# 86 - LOCOMOTOR TRAINING WITH PARTIAL BODY WEIGHT SUPPORT: BRAZILIAN LITERATURE REVIEW.

MARÍLIA NUNES GODINHO[1];
BRUNA FINATO BAGGIO[2];
RODOLFO ALEX TELLES[2];
SANDROVAL FRANCISCO TORRES[3];
GECIELY MUNARETTO FOGAÇA DE ALMEIDA[1]
1-Centro Universitário Unifacvest – Lages/SC – Brasil
3-Universidade do Estado de Santa Catarina – Florianópolis/SC – Brasil
2-Pontifícia Universidade Católica do Rio Grande do Sul – Porto Alegre/RS – Brasil
doi: 10.16887/85.a1.86
marilianunesg@hotmail.com

## INTRODUCTION

The gait has as main function to promote the slight and effective displacement of the body through space, consisting in the alternate advance of a lower limb, while the other sustains the body weight (PIGOSO et al, 2012). It is an extremely complex motor ability, composed by a sequence of cyclic movements of the lower limbs that generate the body's displacement (ABREU e CALDAS, 2008), permitting an automatic control of the nervous system in low levels, counting on interventions of upper areas, supported by sensorial information, for the modulation and adjustment of the movements, in order that subtle modifications may make the gait become effective, ahead with different anticipated and unexpected environment situations (RAMOS et al, 2006), with the least energetic, mechanical and physiological outlay (SOUSA e TAVARES, 2010).

An uncoordinated, arrhythmic, unbalanced march, besides consuming high levels of energy, is considered deficient. Reacquire the capacity of walking freely is the wish of all patients affected by some difficulty in the deambulation (ORTOBONI, FONTES e FUKUJIMA, 2002). For such it is needed to adapt the peculiarities of each patient and search among different specific training approaches one that serves the necessities so that the learning and also the transference to daily life activities may occur (SOUSA, 2009).

Locomotor training with partial body weight support (PBWS) is a method that cover several components of the gait that are simultaneously trained dynamically (BARBEAU et al, 1999 apud PEREIRA et al, 2009). It consists of an electric treadmill and a metal structure by which the individual is mechanically suspended by a security waistcoat above the treadmill (SOUSA, 2009), that keeps him or her in the orthostatic position while lower limbs are moved producing stimuli associated to the coordination between the limbs and thus reproducing the gait movements over an electric treadmill or over the ground (PATIÑO et al, 2007).

The parcel of body weight supported by the individual is gradually increased as he or she acquires a greater capacity to stand it (PEREIRA et al, 2009). It is possible to realize the adjustment of the waistcoat's height and the release of the body weight, by means of calibration with load cells, counterweights, pneumatic elevation and springs. The individual can be fully suspended or suspended according to the percentage of the body weight, that he or she wishes to release. (MATSUNO et al, 2010). The weight discharge value is an important information for the success of the PBWS (PEREIRA et al, 2009).

From studies with animals with spinal cord injury, it was developed an approach of the body partial weight support (PBWS). The existence of a subcomponent of the Locomotor system in the animals' nervous system was found out, and named central pattern generator (CPG), which is formed by spinal neurons and it is responsible for controlling the rhythmic and involuntary patterns during gait (SOUSA, 2009; DUTRA et al, 2013). Even in the absence of sensorial information, they are capable to form motor patterns, unleashing rhythmic and automatic strides, permitting the training of the biodynamic components in different stages of the gait, of the posture control and of the balance (SILVA e DALTRÁRIO, 2008).

So Locomotor training appears as a therapeutic proposition for patients with variations in the gait, whether these are due to neurological pathologies such as cerebral vascular accident, spinal cord injury, spinal cord injury, Parkinson, multiple sclerosis, or due to orthopedic alterations such as osteoarthritis, amputations, postoperative of the lower limbs in general and aging sequela (HAUPENTHAL et al, 2008). This study aims to review the existent Brazilian literature on the use of locomotor training with partial body weight support for rehabilitation of the gait in the many different deambulation disorders.

## METHOD

A bibliographic survey of scientific articles related to partial body weight support in SciELO (Scientific Electronic Library Online) and LILACS (Latin American and Caribbean Center on Health Sciences Information.), was realized from April to June of 2014. The search for the articles used the following key words: “partial body weight support”, “robot therapy” and the words associated to “training” and “gait”, considering that all of them should appear in the same article. From the articles found those related to rehabilitation of the gait through training with partial body weight support in normal individuals, in individuals with disabilities or pathologies were selected.

Only studies in Portuguese published between 2007 and 2014, in its original format, with full text available for free access were selected and posteriorly rescreened by title and respective resume. The recurrent articles were excluded. The data were organized by means of a flow diagram, Microsoft Excel tables and descriptively analyzed.

## RESULTS AND DISCUSSION

130 articles were initially found. Out of these, 27 articles were found in SciELO database and 103 articles in LILACS database. Only seven served to the criterion of inclusion

Figure 1 shows the flowchart with the articles found and the selected ones

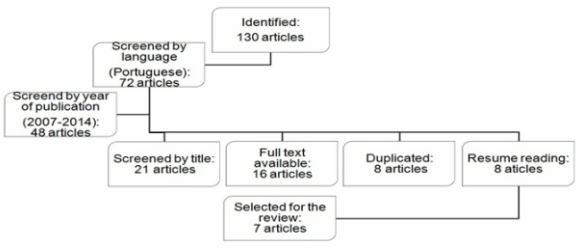


Figure 1: Flowchart of the articles found and selected.

The main articles that used intervention and related the theme are shown in table 1

| AUTHOR/YEAR | OBJECTIVE | DELIMITATION | N | AGE | PATHOLOGY | SUPPORT | RESULTS |
|---|---|---|---|---|---|---|---|
| PATIÑO et al. (2007) | Analyze the kinematic, kinetic and electromyographic characteristics in the walk. | Muscle electrical activity registration, on the catwalk, containing a force platform in the central region to record the strength reactions | 8 | X=22,2 years | Normal | 0, 10, 20 e 30% of the body weight. | Significant differences between the experimental conditions were observed in spatial-temporal variables, ground reaction force. |
| SILVA, M.S e DALTRÁRIO, S.M.B. (2008) | Verify the functional performance after gait training with PBWS | Apply PEDI performed in the presence of the responsible for the participant before the start of the first session and after twenty training sessions. | 1 | 13 years | cerebral palsy spastic diplegia | 30% of the body weight, Treadmill speed from 2,0 km/h to 2,5 km/h | Transfer of learning on the treadmill for daily routine motor, gains in everyday tasks, greater functional independence and autonomy. |
| MATSUNO et al. (2010) | Analyze the use of PBWS on a fixed platform and treadmill. | They were filmed walking at a comfortable speed without the use of the PBWS. | 6 | X= 7,70 years | Spastic hemiplegic cerebral palsy | 0% and 30% of PBWS on the fixed ground and on the treadmill | Children walked with longer and faster strides on the fixed floor. |
| DUTRA et al. (2012) | Determine and compare the bone mineral density before and after six months of training. | Training three times per week, with duration of 15 minutes, speed of 1.5 km / h. Load increase of 5% every two weeks. | 8 | X= 28,6 ± 7,0 years | Spinal Cord Injury with ASIA ratings: A, B and D. Level below or equal to T1. | Started with 20% of body weight and progressed up to 65%. | There was an increase on average mineral density of the total femur |

Legend: PEDI (Pediatric Evaluation of Disability Inventory); ASIA (American Spinal Injury Association); PBWS (Partial Body Weight Support).

Table 1: Main articles which used intervention.

The analysis of the articles pointed to a variety of parameters applied to locomotor training with satisfactory results. The study by Patino et al (2007) found that the walk in individuals without dysfunction and PBWS of 10, 20 and 30% of body weight was slower, and number of steps smaller than in the conditions with no waistcoat and PBWS of 0% of body weight, generating a lower strength during initial contact of the foot to the ground and during propulsion, these aspects are particularly relevant in the process of rehabilitation. Despite these changes, the temporal organization of the step did not change with the PBWS. With the waistcoat on electric treadmill, the control of the trunk can be facilitated, and the demands of balance maintenance are mitigated.

Matsuno et al (2010) found that children with cerebral palsy are able to walk on solid surface and on treadmill with different percentages of PBWS, at the conditions of the fixed floor children walked with a longer and faster stride, with longer duration in the simples support periods and larger swings and decreased double support on fixed ground in relation to the same situation on the treadmill. Regardless of the use of the PBWS the hip was the only articulation that showed differences between the hemibodies and among conditions, with the plegic hemibody presenting lower movement amplitude (MA) than the non plegic hemibody, and the MA was greater without the use of the PBWS than with 30% of PBWS on fixed floor.

Silva e Daltrário (2008), realized a study about the functional performance after the gait training on treadmill in individuals with cerebral palsy, and the functional gains related to mobility were evident, and considered significant and important for the daily routine of the participant. In the functional abilities, a gain in the final PEDI (Pediatric Evaluation of Disability Inventory) score was observed, indicating an overcome on the difficulties and motor gain for the realization of daily tasks, related to the transference on the bus, mobility and transferences in bed, locomotion methods in indoor and outdoor environment and move up and down the stairs. There was also an increase in the final score assisted by the care taker, meaning a decreased necessity of assistance of others for the mobility, assuring a greater functional Independence and autonomy.

Souza et al (2013), verified the benefits of gait with robot assistance in spinal cord injury by means of a literal review, the selected studies evidenced a significant statistic improvement. By means of six minutes and 10 meters walking test, functional Independence measure (FIM), walking index for spinal cord injury (WISCI II) were evaluated. The results evidenced that the benefits of the robot assistance goes beyond the improvement in the gait pattern with spinal cord injury. Jesernik et al (2003) apud Souza (2013), approach an important aspect, the motivation in patients at being able to influence the gait pattern imposed by the robot during the therapy, giving them the impression that they are controlling the machine and not being controlled and point to a decrease in the necessity of orthesis or auxiliary devices.

Dutra et al (2013), identified through a review on the literature the main modalities of Locomotor therapy with PBWS and its parameters of evaluation in the rehabilitation of the spinal cord injury. Most participants were male, the levels of the injury varied from C3 to L3, American Spinal Injury Association (ASIA) for the description of the neurological level of the injury and integrity of the injuries presented marks going from A do D and with injury time varying between 0,3 months and 33 years. He verified that even without a consensus related to the protocol, PBWS is an important ally in the motor rehabilitation of spinal cord injured individuals, and provides the learning of a new gait pattern, mainly by means of neuroplasticity. This learning process depends on specific sensorial inputs, associated with the performance of a motor task and the repetitive practice of this task. The activities based on the activation of the neuromuscular system below the level of the injury have as objective to retrain the nervous system and recover specific motor tasks.

According to Dutra et al (2012), osteoporosis is one of the main secondary complications for the spinal cord injury. The greater fall occurs in the sixth month up to the second year, with a decline that goes from 3 to 6% a year, showing a stabilization after this period. After six months of training, he observed that total femur showed a significant value of MBD, in the femur lap and trochanter regions there was no significant alteration, no gain or loss. This suggests that the bone loss may have been inhibited or there may have been a discrete gain in density, by the mechanical effect resultant from standing up during the training and by the action, even when passive, of the lower limbs during deambulatory assisted process, possibly related to stimuli from the development of osteoblasts, by means of piezoelectric effect.

Haupenthal et al (2008) realized a bibliographic analysis of the body weight support for the gait training. In it the advantages for the gait training performed on the treadmill over the conventional gait training are evident, due to the trunk support, and also a greater security without the fear or risk of fall. The suspension allows a variation in the load the lower limbs are going to stand, providing the opportunity for the patient to walk under the conditions that are necessary so that he or she can

perform the movement. There is the gait support provided by the sliding floor that helps in the extension of the hip in the final stage of the support. This extension is an important sensorial input for the triple flexion in the beginning of the swing phase because of the rhythmic activation of the central pattern generator

There are also some other benefits such as lower energy consumption, demonstrated by lower oxygen consumption and lower heart rate, due to the positioning of the trunk with the waistcoat, which minimizes the postural responses and facilitates the movement of the lower limbs, resulting in lower chance of traumatic event such as cardiac arrest or shortness of breath during training and less fatigue during and after training (PATIÑO et al 2007; HAUPENTHAL et al, 2008).

However, there are controversies about the parameters not yet well defined, as the amount of support that should be offered to patients, what criteria should be considered to analyze this percentage, the treatment duration. In some cases20 minutes can achieve good results, but there are variables in the duration up to 45 minute workout. Due gait training with PBWS has different procedures in various pathologies, the use of different criteria for each study is recommended (HAUPENTHAL et al, 2008; Dutra et al 2013).

**CONCLUSION**

The gait training with partial body weight support (PBWS) is a safe and reliable means, which appeared to innovate functional gait rehabilitation, because it provides a reduction in body support against the force of gravity, providing relief from the burden of the lower limbs symmetrically, stabilizing the trunk, controlling the balance, reducing the risk of falling and injury.

The articles analyzed showed that better results are obtained with gait training with PBWS than with conventional gait training, producing favorable physiological and psychological effects on patients besides presenting significant improvements in gait phases. Regardless of the training protocol used, the benefits relating to increased muscular strength and range of motion, maintaining or increasing bone density, decreased heart rate and increased physical fitness and coordination, are present.

There is need for further studies for its improvement, as the benefits can be even better when combined with other techniques, it is possible to perform a better treatment, rehabilitating and providing better life quality to people who need it.

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Av. Felicíssimo Rodrigues Sobrinho N°70,
Jardim Bandeira. São Joaquim/SC - 88600-000

**LOCOMOTOR TRAINING WITH PARTIAL BODY WEIGHT SUPPORT: BRAZILIAN LITERATURE REVIEW.**

**ABSTRACT**

Introduction: Locomotor training with partial body weight support (PBWS) is a system consisting of a treadmill and a metal structure, in which the individual is mechanically supported by a safety harness above a treadmill, offering partial support of body weight of the individual, keeping it in the standing position while the lower limbs move, producing stimuli associated to gait. Objective: Revise the existing Brazilian literature on the use of locomotor training with PBWS for gait rehabilitation in various dysfunctions of deambulation. Method: a literature survey of scientific articles related to the PBWS in Scielo and Lilacs

databases, using the keywords "partial body weight support," "robotic therapy" and associated words "training" and "gait" published in the last seven years was conducted. We considered only studies in Portuguese, in the original paper format, with full text available for free access, posteriorly there was the screening by title and abstract, which should correlate keywords. Results: Initially 130 articles were found, of which only seven met the inclusion criterion. The analysis showed that best results are obtained with gait training with PBWS than with conventional gait training, providing favorable physiological and psychological effects to patients, regardless of the training protocol used, besides showing improvement in gait phases. Conclusion: The gait training with PBWS is a safe and reliable means which appeared to innovate functional gait rehabilitation, thereby resulting in sustaining the body against gravity, providing relief from the burden of the lower extremities symmetrically, stabilizing the trunk, controlling the balance and reducing the risk of falling and injury.

**KEYWORDS:** Locomotor training, partial body weight support, gait.

**FORMATION LOCOMOTEUR AVEC SUPPORT PARTIEL DE POIDS CORPOREL: REVUE DE LA LITTÉRATURE BRÉSILIENNE.**

**RÉSUMÉ**

Introduction: La formation locomoteur avec un support partiel de poids corporel (SPPC), se compose d'un système constitué d'un tapis roulant et une structure métallique, où l'individu est supportée mécaniquement par un gilet de sécurité sur le tapis roulant, qui offre un support partiel du poids du corps de l'individu, en le maintenant dans la position debout tandis que les jambes production stimuli associés au mars. Objectif: Revoir la littérature brésilienne actuelle sur l'utilisation de la formation locomoteur avec SPPC pour la réhabilitation de la marche dans les divers dysfonctionnements de la marche. Méthode: Nous avons effectué une revue de la littérature des articles scientifiques relatifs à la SPPC dans la base de données Scielo et Lilacs en utilisant les mots-clés: "support partiel de poids corporel", "thérapie robotique" et les mots associés «formation» et «marche», publié dans les sept dernières années. Nous avons considéré seulement les études en langue portugaise, dans le format de l'article original, avec le texte complet disponible gratuitement, ensuite sélectionné par titre et le résumé, qui doit établir une corrélation entre les mots clés. Résultats: Nous avons trouvé 130 articles au départ, et sept ont répondu aux critères d'inclusion. L'analyse a montré que les meilleurs résultats sont obtenus avec l'entraînement à la marche avec SPPC que la formation classique de la marche, produisant des effects physiologiques et psychologiques favorable pour les patients, quell que soit le protocole de formation utilize, en plus de presenter des ameliorations dans les phases de la marche. Conclusion: L'entraînement à la marche avec SPPC est un moyen sûr et fiable qui semblaient innover rehabilitation fonctionnelle de la marche, entraînant l'abaissement de support du corpscontre la force de gravité, promotion de l'allégement de poids des membres inférieurs d'une manière symétrique, stabilisant ainsi le tronc, le contrôle de l'équilibre et réduit le risque de tomber et de blessure.

**MOTS-CLÉS:** formation locomoteur, support partiel de poids corporel, marche.

**ENTRENAMIENTO LOCOMOTOR CON SOPORTE PARCIAL DE PESO CORPORAL: REVISIÓN DE LA LITERATURA BRASILEÑA.**

**RESUMEN**

Introducción: El entrenamiento locomotor con soporte parcial de peso corporal (SPPC) consiste en un sistema compuesto por una estera eléctrica y una estructura metálica, en la cual el individuo es soportado por un chaleco de seguridad sobre la estera, que ofrece sustentación parcial del peso corporal del individuo, manteniéndole de pie mientras los miembros inferiores se mueven, produciendo estímulos asociados a la marcha. Objetivo: Revisar la literatura brasileña existente acerca de la utilización del entrenamiento locomotor con SPPC para rehabilitación de la marcha en las diversas disfunciones de la caminada. Método: Fue realizada una investigación bibliográfica de artículos científicos relacionados al SPPC en las bases de datos Scielo y Lilacs, utilizando las palabras clave: “soporte parcial de peso corporal”, “terapia robótica” y las palabras relacionadas “entrenamiento” y “marcha”, publicados en los últimos siete años. Fueran considerados solamente los estudios en lengua portuguesa, en la forma del artículo original, con texto completo disponible para acceso gratuito, seleccionados posteriormente por título y resumen, que son correlatos con las palabras clave. Resultados: Fueran encontrados inicialmente 130 artículos, siendo que siete atendieran los criterios de inclusión. El análisis ha mostrado que fueran obtenidos mejores resultados con el entrenamiento de marcha con SPPC más que con el entrenamiento convencional de marcha, produciendo efectos fisiológicos y psicológicos favorables a los pacientes, independiente del protocolo de entrenamiento utilizado, además de presentar mejorías en las fases de marcha. Conclusión: el entrenamiento de marcha con SPPC es un medio seguro y confiable que surgió para innovar la rehabilitación funcional de la marcha, proporcionando disminución en la sustentación del cuerpo contra la fuerza de la gravitad, además del alivio del peso de los miembros inferiores de manera simétrica, dando estabilidad al tronco, controlando el equilibrio y reduciendo el risco de caídas y lesiones.

**PALABRAS CLAVE:** entrenamiento locomotor, soporte parcial de peso corporal, macha.

**TREINAMENTO LOCOMOTOR COM SUPORTE PARCIAL DE PESO CORPORAL: REVISÃO DA LITERATURA BRASILEIRA**

**RESUMO**

Introdução: O treinamento locomotor com suporte parcial de peso corporal (SPPC) consiste em um sistema composto por uma esteira elétrica e uma estrutura metálica, na qual o indivíduo é mecanicamente suportado por um colete de segurança acima da esteira, que oferece sustentação parcial do peso corporal do indivíduo, mantendo-o na posição ortostática enquanto os membros inferiores movimentam-se, produzindo estímulos associados à marcha. Objetivo: Revisar a literatura brasileira existente sobre a utilização do treinamento locomotor com SPPC para reabilitação da marcha nas diversas disfunções da deambulação. Método: Realizou-se um levantamento bibliográfico de artigos científicos relacionados ao SPPC nas bases de dados Scielo e Lilacs, utilizando as palavras-chave: “suporte parcial de peso corporal”, “terapia robótica” e as palavras associadas “treino” e “marcha”, publicados nos últimos sete anos. Foram considerados apenas estudos em língua portuguesa, no formato de artigo original, com texto completo disponível para acesso gratuito, selecionados posteriormente por título e resumo, que deveriam correlacionar as palavras-chave. Resultados: Encontrou-se inicialmente 130 artigos, sendo que apenas sete atenderam aos critérios de inclusão. A análise mostrou que se obtêm melhores resultados com o treino de marcha com SPPC, do que com o treino convencional de marcha, produzindo efeitos fisiológicos e psicológicos favoráveis aos pacientes, independentemente do protocolo de treino utilizado, além de apresentar melhora nas fases da marcha. Conclusão: O treino de marcha com SPPC é um meio seguro e confiável que surgiu para inovar a reabilitação funcional da marcha, proporcionando diminuição na sustentação do corpo contra a força da gravidade, promovendo alívio do peso dos membros inferiores de maneira simétrica, estabilizando o tronco, controlando o equilíbrio e reduzindo o risco de quedas e lesões.

**PALAVRAS-CHAVE:** treinamento locomotor, suporte parcial de peso corporal, marcha.