


SEBT in individuals with patellofemoral pain: an integrative review

SEBT em indivíduos com dor patelofemoral: uma revisão integrativa

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Abstract

Introduction: Decreased postural stability can be observed in individuals with patellofemoral pain (PP). The Star Excursion Balance Test (SEBT) is widely used to assess deficits that need to be improved, with different application methods and result presentation formats.

Objective: To map SEBT use in individuals with PP, characterizing the studies that applied it to identify different application methods and result presentation formats.

Methods: The review included randomized and non-randomized clinical trials, cross-sectional, case-control and cohort studies. Searches were performed in Pubmed and SciELO databases. Data extracted from eligible studies were divided into categories: (I) study characterization (II) SEBT application methods and result presentation formats. **Results:** A total of 177 studies were identified in the databases, 13 of which were selected. There are a growing number of new studies that assess the dynamic postural control of individuals with PP using the SEBT, and a variety of test application and result presentation formats. **Conclusion:** The SEBT is a useful, easy-to-apply test that identifies changes in dynamic postural control in individuals with PP. Different application and result presentation formats are in accordance with the literature, but it is recommended that future studies apply the protocols most widely used in previous studies that exhibit a low risk of bias, in order to improve repeatability and comparisons between studies.

Keywords: Functional physical performance. Patellofemoral pain syndrome. Postural balance.

Resumo

Introdução: A diminuição da estabilidade postural pode ser observada em indivíduos com dor patelofemoral (DP). O Star Excursion Balance Test (SEBT) é um teste amplamente utilizado para a avaliação de déficits que precisam ser melhorados e também pode apresentar diferentes maneiras de aplicabilidade e apresentação dos resultados obtidos.

Objetivo: Mapear a utilização do SEBT em indivíduos com DP, caracterizando os estudos que utilizaram o teste, de maneira a identificar diferentes formas de aplicabilidade e apresentação dos resultados. **Métodos:** A presente revisão incluiu ensaios clínicos randomizados e não randomizados, estudos transversais, caso-controle e estudos de coorte. As buscas foram realizadas nas bases de dados Pubmed e SciELO. Dados extraídos dos estudos elegíveis foram designados em categorias: (I) caracterização dos estudos, (II) formas de aplicação do SEBT e apresentação de resultados. **Resultados:** Foram identificados um total de 177 registros nas bases de dados analisadas e 13 destes foram selecionados. Existe um número crescente de novos estudos que buscam avaliar o controle postural dinâmico de indivíduos com DP utilizando o SEBT, sendo que existe uma variabilidade na aplicabilidade do teste e também na apresentação dos resultados. **Conclusão:** O SEBT é um teste útil, de fácil aplicabilidade e que identifica alterações do controle postural dinâmico em indivíduos com DP. Diferentes formas de aplicação e apresentação dos resultados do teste estão de acordo com a literatura, porém recomenda-se que estudos futuros utilizem os protocolos mais utilizados em estudos prévios que apresentem baixo risco de viés, para que seja possível melhorar a repetibilidade e as comparações entre estudos.

Palavras-chave: Desempenho físico funcional. Síndrome da dor patelofemoral. Equilíbrio postural.

Introduction

Patellofemoral pain (PP) is characterized by diffuse pain in the anterior region of the knee, with insidious onset.¹ Pain is aggravated by activities that increase compression forces in the patellofemoral joint, such as squatting, climbing up and down stairs, running and remaining seated for a long time.² This is one of the most common knee injuries in physically active individuals,

exhibiting high rates of functional disability.³ The origin of PP is multifactorial. Evidence shows that weak femoral quadriceps muscles is a risk factor for this condition,⁴ but many other factors seem to be involved, such as anatomic, biomechanical and psychosocial factors, making PP a clinical challenge.⁵

In recent years, individuals with PP have demonstrated neuromuscular hip alterations and changes in lower limb movement during dynamic activities.^{6,7} It is suggested that hip muscles are essential to maintain posture and balance.⁸ These muscles minimize acceleration of the center of mass of the body as a response to postural disorders in the anteroposterior and mediolateral directions.⁹ Studies indicate that the postural stability of individuals with PP declines during their activities of daily living and sport practices.^{10,11} Thus, dynamic postural control assessment seems to be a good strategy for evaluating deficits that need to be improved in this population.^{12,13}

One of the tests that has attracted attention in clinical and research settings is the Star Excursion Balance Test (SEBT),¹¹ which involves the individual establishing a stable support base standing on one leg, and reaching in the different directions of the star pattern with the other foot.¹⁴ The measures (reach distances in the different directions) are used with a dynamic postural control index.¹⁴ The initial idea with the use of SEBT is to measure the reach deficit indicated by difficulty in maintaining dynamic postural stability.¹⁴ The SEBT is indicated to compare injured limbs before and after interventions to quantify improvements.¹¹ The test allows different execution possibilities and result presentation formats. The literature demonstrates different data presentations, which may hinder study comparisons. An integrative review is a broad methodological approach including different types of studies for full understanding of the object of analysis,^{15,16} with a variety of purposes, such as defining concepts, reviewing theories and analyzing methodological problems for a specific topic.¹⁵ Thus, an integrative review also makes it possible to determine the gaps in a specific topic and the feasibility of conducting a systematic review with meta-analysis.¹⁵

The aim of this integrative review was to map the use of SEBT and characterize studies, as well as analyze the forms of application and result presentation of this functional clinical test, identifying the variations used in each study for a population with PP.

Methods

First, a search was carried out in the PROSPERO (International Prospective Register of Systematic Reviews) and PubMed databases in order to identify any type of review on the proposed topic, but none was found. This integrative review used specific strategies, based on Whittemore and Knafl,¹⁶ to increase the methodological rigor of the process. The following guiding question was used: how is SEBT being applied and how have the results been presented in studies that used the test as a clinical assessment tool in individuals with PP?

Inclusion and exclusion criteria

This integrative review adopted the acronym PCC: participants (individuals with clinical diagnosis of patellofemoral pain, of any age and either sex, submitted to assessment of dynamic postural control); concept (SEBT applied in individuals with PP); context (changes in dynamic postural control in individuals with PP compared to control subjects or limb without pain; and/or after any physiotherapy intervention). The types of studies included were experimental, such as randomized and non-randomized clinical trials (quasi experimental), cross-sectional studies, case-control and cohorts, in English or Portuguese, published in the last 10 years. Excluded were studies with other diagnoses (osteoarthritis of the knee, anterior cruciate ligament injury, arthroplasty of the knee and ankle instability), those that used other tests and equipment for assessment and studies that did not evaluate dynamic postural control.

Search strategy

An electronic search was conducted in the PubMed and SciELO databases. The following terms were used: ("star excursion balance" OR "SEBT" OR "Y- balance test" OR "dynamic postural stability" OR "dynamic postural control" OR "balance") AND ("patellofemoral pain" OR "anterior knee pain" OR "patellofemoral pain syndrome"). These terms were adapted for advanced searches in each of the databases. Mendeley software was used for study selection, involving the screening of duplicates, titles, and abstract reading, followed by the selection of

potentially relevant complete studies. An independent reviewer selected the studies and extracted data from the complete studies. In the event of disagreement, a second and third reviewer were consulted to obtain consensus via discussion or arbitration. All the data extracted were combined in a pre-established electronic spreadsheet for subsequent analysis. The data were classified as (I) study characterization and (II) forms of application and result presentation.

Quality (risk of bias)

Different tools were used to assess the risk of bias of the eligible studies. The Physiotherapy Evidence Database (PEDro) scale was applied in the experimental studies and the following score ranges were used for interpretation purposes: 6-10, high methodological quality; 4-5, medium methodological quality; and 0-3, low methodological quality with high risk of bias.¹⁷ The scores provided were verified on the database of the experimental studies.

For the prospective cohort designs and case-controls, the Newcastle-Ottawa scale was used, adopting the following classification: scores between 6 and 8 were classified as moderate studies, and those 5 points or less as low quality.¹⁸

Finally, cross-sectional studies were assessed using the Joanna Briggs Critical Appraisal Tools checklist, calculating the percentage of "yes" answers. Studies were considered high risk of bias when the percentage of "yes" answers was between 50 and 69% and low risk when the percentage was 70% or more.¹⁹

Results and discussion

The database search resulted in 177 studies. After screening for duplicates and eligibility, 13 articles published in the last 10 years in English and Portuguese were selected (Figure 1).

The types of studies found in this review were three quasi-experimental,²⁰⁻²² three randomized clinical trials,²³⁻²⁵ two prospective cohort studies,^{26,27} three case-control²⁸⁻³⁰ and two cross-sectional studies.^{31,32} Zamboti et al.³² established a moderate correlation between the SEBT test and the gold standard for analysis of dynamic postural control, namely the force platform.

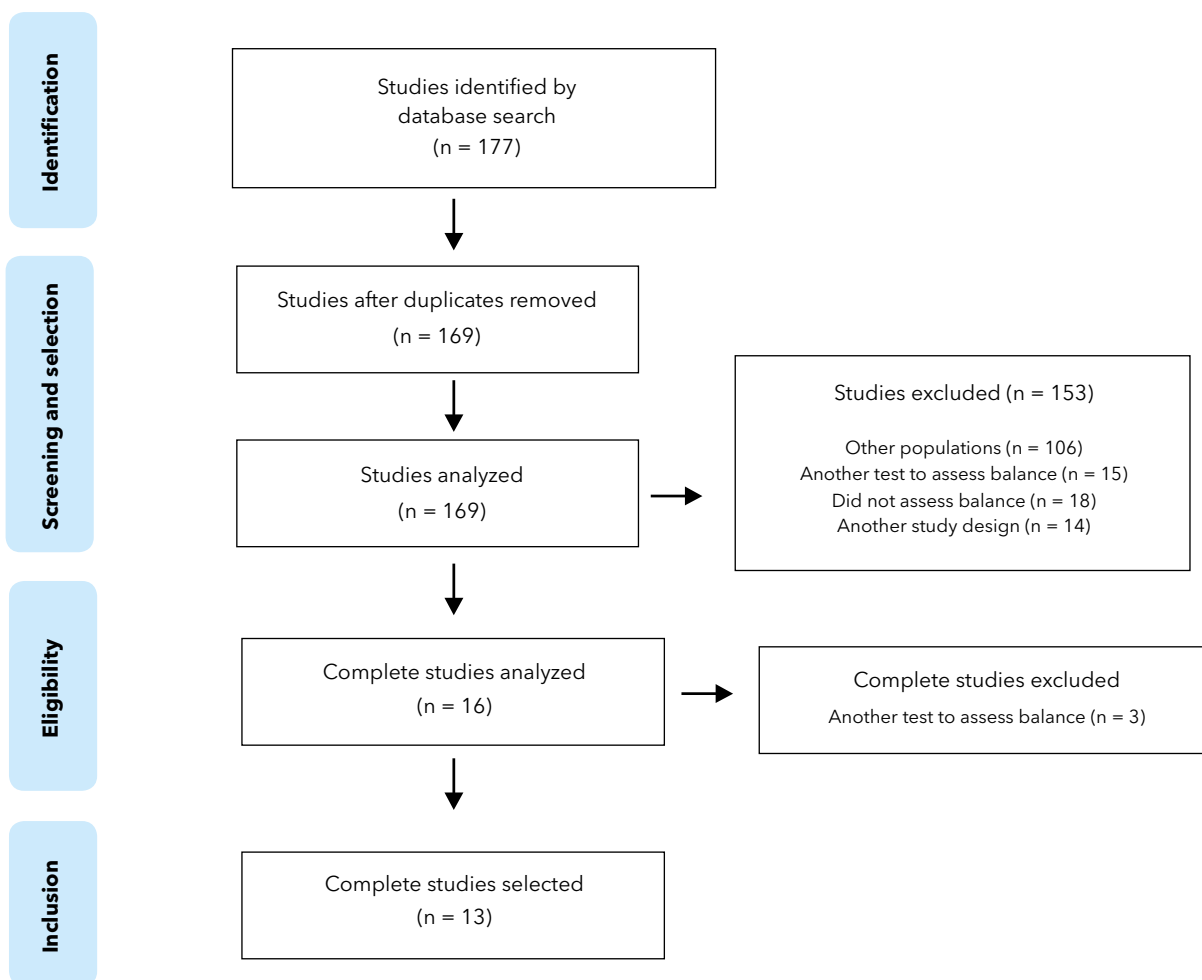


Figure 1 - Integrated review phases.

Four different designs were included in the present review, hindering quality comparisons between studies (Table 1). In general, the experimental studies obtained better assessments, with five studies^{20,22-25} assessed as high methodological quality. Among the prospective cohort and case control studies, one²⁹ obtained the maximum quality score, while another²⁷ achieved the minimum score, thus attributing high risk of bias. Cross-sectional studies^{31,32} were classified with a percentage above 70%, indicating low risk of bias.

The SEBT is a reliable measurement tool and valid as a dynamic test to identify dynamic postural control deficits and predict risk of lower limb injury, as reported in the prospective study of Nakagawa et al.²⁶ In addition, in the present integrative review, this test is inexpensive, does not require sophisticated technology and can be easily used in clinical and research settings when a force platform (gold standard) is not available.

Details on study characterization are presented in Table 2. Two studies^{20,23} investigated the effects of training on core muscle strengthening versus conventional physiotherapy for pain and dynamic postural balance in individuals with PP. Three studies^{21,22,30} assessed the efficacy of bandages (Kinesio taping) on pain, function and dynamic postural control, two of which compared the efficacy of Kinesio taping versus the mobilization with movement technique (straight leg raise with traction and tibial sliding)²¹ and manipulation of the lumbopelvic region.²²

The findings of this integrative review on the use of bandages for individuals with PP corroborates the latest clinical practice guideline for PP,³³ since it is a resource that may produce therapeutic benefits for this population in the short term and when combined with therapeutic hip and knee exercise. This result may be attributed to pain modulation and contributions in the cutaneous

receptors in hip and kinesthesia proprioception, helping increase motor control.³⁴ Motealleh et al.²⁴ also used lumbopelvic manipulation to determine whether pain diminishes, the error in joint sense position of the knee decreases and balance improves in individuals with PP. In the clinical trial by Zarei et al.,²⁵ the authors tested

the additional effect of gluteus medius and quadratus lumborum dry needling in conventional exercise therapy for athletes with PP. In a cross-sectional study, Steinberg et al.³¹ examined the efficacy of two physical exercise programs (isometric exercise program versus somatosensory exercises) in ballet dancers with PP.

Table 1 - Assessment of risk of bias according to the study designs and their respective scales

Studies	Design	Physiotherapy Evidence Database (PEDro)	Newcastle-Ottawa	Joanna Briggs Critical Appraisal Tools
Chevidikunnan et al. ²⁰	Quasi-experimental	7/10	-	-
Demirci et al. ²¹	Quasi-experimental	5/10	-	-
Erdoganoglu et al. ²⁷	Prospective cohort	-	1/9	-
Goto et al. ²⁸	Case control	-	6/9	-
Miller et al. ²²	Quasi-experimental	6/10	-	-
Motealleh et al. ²³	Randomized clinical trial	7/10	-	-
Motealleh et al. ²⁴	Randomized clinical trial	8/10	-	-
Nakagawa et al. ²⁶	Prospective cohort	-	6/9	-
Steinberg et al. ³¹	Cross-sectional	-	-	6/8 (75%)
Priore et al. ²⁹	Case control	-	9/9	-
Song et al. ³⁰	Case control	-	4/9	-
Zamboti et al. ³²	Cross-sectional	-	-	6/8 (75%)
Zarei et al. ²⁵	Randomized clinical trial	8/10	-	-

Note: In relation to quality assessment, different tools were used according to the study design. The PEDro scale was used for experimental studies and its maximum score, which represents the highest study quality, is 10 points. For prospective cohort and case control studies the Newcastle-Ottawa scale was used, with a maximum score of 9 points for the best study quality. The Joanna Briggs Critical Appraisal Tools scale was used for the cross-sectional design, with a maximum score of 8 points, indicating better quality and lower risk of bias.

Two prospective studies were found in this integrative review: one investigated whether dynamic balance and the frontal plane knee projection angle are risk factors for PP in military recruits²⁶ and the other the relationship between changes in upper limb alignment by radiography and dynamic balance in individuals with PP.²⁷ One of the case control studies compared lower limb muscle activity, kinematics, dynamic postural balance and pain level in individuals with PP versus healthy controls.²⁸ Another case control²⁹ investigated the association between kinesiophobia and pain catastrophizing and function in women with PP. Finally, in a cross-sectional study, Zamboti et al.³² quantified pain, functionality, muscle strength and dynamic postural balance in women with PP.

Figure 2 shows the applicability characteristics and SEBT result presentation in the eligible studies. Despite using the same test to assess dynamic postural control, there are different application formats for each of the

methodologies found, where 84.61% applied modified SEBT (Y balance test), which includes three reach directions (anterior, posteromedial and posterolateral) and 15.38% used only the anterior direction of the test. With respect to demonstrations and instructions prior to the test, opportunity for pretest attempts and rest between valid attempts were 100, 46.15 and 30.76%, respectively. Some studies (15.38%) presented test results using the average valid attempts in a single score (total SEBT), while others (69.23%) used valid attempts for each of the directions (anterior, posteromedial and posterolateral). The greater reach distance was used in 15.38% of the studies analyzed. Finally, 92.30% of the data obtained were normalized by the leg length of each participant (measured from the anterosuperior iliac spine to the medial malleolus) to calculate the direction score of the SEBT: distance reached (cm) ÷ leg length (cm) x 100 = % of maximum reach - calculated for each of the directions.

Table 2 - Study characterization and relevance of the test for outcomes

Studies	Study objective	Sample		Outcomes	Training/ intervention frequency	Dynamic balance result (SEBT)
		Experimental	Control			
Chevidikunnan et al. ²⁰	Assess core muscle strengthening.	PP n = 10 21.4 years	PP n = 10 22.2 years	Pain, balance.	Exp. (conventional physiotherapy + core), Cont. Group (conventional physiotherapy) 4 weeks; 3 x week.; 30 to 45 min.	There is an intergroup difference in dynamic balance, with the experimental group exhibiting a more marked improvement.
Demirci et al. ²¹	Compare mobilization with movement and Kinesio taping.	PP n = 18 37.5 years	PP n = 17 36.7 years	Pain, function and balance.	Mobilization or Kinesio taping: 2 weeks; 2x week + 6-week home-based exercise program.	Both groups improved dynamic balance.
Erdoganoglu et al. ²⁷	Investigate the relationship between lower limb alignment, balance and physical function.	PP n = 62 44.1 years	-	Pain, physical function, balance and lower limb alignment.	-	Negative correlation for pain intensity and balance in the posterolateral direction. As pain increased on the affected side, balance in the posterolateral direction worsened.
Goto et al. ²⁸	Compare muscle activity, kinematics, pain and anterior reach distance.	PP n = 14 21.7 years	n = 14 20.9 years	Lower limb muscle activity, kinematics, pain level and balance.	-	Individuals with PP demonstrated shorter anterior reach compared to the control group.
Miller et al. ²²	Immediate effects of Kinesio taping on the hip and manipulation of the lumbopelvic region.	PP n = 12 19.5 years	PP n = 6 19.5 years	Balance, function, ROM of squatting.	3 groups immediate effect: Kinesio taping; manipulation and placebo. All groups performed lower limb flexibility exercises.	Kinesio taping aimed at facilitating gluteus medius activation may increase immediate postural stability.
Motealleh et al. ²³	Determine the effects of core neuromuscular training.	PP n = 14 28.3 years	PP n = 14 30.4 years	Pain, function and balance.	Exp. group (conventional physiotherapy + core training). Cont. group, 4 weeks, 3 sessions per day - 1 supervised session per day.	The score improved in all 3 directions after therapy in both groups. The improvement was greater in the experimental group only in the posteromedial direction.
Motealleh et al. ²⁴	Lumbopelvic manipulation diminishes knee pain and joint sense position error of the knee and improves balance.	PP n = 22 23.1 years	PP n = 22 24.1 years	Joint sense position of the knee, pain and balance.	Exp. group. (received lumbopelvic manipulation at a single session). Cont. group (placebo).	Excursion distance increased in the anterior direction immediately after intervention in the exp. group.
Nakagawa et al. ²⁶	Investigate whether balance and frontal plane knee projection angle are risk factors in military recruits.	n = 135 18.4 years	-	-	-	14 recruits developed PP. Those with greater asymmetry in the posterolateral direction and in the frontal plane projection angle were at greater risk of developing PP.
Steinberg et al. ³¹	Examine the efficacy of two intervention programs in young ballerinas.	PP n = 98 13.4 years	-	Pain, crepitation and patellar inhibition; anthropometric parameters; balance; proprioception and muscle strength.	2 exp. groups Isometric and somatosensory exercises 1 cont. group 2 weeks, 3x week, 15 min.	Dynamic balance was better for the two experimental groups compared to controls in the anterior direction.
Priore et al. ²⁹	Compare kinesiophobia, catastrophizing and objective function in women with PP.	PP n = 55 21.8 years	n = 40 22 years	Tampa Scale of Kinesiophobia and Pain Catastrophizing Scale, objective function (forward step down, single leg hop and balance).	-	Participants with PP exhibited worse dynamic balance than that of the control group without pain. No correlation was found between balance and kinesiophobia/ catastrophizing.
Song et al. ³⁰	Investigate the effects of femoral rotational bandage on task performance, balance and pain.	PP n = 16 25.7 years	n = 8 28.6 years	Maximum anterior excursion, three-dimensional kinematics of the hip and knee of the supporting leg and pain score during the SEBT.	Exp. group and cont. group submitted to 3 conditions: bandage, placebo bandage and no bandage.	Rotational bandage decreased hip adduction in the exp. group, increased the maximum anterior excursion distance and decreased pain in the bandage and placebo groups.
Zamboti et al. ³²	Quantify pain, functionality, gluteus medius quadriceps muscle strength, external rotators of the hip and balance in women with PP.	PP n = 10 21.1 years	n = 10 22 years	Pain, function, muscle strength and postural balance analysis by the SEBT and force platform.	-	Moderate correlation between the SEBT and COP during one-leg standing demonstrates the possibility of using this test when a force platform is not available.
Zarei et al. ²⁵	Compare the effects of exercise therapy alone and with gluteus medius and quadratus lumborum dry needling in athletes with PP.	PP n = 20 22.2 years	DP n = 20 25.6 years	Pain, function, pressure pain threshold, step down test and balance.	Exp. group (exercise therapy + dry needling). Cont. group (exercise therapy). 4 weeks, 2 clinical and 3 at home sessions per week (15-40 min.).	Improvements in SEBT performance (all 3 directions in both groups).

Note: PP = patellofemoral pain; n = sample number; COP = center of pressure; Exp.= experimental; Cont. = control; Min. = minutes; ROM = range of motion; SEBT = Star Excursion Balance Test.

Studies	3 reach directions (ANT, PM and PL)	1 reach direction (ANT)	Demonstrations and directions	Opportunity for pretest attempts	Rest between valid attempts	Average valid attempts in a single score	Average valid attempts for each direction	Greater reach distance	Normalization* x 100 = % maximum reach
Chevidikunnan et al. ²⁰	x		x	x	x	x			x
Demirci et al. ²¹	x		x	x			x		
Erdoganoglu et al. ²⁷	x		x		x		x		x
Goto et al. ²⁸		x	x				x		x
Miller et al. ²²	x		x	x			x		x
Motealleh et al. ²³	x		x				x		x
Motealleh et al. ²⁴	x		x	x	x			x	x
Nakagawa et al. ²⁶	x		x	x			x		x
Steinberg et al. ³¹	x		x	x			x		x
Priore et al. ²⁹	x		x				x		x
Song et al. ³⁰		x	x					x	x
Zamboti et al. ³²	x		x		x	x			x
Zarei et al. ²⁵	x		x				x		x

Figure 2 - Applicability characteristics and SEBT result presentation in the eligible studies.

Note: *Normalization = maximum distance/leg length.

In a systematic review, Gribble et al.¹¹ provided a list of recommendations and instructions for the SEBT, based on study observations. The authors underscore that there is redundancy in the reach directions, demonstrating that the test can be conducted with greater efficiency using only one or more than one direction without sacrificing information quality. One of the main test variations and potential error sources is whether the reach foot touches the ground or not, as well as foot position, which is in the initial position. This integrative review found an increasing number of studies that assessed the dynamic postural control of individuals with PP in different contexts in the last ten years.

The SEBT test is important for assessing changes in dynamic balance in individuals with PP and should be used for this population. In addition, the SEBT has proved to be a useful and easy-to-apply clinical assessment and research tool. However, there are various test application and result presentation formats in the different studies analyzed. Future research should follow the protocols most widely used in earlier studies (with low risk of bias), particularly in terms of result presentation, for better study comparison and, based on standardized and analog data, extract information and conduct more robust research.

Pain and compromised dynamic postural control are important aspects to consider in PP rehabilitation. However, some discrepancies in test applicability, such as more repetitions, longer or shorter pretest periods, and resting or not between repetitions may cause participants to increase physical exertion, thereby changing the final result and hindering possible comparison between studies. It is important to note that since authors do not always report all the test steps in the description of the methodology used in their study, we cannot confirm that they were not performed or merely not described by the authors.

This study has some limitations, such as restricted data and languages in the search; in addition, some important databases were not surveyed and gray literature studies were not considered.

Conclusion

There are methodological variations in the execution protocols and result presentation of the SEBT in different studies. The SEBT is a useful, easy-to-apply test that identifies changes in the dynamic postural control of individuals with PP.

Compromised dynamic postural control is an important topic to consider in studies with PP. The issue is current and needs more studies, since dynamic postural control deficits are present in these individuals and seem to be modifiable with rehabilitation programs. Different application and test result presentation formats are consistent with the literature, but it is recommended that future research use the protocols most widely applied in previous studies that exhibit low risk of bias, in order to improve repeatability and comparisons between studies.

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Authors' contributions

GSS and AFS designed and conceived the study. GSS obtained and interpreted the study data. GSS and CER wrote the text. GSS, CER and AFS revised the manuscript.

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