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Balance evaluation and proprioceptive training on ballerinas - Part I: questionnaire design and proprioceptive training program for ballet dancers

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Abstract. Static and dynamic balance are essential in the training of ballet dancers to perform on stage and to improve artistic technique. Ballet dancers have specific postural balance pattern, highly dependent on visual inputs to maintain balance. Furthermore, dancing "en pointe" can give rise to numerous injuries in young dancers, especially due to ankle instability. We meant to assess the auto- perception of balance in professional and pre-professional ballet dancers through a new self-assessment balance questionnaire, the Self Assessment Balance Ballet Questionnaire, which is able to determine the perceived balance in ballerinas and the differences among them, to produce a valid and easy-to-use instrument of evaluation of balance in the specific field of ballet. We meant also to propose a new Proprioceptive Eye-Closed Training Program of exercises, specifically settled on female ballet dancers performing "en pointe", with time standardization in training and increasing difficulty in execution to provide teachers, physicians and physiotherapists an effective tool in ballet training, prevention of injuries and ankle rehabilitation post traumas.
Key words: *balance, ballet, proprioception, training, ballerina*.

Introduction

Currently people are participating in sports for personal interest, relaxation, fitness and sport training. But sport is one of the major causes of injuries causing pain, loss of playing or working time, as well as high medical expenditure. Ankle injuries are one of the most common acute soft tissue injuries, with a significant treatment cost to both the individual and society. An epidemiological study about sport injuries in 43 sports showed that ankle sprain was the most common injury (33 sports, 76.7%) and in some sports, all of the reported ankle injuries were ankle sprains (100%) (1).

Balance is a lifetime achievement, a process of learning to navigate in the world that begins in infancy and continues into old age (2). For ballet dancers, the achievement of both static and dynamic balance is fundamental to perform on stage and train in studios to improve artistic technique. Studies comparing the balance of ballet dancers to other sports confirmed that they have specific postural balance pattern. Nevertheless, in association with visual restriction, ballet dancers show a greater center of pressure dislocation and instability compared to other sports, which suggests that they have higher visual dependence to maintain balance (3).

In order to improve balance skills and ability in ballet, many exercises training program for postural static and dynamic balance have been created for dancers in time; several studies have shown the fundamental role of proprioception (4) to achieve and maintain a correct and satisfying balance, especially on stage, where there is a natural decrease of visual optimal conditions, dues to the presence of stage lights. Furthermore, ballerinas dance "en pointe", a specific technique of ballet that can give rise to numerous injuries in young dancers, especially affecting the lower limb due to ankle instability (5).

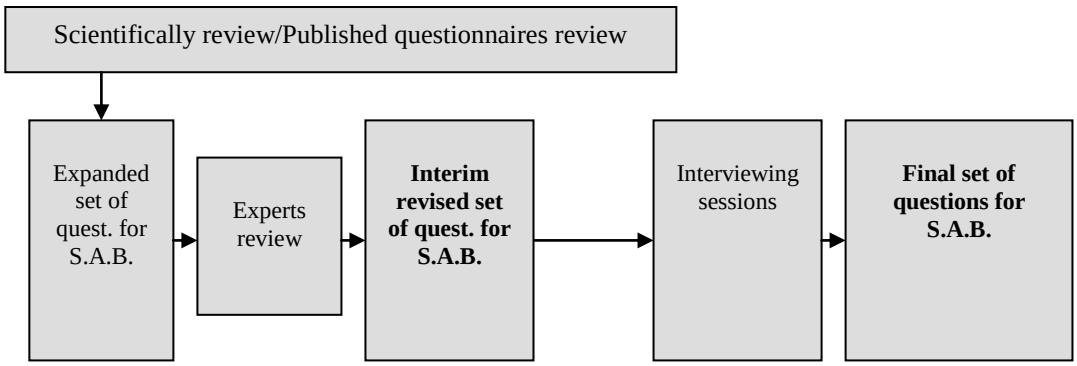
Furthermore, having ballerinas greater postural and balance control than people who are not dancing or practicing other sports, our preliminary study meant to assess the auto perception of balance in professional and pre-professional ballet dancers, through a new self-assessment balance questionnaire, able to determine the perceived balance in well trained ballerinas and the differences among them. We meant also to propose a new eye-closed program of proprioceptive exercises specifically settled on female ballet dancers, in order to improve core stability through proprioception neuromodulation and the removal of visual inputs (6).

Therefore, the aim of our study was to develop and establish the initial content validity of a new questionnaire as a reliable and valid tool to measure the perception of both static and dynamic balance in ballet dancers, and to describe the process, including focus groups used to develop the questions content. The process for creating the Self Assessment Balance (S.A.B.) has involved the development of new items to create a questions bank; the method for questions bank development was the focus groups method that help to determine both general themes and specific ideas of participants about particular issues, products, and/or services and can, thus, be used to identify functional activities for new test items (7).
Proprioception is defined as the ability to establish a sense of position in space, especially at a joint. It is associated and interrelated with the joint mechanoreceptors. If the mechanoreceptors are damaged when an ankle sprain occurs, proprioception will be affected, which results in a reduction in the body's ability to balance. Thus, proprioception will not be an effective mechanism for reducing the chance for further injury. Reeducation of the mechanoreceptors becomes a vital key to returning an individual to a perceived sense of stability and a complete lower limb function (8). By this study we also introduced and test an eye-closed program of proprioceptive exercises to improve balance in ballerinas dancing "en pointe".

Material and method

Information from the experts' survey, scientifically literature, and professional dancers' interviews were used as a basis for item generation and definition of structural limitations for a questionnaire that would be practical and easy to use as auto-evaluation of balance in ballerinas, according two phases:
Phase I, Development of New Questions, included generating of an expanded set of items using a review of existing questionnaires, expert review and focus groups.
Phase II, Questions Revision that includes a series of interviews.

Figure 1. Development process for S.A.B. questions content



The study teamwork developed an *expanded set of questions* regarding perception of balance in professional and pre-professional ballet dancers.
Subjects and procedure: 3 specialist medical physicians and 1 physiotherapist were recruited from *2 different settings* within the medical rehabilitation and physiotherapy field, including public and private rehabilitation clinics, and research settings. The specialists were recruited through personal and professional contacts if they satisfied the following criteria: active in clinical practice and having expertise in sports rehabilitation, assessment and measurement of the musculoskeletal and balance complaints, instrument design, validation, and score construction.
Instrument: an open-ended questionnaire was designed to investigate what questions are more important to include on this new tool to evaluate the satisfaction perceived by subjects performing specific tasks, such as balance on two legs when dancing, balance on the single leg when dancing, or the perception of instability on both legs. Three of the project team members examined drafts of the questionnaire to ensure completeness, clarity, and applicability. Few minor revisions were made. The questionnaire was translated into Romanian language by a native Romanian-Italian speaking PRM specialist physician.

According to correct procedures for designing questionnaires (9,10) the final draft was pre-tested by the fourth team member, expert dance trainer and physiotherapist, and final minor revisions made (Fig. 1).
The program of exercises was drawn on the basis of several proprioceptive exercises program in patients with ankle instability (11, 12) and identifying the appropriate and precise tasks that need improvement, using these tasks in the training program and as a part of the test battery that evaluates the efficacy of the training program (13).

Results
S.A.B. Self Assessment Balance Ballet Questionnaire. It means to measure the auto-perception of balance in well trained professional and pre-professional ballet dancers, through five questions about the satisfaction perceived by subjects performing specific tasks, such as balance on two legs when dancing, balance on the single leg when dancing, the perception of instability on both legs when performing and an auto-evaluation of stability in the movement of relevé (14) (Table I).

Table I. Self Assessment Balance Ballet Questionnaire

		Not at all	**Little**	**Mild**	**Much**	**Very much**
1.	I am satisfied with my balance when dancing	1	2	3	4	5
2.	I feel in balance on two legs when dancing	1	2	3	4	5
3.	I feel in balance on one leg when dancing	1	2	3	4	5
4.	I feel uncertain/unstable when dancing	Very frequently 1	Frequently 2	Sometimes 3	Rarely 4	Never 5
5.	Give a score to your stability in the position of relevè	Very low 1	Low 2	Sufficient 3	Good 4	Very good 5
TOTAL SCORE						

Training Proprioceptive Program for Ballet dancers. The Proprioceptive Eye-Closed Training Program means to improve balance in professional ballet dancers dancing en pointe, through the eye-closed execution of specific tasks requested in ballerinas when dancing, performed on a (15). We intend to develop a new proprioceptive program with increasing difficulty specifically settled on ballerinas, to standardize exercises and time of execution of each item. To do that a population of 12 professional and pre-professional female ballet dancers, with an age from 15 to 25 were enrolled in a preliminary study and tested for balance through the Star Excursion Balance Test (S.E.B.T.) (16). Ballerinas were tested before and the execution of this eye-closed training proprioception program. The S.E.B.T. showed satisfying results in the implement of balance in this population.
This new three weeks and one session lasting Proprioceptive Eye-closed Program means to be executed with a frequency of 3 times per week and a total of 10 workout sessions, carried out before the classic warm-up at the ballet bar.

1. in seated position: with both legs placed on the platform (Freeman platform) try to get both legs in perfect balance for 30s without any external perturbation;
2. repeat exercise number 1 with external perturbation of your balance;
3. in seated position: place one foot above the platform and perform 10 movements of *flexion-extension* of the ankle joint, then repeat with the other foot;
4. Repeat the exercise 3 performing 10 movements of *inversion-rversion* of both feet;
5. Standing on the platform with hand support try to maintain balance in bipodal support with flat feet for 30 seconds without any external perturbation of balance;
6. Repeat exercise 5 with external perturbation of your balance (through the help of your teacher);
7. Repeat exercise number 5 and exercise number 6 without hand support on the bar;

8. Standing on the platform, with the hands on the bar, maintain on single leg stance balance. Put the other free leg in position of COU DE PIED EN DEDANS. Perform two repetitions of 30s for each leg;
9. Repeat exercise number 8 with the free leg extended or lightly bent posterior at 45° (*Arabesque or attitude en arrière*) (Fig. 2);
10. Repeat exercise number 8 and exercise number 9 without hand support on the bar;
11. Standing on the platform, with support of both hands on the bar try to maintain bipodalic balance on *demi-pointe* position (relevé in 6th position or closed 1st position), 2 repetitions of 30 seconds;
12. Repeat exercise number 11 in monopodalic balance, first with right leg and then with left leg, putting the free leg on position of *cou de pied*, 2 repetitions of 30s for each leg;
13. Standing above the platform with hand support, try to perform 10 movements of *releve*' in 6th position or narrowed 1st position with both legs standing on platform (bipodalic balance) (Fig.3);
14. Repeat exercise number 13 in monopodalic balance (one leg stance), first with right and then with left leg, with the free limb in position of *cou de pied* or *arabesque* (Fig.4).

Figure 2. Monopodalic balance in the position of attitude *en arrière*

Figure 3. Movement of *relevé* in 6th position

Figure 4. Movement of *relevé in cou de pied* en dedans

Discussion and conclusion

Ankle instability and sprains often result in pain, disability, dysfunction, time lost from activity, the requirement for treatment, and economic burden (17). Balance training is often the first choice of treatment in patients with functional ankle instability (FAI); however the effect of balance training on the ankle proprioceptive sensation in these patients is debatable (18). Several authors have shown the effectiveness of these interventions in reducing sport-related injury risk as well as in enhancing functional performance after sport injury (19,20). It has been suggested that changes in proprioception and neuromuscular control are predominantly responsible for these effects (21).

By this paper we introduced a self-assessment questionnaire, that was designed and focused on the specific tasks and skills of ballet dancers, to evaluate the auto-perception of balance in a selected population composed by ballerinas, which according to literature and common experience, have postural static and dynamic balance greater than a not dancing population, either than other sports.

The new proposed Proprioceptive Eye-Closed Training Program was focused on the specific balance skills and dancing steps performed by female ballet dancers dancing en pointe, through the implement of balance by exercises already executed by dancers, but with increasing difficulties such as: the exclusion of visual inputs, the execution of the program using a proprioceptive table, the use of exercises and positions strictly referred to ballet technique, such as the movement of "relevé en demi-pointe", the position of "cou de pied" and "arabesque", and the standardization of timing and increasing difficulty of the program.

In our opinion, this new Proprioceptive Eye-Closed Training Program of exercises could ameliorate balance during the performance en pointe on stage and prevent injuries due to anatomical distress and overuse syndrome of the ankle joints. Proprioceptive exercises are ones of the newer beneficent therapies available in rehabilitation. With every new study it is proved their excellent effect, so physical therapists and athletic trainers are able to provide better care to their patients and trainees.
The development of tools that enable the assessment of balance in ballet dancers is a fundamental step to measure balance in a selected population who has higher balance than common people, but needs to test in order to improve program of exercises useful in training and rehabilitation for a better stability of joints (especially ankle). This assessment could also promote a scientific link between ballet dancers needs and physicians, physiotherapists and trainers' approaches to prevention of injuries and improving in ballet technique. In the future, it is likely more studies will indicate that balance and proprioceptive exercise, along with rehabilitation and strengthening, will lead to functional improvements (such as better postural control) and reduced injury rates after balance training (often associated with adaptations in neuromuscular control mechanisms), likewise helping to a faster patient return to activity with a more functionally stable ankle.

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