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REVIEW ARTICLE

DANCE AND PHYSICAL CONDITION SYSTEMATIC REVIEW

^{*1}Calvo-lluch, A., ²Otero-saborido, F., ²Suarez-arrones, L, ³Gobea-soto, J.A.
³Villalba-fernández and ⁴León-prados, J.A.

¹Phd Profesor Pablo de Olavide University, Faculty of Sport Science Ctra Utrera nº1 41013 Seville, Spain

²Phd Profesor Pablo de Olavide University, Faculty of Sport Science

³Degree in Physical activity and Sports

⁴Profesor Pablo de Olavide University, Faculty of Sport Science

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ABSTRACT

The main objective is to review the scientific literature regarding dance and physical demand. Databases concerning physical activities have been revised: Scopus and Proquest. In medical sciences: PubMed, Medline and Medes. In social sciences: Dialnet and PHD databases: Teseo, and other databases have been selected next to 34 JCR articles, and it's content makes reference to the physical training of the dancers. The revision of all these articles happened in 2017 and it excluded every article or PHD that did not talk about this two following topics; Physical conditioning and fitness training relating it to dance. They all agree that dance by itself is not enough to challenge the dancer's physical condition; therefore physical preparation is essential in a dancer's schedule.

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INTRODUCTION

The evolution of the different dance techniques, like ballet (as one of the first ones to appear in the dance history) or "release" which is a new technique of dance that a lot of people are starting to practice nowadays, has brought down the dancers physical condition. As a consequence, dancers from all around the world get injured more often nowadays than in the past and due to this many dancers decide to quit performing this art because of how dangerous it can be at some times. The number of dancers worldwide has been going down lately according to the latest surveys not only in general but specifically in people; taking or teaching dance classes, practicing by themselves, assisting or performing at a dance show. The creation of new dance techniques and styles next to the fact that acting has become an important part of dancing and currently in this moment of dance's history that we live in you need acting as part of your dancing career in order to succeed. Physical condition of nowadays dancers isn't as good as it used to.

As we mentioned before this leads to dancers having way more injuries that in the past. It is considered ironic by many dance expertise the fact that in many official Spanish Dance Centers physical condition it is not required at any level for any student if they don't want to take it. Investigation contributes to the process of gathering valuable information. For example DIALNET (database for investigation) shows us 1088 different documents where the word 'dance' is mentioned, and out of all these documents we found out that the majority were about the methodology of dance and nothing, or almost nothing about physical condition for dancers. Out of all the revised articles 21 were Doctoral Thesis referred to dance. This database is completely in Spanish. Elvira Esteban, A.I, 2000 Some author exposes the difficulties that may appear when gathering information about dance, and also estimates the three biggest areas of investigation inside of it; for teaching, the methodology of teaching dance and the injuries caused by dance (Elvira Esteban, 2000). It is difficult to imagine the idea of not having a fitness trainer and/or a post-injuries trainer, in sports like these ones. Is dance as physically demanding as other sports that are practiced by professional athletes? The answer for this question is; yes, looking at it from a general point of view dance is at least as demanding as any other sport. We can also see this happening in sports like rhythmic gymnastics, acrobatics and ice-skating or even ski and

*Corresponding author: Calvo-lluch, A.,

Phd Profesor Pablo de Olavide University. Faculty of sport science
Ctra Utrera nº1 41013 Seville, Spain

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synchronized swimming (Fuentes Serrano, 1999 and García Ruso, 2000). We can find several studies that have been published in the last 6 years that talk about the anthropometry of a specific group of Cuban dancers. In these studies (Betancourt, 2011), estimate the fat percent in a specific group of ballet and contemporaneous dancers. In 2011 (Betancourt, 2009), these authors added to their first study another group of dancers from a different technique, they were folk and classic cultural dancers, carrying out a sub-study about this last group of dancers and their body measurements. In these studies plus in the ones published gives us all the clues that we need in order to have the anthropometric analysis (Betancourt, 2011; 2009 and Vázquez, 2003). We need this analysis in order to see which dancers have a higher fat percent and then work in reducing it. His thesis studies (Pozo, 2003), are really helpful when it comes to this kind of data. In his latest work that took place during 2009 he already specifies the level of training that these dancers need as well as some other characteristics like corporal composition, nutrition, pathological build ups... in a group of Spanish dance students. But on the other hand we were unable to find in any of these studies a reference to the importance of the dance's fitness training.

We analyzed 22 JCR articles that were published between 1999 and 2017 in them we can find information about dance and about how dancers can prepare their physical condition. After revising the limited amount of articles that we found, that may be specifically connected to dance and physical condition, we now can highlight the fact that all of them make allusion to how important the physical condition of the dancer is. And how this directly affects the dancer's performance and how often they get injured. Several authors (Rafferty, 2010; Vargas, 2009; Angioi, 2009; Angioi, 2009 and Koudetakakis, 2007), agree with the idea of physical preparation in nowadays dancers not meeting the high expectations created by this a very demanding sport in many different ways. Traditionally this has always been dependent on how dancers prepare their dancing technique. They all agree that it would be necessary to do it independently and also following the instructions of a professional trainer in order to improve their fitness. Having a program containing all the different types of trainings that the athlete is going to go through and that it also includes every performance that they have to do, is extremely important in order to avoid doing overtime practicing, low performance and/or injuries. These authors estimate that periodization is a dynamic process that should be checked every time there are changes in his performance, physical condition and availability. (Wilcosky, 2011).

Just like the previous mentioned authors, agrees that the practice of dance by itself is not enough to achieve positive changes in the dancer's aerobic skills and that doing a specific practice in order to improve their physical condition is extremely important. In addition (Wilcosky, 2013), studies the main reason why dancers do not want to work on their physical condition and fitness. Some reasons why they may not want to are the following; to not affect negatively their dance technique or physical appearance, this is proven by who in a well-planned practice program (they had 3 sessions of 3-5 repetitions of WDV of 40 seconds, with at least 1 minute to rest) (Giuseppe, 2007) significantly improved their high jump strength in their legs and reduced the amount of injuries that the dancers suffered from, and this also contradicted (Wilcosky, 2011) because these dancers noticed improvement in both their physical appearance and their dance technique. We can also

find some other studies carried out in which they put in practice a specific practice plan that includes shifts and vibrations, (Wyon, 2010), similar to the ones created by other authors (Giuseppe, 2007). These studies all end up in the same conclusion, which is that this planned practice program significantly improves the high jump and muscular strength while it doesn't modify the dancer's anthropometry. Other authors (Koudetakakis, 2007), propose other types of practices that get closer to achieve a significant improvement in the dancers endurance and maximizes the oxygen consumption. When using this kind of practice dancers experience a major improvement in their overall dancing skills, maximization of oxygen consumption, flexibility and lower body strength and these factors are what makes the believe that physical preparation and fitness in dancers is essential.

Overall they understand the fact that the practice of dance by itself does not improve neither the dancer's endurance or oxygen consumption. Vetter, R.; Dorgo, S. (Vetter, 2009) proposes other kind of practice, which consists of 60 minutes sessions for eight weeks doing what we call partners improvisational resistance training (PIRT), plus an intensive practice focused on improvising dancing techniques by partners, this practice has as a goal to improve the dancer's muscular strength. The experimental group that practiced using this plan experienced and increase in their muscular capacity and a decrease in their body fat percent, but the physical appearance did not change negatively in any of the dancers in the experiment. This is why we can now say that the PIRT can be considered to be a very efficient method to reduce body weight and to improve physical appearance. This is another study that contradicts the false idea of a specific practice to improve the dancer's physical condition affecting negatively their physical or esthetical appearance.

Some other authors centralize the idea of fitness and physical preparation being the only exclusive method available that we can use in order to improve the dancer's artistic performance. Different ways of practicing and improving the explosive strength are explained (Lukic, 2011). The obtained results in the study show the importance of focusing on different things when we are planning a programming the process of the dancer's practice, especially in Latino dances, this is because of the diversity in dynamics moves in this type of dances, also due to technique and the corporal expression. On a different page, differentiate ballet and modern types of dance like contemporaneous dance could be (Krasnow, 1999). The existing studies only have small samples and were done with small populations of students, which makes it more difficult to analyze sadistically and there is no data for professional dancers. They think that contemporaneous dance should be studied separately from ballet, because they collide in three basic concepts; level and injuries location, corporal composition and bio mechanic mechanisms (Krasnow, 1999). This differentiation is needed and they have proved that at a professional level, contemporaneous dancers show a higher maximum oxygen consumption, muscular endurance and fat percent than the ballet dancers (Angioi, 2009). But on the other hand there are no significant differences in physical condition or corporal composition in student of both styles. This must be because the practice of dance by itself is not enough to overcharge the system of muscles and the anaerobic and aerobic preparation of the dancer. Also these authors agree that from time to time physical condition tests should be done to the dancers in a validates laboratory (Angioi, 2009).

Table 1. List of articles and main consequences obtained

SCIENTIFIC REVIEW IN DANCE - PHYSICAL CONDITIONING					
Autors	Name of article	Year	Sample	Results	Physical quality required
- Krasnow, D - Kabbani, M	Dance Science Research and the Modern Dancer	1999	---	- There are very few studies that specifically addressed the problems of modern dancers. - Very small samples and based on student populations, so that statistical analysis is difficult and no data of professional dancers. - Should be considered separately from the ballet, it differs from it in 3 basic aspects: level and site of injury, body composition and biomechanical mechanisms.	(Review).
-Yiannis Koudetakis -Athanasios Jamurtas	The dancers as a performing athletes. Physiological consideration.	2004	---	-Dancers have the same physiological request than athletes. -Fitness level in any case is similar that sedentary people than dancers. -Improve fitness level could be the key to prevent injuries. -Future training program must not interfere with aesthetics and artistic components.	
- Deighan, M.A.	Flexibility in Dance	2005	---	- It Would be necessary evaluated more frequently passive and active range of motion, like a good indicator of the degree of joint stability and muscle strength deficit, hypermobility data that reveals instability and risk of injury occur. - The main physical requirement is the external rotation of the hip, with professional dancers 10th most "of turnout". - At the end of the season more injuries often occur and flexibility is lost due to muscular exhaustion. - Stretching exercises during heating impair muscle strength and power. Considers that the FNP produce long-term benefits	Range of Motion
- Wyon, M - Allen, N - Angioi, M - Nevill, A - Twitchett, E	Anthropometric Factors Affecting Vertical Jump Height in Ballet Dancers	2006	49 dancers, 21 men and 28 females.	- Men have a better vertical jump that women and soloists and leading artists they have significantly better than the cast of both genders. - Men are significantly more leg circumference than women although no significant bilateral differences between perimeters.	Strength Antropometrian
- Giuseppe, A - Elvira, P - Castagna, C - Salvo, V - Minichella, S	Effect of whole body vibration (WBV) training on lower limb performance in selected high-level ballet students	2007	22 dancers students 8 years of experience	- 3 sets of 3-5 reps of WBV 40 " with at least one minute recovery significantly improve vertical jump height. - These improvements are due to neuromuscular adaptations. -The dancers perceived improvements in their physical appearance and technical efficiency during performances. - With the WBV training you can maintain vertical jump height - It is difficult to say whether the increased muscle strength and explosive dynamics can increase performance in ballet, but it can help dancers to be safer and prevent muscle damage related to your plyometric activity.	Strength, entrenamiento con WBV
- Koutedakis, Y - Hukam, H - Metsios, G - Nevill, A - Glakas, G - Jamurtas, A - Myszkewycz, L	The Effects of three months of aerobic and strength training on selected performance-and fitness-related parameters in modern dance students	2007	32 dancers students of modern dance (27 females y 5 men)	- Aerobic training (2-3 sessions of 40-50 min a week) and force (3 sessions of 50 minutes) for 12 weeks produced significant increases in performance dance, maximal oxygen consumption, flexibility and strength lower body. - The improvements in aerobic capacity and lower body strength not impede the performance in dance. - The only training in dance is not enough to produce improvements in the physical condition of the dancers.	Strength, Range of Motion.
- Koutedakis, Y - Owolabi, E.O. - Apostólos, M	Dance Biomechanics A Tool for Controlling Health, Fitness, and Training	2008	---	-The demanding performance requirements in dance make increasingly sophisticated analytical methods are used. - Biomechanics, is used increasingly often through motion capture techniques muscle function and muscle strength.	Injuries, program

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- Huber, A - Cattelan, K	BMI and flexibility in ballerinas of contemporary dance and classical ballet	2008	22 dancers (11 of ballet y 11 of modern dance)	- There are no significant differences in BMI between contemporary and ballet dancers. - Higher than the reference standard (28-29 cm) above the linear flexibility of the muscular posterior chain results, however, lower than that of ballet dancers - All evaluated amplitudes of movement are higher in the group practicing ballet, but only the abduction movement had statistically significant difference between the 2 groups.	Range of Motion
- Angioi, M - Metsios, G.S. - Twitchett, E. - Koutedakis, Y - Wyon, M	Association Between Selected Physical Fitness Parameters and Aesthetic Competence in Contemporary Dancers	2009	11 females pre-professional s	- The muscle strength of the upper body (measured with the use of push-ups) and muscle strength of the lower part (measured jump) strongly predict the aesthetic component of the population studied contemporary dance. - However, there is no significant relationship between aerobic fitness and aesthetic component, as levels of flexibility.	Lesiones, stetic, Physical appearance
- Angioi, M - Metsios, G.S. - Twitchett, E. - Koutedakis, Y - Wyon, M	Physical fitness and severity of injuries in contemporary dancers.	2009	5 professional female contemporary dancers and 11 dance student pre-professional.	-The standing vertical jump is a reliable predictor of injury. This fact is due to low power is associate to days off because of injury. -For this reason, is necessary an adequate conditional fitness to minimize injuries. -Conventional lesson of dancer could not be sufficient in strength and power level. -For this reason, supplemental strength training could be necessary.	
- Vargas, A	Dance and fitness	2009	---	- In most of the analyzed variables (VO2max, strength...) dance practitioners outperform a standard population but well below that athletes of the same age. - The physical demands of effort it requires different modalities if dancísticas are quite comparable in acyclic sports. - The physical preparation dancer will not consistent with the physical demands of dance.	Resistance
- Angioi, M - Metsios, G. - Koutedakis, Y. - Wyon, M. A.	Fitness in Contemporary Dance: A Systematic Review	2009	Profesionals dancers	- Professionally, contemporary dancers show higher consumption VO2 max, muscular strength and body fat percentage ballet dancers. No significant differences in body composition. - Almost all items that have been made compared with other athletes but not with contemporary ballet. - Most studies have focused on the physical condition of the dancers, not having well-conducted studies evaluating objectively the aesthetic aspects of contemporary dancers. - Regular assessments of the levels of fitness (strength, flexibility...) through laboratory validated procedures should be undertaken. - It would be desirable to perform a specific strength training in dance to avoid injury.	Resistance, strength, Range of Motion.
- Vetter, R. - Dorgo, S	Effects of partner's improvisational resistance training on dancer's muscular strength (PIRT)	2009	19 dancers ballet, modern and jazz.	- 3 sessions of 60 minutes during 8 weeks of resistance training improvisational pairs (PIRT). 8 isometric eg pairs. plus technical training produces improvements in muscle strength dancers with little or no experience in resistance training. - The experimental group (7 dancers who performed well PIRT technique classes), showed a downward trend in the percentage of body fat and increased lean body mass, whereas the control group showed otherwise. However, there were no significant differences in body composition of the dancers in both groups. - 4 of the 5 body circumferences measures were lower in the post, being significant the waist and hips. - The PIRT can be considered as an effective method to reduce body weight and improve aesthetic appearance.	Strength. resistance
-Koutedakis, Y. -Clarke, F. - Wyon, M. A. -Aways, D. - Owolabi, E.O.	Muscular Strength: Applications for Dancers. Review	2009	Dancers	-Strength training regimens not are different for styles of dance but lower strength levels is associate with greater several of injury. -Foot and ankle are the most common part of the body liable to injury in ballet dancers, while low back and knee are more common in contemporary dancers.	Test, High intensity.

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-Redding, E. -Weller, P. -Ehrenberg, S. -Irvine, S. -Quin, E. -Rafferty, S. -Wyon, M. -Cox, C.	The Developed of a High Intensity Dance Performance Fitness Test.	2009	16 Contemporary dancers (4 males and 12 females)	-Fitness training is being recommended in dance training to bear the demands of their movement. -This test looks reliable to assess the physiological capabilities at high intensity by means of contemporary dance.	
- González, A. - Gómez, R - Fernández, J - Costa, J	Assessment of articular amplitudes and muscle shortening in flamenco dance	2010	37 flamenco dancers	The flamenco dancers have a deficit in physical condition by shortening the muscles in the upper body and lower body. Decompensation and muscle shortening are evident bilaterally.	Range of Motion
- Wyon, M -Guinan, D -Hawkey, A	Whole-body vibration training increases vertical jump height in a dance population	2010	18 University dancers students	- 2 sessions of WBV a week with 2 repetitions of 30 seconds significantly improve vertical jump height. - There were no significant changes in anthropometric measurements and data hydration of the dancers	Strength
- Wyon M	Preparing to Perform Periodization and Dance	2010	---	- A periodized training with testing and performance demands is essential for the prevention of overtraining, poor performance and injury. - Only a few companies and dance schools have implemented this methodology - Professional dance training is more complex due to the multiple goals you have.	Strength
- Rafferty, S	Consideratios for integrating fitness into dance training	2010	---	You must include fitness training within the usual dance classes, since this is such an important factor as artistically expression	Range of Motion
- Wilcosky, B	Fitness in Dance: Going Beyond Flexibility	2011	---	- The dance activity alone is not sufficient to achieve positive adaptations in aerobic dancers system. - The dancers do not want to participate in training to not adversely affect the quality of its technical performance or physical appearance	Resistance, Range of Motion. Physical appearance
- Lukic, A - Bijelic ,S - Zagorc, M - Zuhric-Sebic, L	The importance of strength In sport dance performance technique	2011	49 dancers (25 females 24 men)	- The strength does not serve to predict the efficiency of the technical elements of ballroom dancing. - The strength if used to predict the technical elements of Latin-American dance. - The results of the study show the need for a different approach to planning and scheduling the training process.	Strength
-Smol, E. -Fredyk, A.	Supplementary low-intensity aerobic training improves aerobics capacity and does not affect psychomotor performance in professional female ballet dancers.	2012	6 professional female ballet dancers.	-The typical workload used in ballet class is not enough to improve aerobic capacity. -6 week of supplementary of low intensity endurance training improve aerobic capacity in female ballet dancers without decreasing psychomotor performance which important in this sport discipline.	
-Wilhelm Mistiaen -Nathalie A, Roussel -Dirk Vissers -Liesbeth Daenen -Steven Truijen -Jo Nijs	Effects of aerobics endurance, muscle strength and motor control exercises on physical fitness and musculoskeletal injury rate in preprofessional dancers: an uncontrolled trial	2012	41 preprofessional dancers	-This study show the improve of physical condition in preprofessional dancers and are not clear for commun injuries in dancers. -A control group is need to asses the effect magnitude by training.	
-Montesinos, JLG - Vargas AM, Santos JDF - Galo ,AG, de los Monteros, RGE, Sepulveda, JL.	Physial assessment in Flamenco Dance	2011	17 Flamenco dancers	-Maximal oxygen consumption and the numberof metabolic equivalents are higher than those required in other similar dances and high level sports Flamenco dance practice requires greater physicalworkloads than to any other high level sport.	

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-Morrin, N. -Redding, E.	Acute effect on warm-up stretch protocols on balance, vertical jump height and range of motion in dancers.	2013	10 trained female dancers.	-The static stretch has a positive effect in ROM. The dynamic stretch has a positive effect in vertical jump. -The combination of both protocols appears that improve a vertical jump, ROM and balance. -A cardiovascular warm-up followed by 30" static stretch and followed by 30" dynamic stretch show the optimal performance un vertical jump, balance and ROM.	Stretch, balance, vertical jump and ROM
-Berkiye Kirmizigil -Bahtiyar Ozaldizan -Muzaffer Colahoglu	Effects of three different stretching techniques on vertical jumping performance.	2014	101 male athletes	-Ballistic stretching improve vertical jump in subject with low flexibility and poor jump. -Proprioceptive neural facilitation and ballistic stretching both affect vertical jump in subject with high flexibility. -Proprioceptive neural facilitation and static stretching both show a worse in vertical jump for subject with high flexibility and jumping.	Stretching, vertical jump.
-Nathalie A. Roussel -Dirk Vissers -Kevin Huppens -Erik Fransen -Steven Truijen -Jo Nijs -Wilfried De Backer	Effect of a physical conditioning versus health promotion intervention in dancers: a randomized control trial	2014	44 dancers	-This study show a training period about 4 month, 2,5 hour per week. The result reflect no change in training group (A). -May be is necessary a long period of train to improve physical conditioning. - One group (B) was informed about a health promotion, this group no experimented physical conditioning changes. -Training group (A) only improve pain sense in back.	
-Sozbir K. -Acay Sozbir S. -Aydin K. -Karli U.	Effects of plyometric on anaerobic performance of collegiate female contemporary dancers.	2014	27 contemporary modern female dancers	-This study shows the effect of plyometric training in vertical jump (VJ) and peak anaerobic power (PAP). -2 days per week during 6 weeks enhance vertical jump and peak anaerobic power in experimental group in contrast to control group. -in addition, both group kept contemporary dance training. -the main author suggests that contemporary dance training is not enough to improve physical conditioning dancers alone.	
-Josianne Rodrigues-Krause -Mauricio Krause -Álvaro Reischak Oliveira	Cardiorespiratory considerations in dance from classes to performances	2015	---	-Metabolic demands are different depend each dance style as well as the facts of choreography. -This demands needs supplementation of fitness training. -Supplementation of fitness training improve aesthetic competence and physical condition as endurance, strength, body composition and flexibility.	Physical condition
-Nitzsche N. -Stutzig N. -Walther A. -Siebert T.	Effects of plyometric training on Rock 'n' roll performance.	2015	15 semi-professional rock 'n' roll dancers	-Plyometric training improve performance in Rock 'n' roll dancers. -This may be for gains in reactive strength. -This study don't reveal any information about neural/muscle adaptation un plantar flexors.	
-Jatin P. Ambegaonker -Nelson Cortes -Shane V. Caswell -Gautam P. Ambegaonker -Matthew Wyon	Lower extremity hypermobility, but not core muscle endurance influence balance in female collegiate dancers	2016	15 female collegiate dancers.	-Lower extremity hypermobility may be related with balance but not with core endurance. -Further study are need to relate hypermobility influence in balance. -Core training with multiple muscles could improve performance that isolate muscle core training.	
-Sozbir K.	Effects of 6 week plyometric training on vertical jump performance and muscle activation of lower extremity muscle	2016	24 highly physically active physical education students.	-The paper show 6 week of plyometric training enhances neuromuscular activation (EMG) in lower extremity muscle but not improve the height of jump significantly. -This suggests vertical jump maybe not only related with performance. -Experience and technique both also improve vertical jump.	
-Todd Watson -Jessica Graning -Sue Mcpherson -Elizabeth Carter -Joshuah Edwards -Isaac Melcher -Taylor Burgess	Dance, balance and core muscle performance measures are improved following a 9-week core stabilization training program among competitive collegiate dancers.	2017	24 female collegiate dancers	-9 weeks core training improves dance performance, balance and core performance. -Core stabilization training program causes improvements in different dance positions.	Core training

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As these authors say, there is a difference between the fat percent in contemporaneous dancers and ballet dancers. Hubber et al. (Angioi, 2009), explains there is no significant differences in the CMI between contemporaneous dancers and ballet dancers.

Conclusion

The majority of these articles expose a lack of extensive bibliography about the treated topic. They repeat over and over the importance of working on the dancer's physical condition, especially strength and endurance (just for professional dancers). All the different tests that are done on the dancers (CMJ...) are predictors and can evaluate the dancer's fitness condition. The use of technology WBV is beneficial for the dancers practices and training sessions and does not modify their corporal structure (Ambegaonkar, 2016; Koutedakis, 2008; Gonzalez Galo, 2011; Deighan, 2005; Kirmizigil, 2014; Koutedakis, 2009). The specific fitness for dancers must have performance and aesthetic factor into account in the stage. It's important to couple the physical training of technical requirements. ROM is more profitable if done dynamically. (Clavo-Lluch, 2011; Koutedakis, 2004; Montesinos, 2011; Morrin, 2013; Nietzsche, 2015; Redding, 2009). An extra cardiorespiratory work benefits the dancers (Rodrigues-Krause, 2015; Roussel, 2014; Smol, 2012; Sozbir, 2016 and Wilhelm, 2012). Plyometric work increases strength in all types of dancers (Sozbir, 2016; Sozbir, 2014; Wyon, 2006; Watson, 2017; Wilhelm, 2012).

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