencies detected are associated with phases where stability and body orientation are critical. In the case of the cartwheels, the movement phases less dominated by students are those related to the muscle actions of folding and unfolding legs, and the actions in which the repulsion of arms intervenes. These phases are characterized by temporal coordination and translation of movement and depend on elasticity and strength as qualities necessary for correct execution (Becerra-Patiño et al., 2022); in addition, Delaš et al. (2008) found a positive correlation between better flexibility and correct cartwheel execution. Furthermore, it is important to mention that several studies point to the low physical condition of adolescents (Charlton et al., 2014; Fonseca et al., 2017) and suggest that these deficiencies could influence the insufficient development of performance in the acrobatic movements analyzed.

On the other hand, in the handstand, the phases of movement with the greatest errors in execution correspond to the absence of arm–trunk–leg alignment; muscle actions related to the fold and deployment of these segments; and the inability of students to maintain the inverted position for 2", where balance and position of body blockage are fundamental. These phases require good spatial orientation and strength for body stabilization. The development of the muscles involved and the attention of the muscle and joint actions for the execution of the handstand (blocking position) should be considered for the exercise to be executed efficiently from a mechanical point of view (Estapé, 2002; Gómez-Landero et al., 2013). As we mentioned earlier, this may also be related to the lack of experience in such activities, as pointed out by Ávalos and Vernetta (2020) and Ávalos et al. (2015). Since many of the required actions are developed with different basic gymnastic activities that help develop body management, that is, biomechanical principles on rotation, weight bearing, balance, and absorption of force (Baumgarten & Pagnano-Richardson, 2010).

After analyzing these eight academic years and despite the specific characteristics of the students of the first-course Sciences of Physical Activity and Sport, where interest in sports practice is recognized (Hernández & Franco, 2020; Zurita et al., 2016) it was observed that the percentage of PAS students who arrive at the university stage with basic gymnastic deficiencies is high, and some of the participants are not even capable of executing these skills. Although some significant differences were found between some academic years, we cannot associate these differences with previous experience since they are not related. These findings may be linked to experiences in other physical activities carried out by the students and that in this case were not addressed, which constitutes a limitation of our study. This situation indicates the deficiency in the motor development of specific motor skills in the training stages prior to university, where motor maturation should be achieved since it is the basis for dealing with different motor problems in different situations (Carrasco et al., 2015). The physical qualities of flexibility and strength also demand urgent attention in primary and secondary education, which is also reflected in the studies of Burner et al. (2019), Nogueira et al. (2019), and Planas et al. (2020), among others.

In addition, the different concepts, and changes in educational models in recent years may have influenced the way in which we approach and develop gymnastic content in the educational field (Potdevin et al., 2018). Therefore, it is necessary to recover the work and the implementation of sports skills in secondary students learning, as it is there and in the primary stages that students develop a simple motor background that then allows them to develop more complex tasks (Jaakkola & Washington, 2012; O'Brien, et al., 2016).

Restructuring the curricula could be envisaged to guarantee the implementation of such skills. The wide range of curricular content in the subject of PE has great potential, but it could nevertheless diminish the depth when developing all the content proposed in the different educational stages. In some educational programs within the subject of PE, there is diversity in the overall structure of texts, general recommendations, and expected learning outcomes of students (Larsson & Nyberg, 2016). Along these lines, Forest et al. (2018) conducted a content analysis of current curriculum materials in three countries (France, Switzerland, and

Sweden), addressing the contents of gymnastics and physical training and showing a great lack of coordination in the approaches in each country. Furthermore, in the case of Spain, the curricular structure and its great diversity and volume are not consistent or balanced with the number of teaching hours in the subject of PE, e.g., two hours per week is not enough to achieve motor skills and all that such skills entail (Méndez et al., 2017). Along these lines, Aznar et al. (2017), advocate for three hours per week in school to achieve improvements in motor competence. The possibility of developing a good range of motor skills allows students to tackle the different situations that may arise throughout their lives. The obligation to offer numerous opportunities for practice with numerous learning environments, as well as to promote and disseminate physical activity and sports programs outside school hours for children and young people, could be a reinforcement and complement to the development of motor and physical competences in schools. In recent years, a low motor competence of children and adolescents (Ruiz-Pérez, 2019) and a decrease in the practice of physical activity and sport outside school hours have been observed; institutions should consider offering solutions to such issues, such as the design and implementation of physical improvement plans.

Conclusions

From this study, it is apparent from the initial evaluation that the level of execution of cartwheel and handstand skills is insufficient, as well as the physical qualities of flexibility and strength involved in the evaluated actions.

The main conclusions focus on the one hand, on the fact that the phases of the movement less mastered by the students in the execution of the side cartwheel are those related to the muscular actions of folding and unfolding the legs, and the actions involving the repulsion of the arms. These phases are characterized by time coordination and depend on elasticity and strength as necessary qualities for their correct execution. And, on the other hand, in the vertical handstand, the erroneous execution phases of the movement are related to the lack of arm-trunk-leg alignment, with the muscular actions of folding and unfolding of these segments, and with the inability to maintain the inverted position for a few seconds, where the balance and the blocking position of the body are fundamental.

Moreover, the trend maintained over the analyzed eight academic years shows the low values obtained by PAS students in relation to competence in gymnastics. This suggests that in the stages of initial training, basic gymnastic and acrobatic skills are being underdeveloped in the curriculum within the subject of PE. Finally, these findings reflect the need to reinforce both specific initial training and in-service training of PE teachers to ensure effective acquisition in motor learning and, specifically, in basic gymnastic skills.

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