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ROLE OF PARTIAL BODY WEIGHT SUPPORT TREADMILL TRAINING TO IMPROVE GAIT AFTER STROKE: A SYSTEMATIC REVIEW

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Abstract
Objective: *To explore the current evidence on the role of partial body weight support treadmill training (PBWSTT) to improve gait, walking ability and daily living activities after chronic stroke.*
Methods: *A systematic review was conducted. We searched the relevant literature from 2003 to August 2020 by hand searching and from Cochrane, PubMed, Pedro and MEDLINE with proper search strategy develop as PICO format and Boolean operator. We found 13 studies on the use of PBWSTT on gait, walking outcomes in persons with chronic stroke and one on the quality of life outcome. Risk bias tool was used to evaluate the biasness in studies and Critical review form was used to evaluate the methodology quality of studies.*
Results: *Total of 13 studies were included for assessment based eligibility. All studies were Randomized controlled trials. All studies lies between 11 to 15 score of Critical review form which showed high quality of methodology. Only one study targeted the quality of life outcomes other 12 studies not evaluate the quality of life outcome improvement after PBSWTT. Risk of bias in term of selection bias and detection bias was varies in all studies.*
Conclusion: *This systematic review concluded that all studies support that partial body weight support treadmill training in improve walking ability and gait in persons with chronic. Study can't conclude that partial body weight support treadmill training improve quality of life because only one study found in favor other studies not assessing the quality of life with walking and gait outcomes.*

Introduction

In regard to the disability attuned life years the stroke has the sixth highest disease burden. It is the prime most cause of severe disability in people who live in their residences [1]. It is ranked as the chief reason of mortality in brazil[2,3] & second foremost reason of death behind heart disease in rest of the world[4]. For year 2010 prevalence of stroke was estimated as 33 million worldwide[4]. One-third of the patients surviving an acute stroke require more than three months of time after their admission to the government hospital to start walking[5]. These surviving patients show functional infirmities and movement problems[3].

Partial body weight supported treadmill training is a activity related technique to regain the walk and gait pattern persons with stroke[4,6]. When compared to the conventional therapy program PBWSTT is far superior due to repetitive, high intensity and activity related exercise in the same given amount of time.[4,7]. Many different studies have shown the better effects of BWSTT when compared to conventional physical therapy treatment[8-11]. It has been shown that the gain gait and balance with chronic stroke is due to the changes induced by BWSTT in the corticomotor excitability[12].

For rehabilitation and treatment of patients with impaired gait and hemiparesis treadmill training (TT) has been used as an investigational therapy for long time[13,14]. TT can drastically increase the outcome of other interventions when used in combination with the other regular gait training exercise. Treadmill training with partial body weight support is recommended in patients who are seriously affected by hemiparesis and are unable to walk on their own power. Recent studies[15,16] suggest that patients with PD can also benefit from the treadmill training with BWS which results in better improvements in the gait parameters as compared to the gait therapy and orthodox treatment[13]. In regard to patients after stroke many authors have suggested that BWSTT is better than basic treadmill training because of the safety from fall and the free leg movement which is not possible in basic treadmill training[7]. Furthermore the patients who were treated with BWSTT walked longer distance with minor increase in their heart rates[17]

There are a large number of exercises for muscle strengthening. Given below are the detail of some of the exercises that are used in the rehabilitation in stroke patients[18]. (*i*) Task specific training (*ii*) Progressively resistance training[19], (*iii*) Functional stimulation trough electrically, (*iv*) Aerobic exercise and (*v*) Stable and unstable trunk exercises[20].

At present there are many different training programs to improve the gait patterns in the patients recovering from stroke but there are no specific recommendations for the use of partial weight support in gait improvement after stroke. Purpose behind this review is to gather all information about partial body weight support treadmill training to improve walk and gait after chronic stroke. Then, evaluate the evidence of PBWSTT for clinical use to inform clinical practice training on walk and gait following chronic stroke.

Methodology:

A detail search was conducted by 2 authors independently from 2003 to September 2020 using search strategy developed for different databases including Cochrane Central register of control trials, PubMed, Pedro and MEDLINE. Hand searching was also conducted on different databases to avoid relevant article missing. Search strategy was designed for each database by combining the key terms and Boolean operators i.e. AND, OR and NOT related to objective of study. Full text articles were retrieved for eligibility or in case if conflict exists in article than supervisor or co-supervisor decide whether include it or not for study. Indexing terms, synonyms and PICO format terms were used and filtered applied: Full text, clinical trials, RCT, Humans and English.

Study eligibility were based on PICO format. Relevant information from the included studies was extracted and reviewed by the authors. Prisma flow diagram (Figure 1) was used to show how articles were searched and included in the study. Studies were included when: (*i*) Trials/Studies of persons with chronic stroke and having abnormal walk and gait pattern. (*ii*) If participants having age between 35-85 years old and able to walk atleast 10 meter with or without support.[21] (*iii*) Participants were able to understand verbal and written information in included studies. (*iv*) Peer reviewed studies (*v*) Only from Professional and Scientific journals (*vi*) If contain any standardized assessment tool of intervention's outcome. (*vii*) Study designs used RCTs or controlled clinical trials and (*viii*) Full and free text articles was published in English language from 2003 till August 2020. Studies were excluded when: (*i*) participants in the study suffered from any other neurological disorder or trauma like traumatic brain injury. (*ii*) Any form of editorials, commentaries, cases series and grey literature. (*iii*) Presence of health medical conditions that could interfere with tests or the rehabilitation program.

Search records were saved in EndNote X8 software. Duplicates record were removed after that different screening of articles were conducted on the base of abstract and full text articles. In the end final text articles which was included from different databases were used to create table which describe different variables like methodology, sample size, demographic data. Studies were assessed thoroughly to calculate standard mean difference and effect between intervention and control group. A table was created to describe the differences between these groups, to divide these outcomes measures and studies were managed according to quality scores. Differences between experimental and control group for outcome measures described in the table.

Methodological quality of all studies were assessed by critical review for by Law et. at. and developed by McMaster University research group.[22] The whole quality of each article was evaluated by fifteen (15) closed ended questions, total score range from 0 to 15. Each question was marked as 1 or 0. 1 for totally fulfill criteria and 0 for not fulfill criteria. Total score was added for each question for all included articles. Fifteen (15) score indicate excellent methodological quality of related study. (Table 3)

Risk of bias for every included study was assessed by two independent authors for the quality of methodology of the included studies using the 'Risk of bias tool' in accordance with Cochrane handbook for systematic review of interventions.[23] Selection bias assessed by allocation concealment and random sequence generation, as well as detection bias by blinding of outcome assessment and marked as Unclear (?), Low risk (+) and High risk (-) in each study. (Table 4)

Results:

Initially 2117 studies were found through PubMed, Cochrane, Pedro and MEDLINE databases as well as through other records identify through Hand searching. 105 out of 2117 studies were removed because of duplication records. 1922 studies/articles were screened for the eligibility on the bases of studies title & abstract and 90 studies were included. 62 studies were excluded which did not meet our inclusion criteria. Characteristics of excluded studies mentioned with reason and explain in (Figure 1). For the eligibility of studies 28 full text articles assessed out of which finally 13 studies included for study analysis and synthesis and result were drawn. (Figure 1)

Result are summarized in Table 1 to Table 4. Characteristics of excluded studies with reason explain in Figure 1. Demographic data like age (Mean and SD), gender (M/F), dropout, participants or sample size in each group and affected side (L/R) of included studies elaborated in Table 1. Methodological Characteristics of included studies like method/study design, interventions in each group, outcomes related to (walking, gait and quality of life) and conclusion drawn in Table 2. Methodological quality of articles assessed through Critical review form by Cochrane. Methodological quality of all studies were assessed by critical review for by Law et. at. and developed by McMaster University research group.[22] The whole quality of each article was evaluated by fifteen (15) closed ended questions, total score range from 0 to 15. Each question was marked as 1 or 0. 1 for totally fulfil criteria and 0 for not fulfill criteria. Total score was added for each question for all included articles. Fifteen (15) score indicate excellent methodological quality of related study. All of included studies lies between 11 to 15 which show high quality of methodology. Methodological quality of articles assessed in terms of study, purpose, literature, design, sample size, outcome, intervention, result and conclusion elaborated in Table 3.

Risk of biasness for every included study was assessed by two independent authors for the quality of methodology of the included studies using the 'Risk of bias tool' in accordance with Cochrane handbook for systematic review of interventions.[23] Selection bias assessed by allocation concealment and random sequence generation, as well as detection bias by blinding of outcome assessment and marked as Unclear (?), Low risk (+) and High risk (-) in each study Table 4.

Out of 13 included studies only in one study (Duncan et al., 2011)[24] elaborate the result in term of walking improvement and quality of life improvement after stroke with BWSTT. Other studies not elaborate the results in term of quality of life improvement after stroke. (Table 2)

Table 1: Demographic data of Included Studies

No.	Study Author (Latest to old)	Table 1: Demographic data of Included Studies					
		Country	Age Mean (SD)	Gender (M/F)	Dropout	Participants	Side(L/R)
1	(Graham et al., 2018)[28]	USA	EG: 60.3 (12.8) CG: 48.9 (14.4)	M: 15 F: 14	14	29 EG: 15 CG: 14	L: 20 R: 9
2	(Ullah et al., 2017)[26]	Pakistan	EG: 51.24 (6.78) CG: 50.96 (7.02)	NM	NM	50 EG: 25 CG: 25	NM
3	(Kim et al., 2017)[35]	Korea	EG: 48.27 (16.05) CG: 50.73 (13.50)	M: 18 F: 12	1	30 EG: 15 CG: 15	L: 18 R: 12
4	(Srivastava et al., 2016)[27]	India	G1: 44.40 (12.31) G2: 47.93 (9.95) G3: 44.2 (11.7)	M: 24 F: 9	23	G1: 15 G2: 15 G3: 15	L: 21 R: 24
5	(Gama et al., 2015)[25]	Brazil	CG: 52. 92 (9.51) EG: 57.64 (8.15)	M: 19 F: 9	0	28 EG: 14 CG: 14	L: 17 R: 11
6	(Middleton et al., 2014)[34]	South Carolina	EG: 61.4 (15.7) CG: 60.7 (11.4)	M: 30 F: 13	12	50 EG: 27 CG: 23	L: 16 R: 27
7	(Mackay-Lyons et al., 2013)[32]	Canada	EG: 62 (15) CG: 59 (13)	M: 29 F: 21	5	50 EG: 24 CG: 26	L: 29 R: 21
8	(Duncan et al., 2011)[24]	USA	EG: 62 (12) CG: 63 (13)	M: 224 F: 184	35	408	L: 182 R: 226
9	(Ada et al., 2010)[30]	Australia	EG: 70 (9) CG: 71 (9)	M: 71 F: 55	NM	126 EG: 64 CG: 62	L: 45 R: 55
10	(Langhammer and Stanghelle, 2010)[33]	Norway	EG: 74 (13.3) CG: 75 (10.4)	M: 16 F: 23	5	39 EG: 21 CG: 18	L: 11 R: 28
11	(Luft et al., 2008)[29]	USA	EG: 64 (10) CG: 63 (9)	M: 33 F: 38	42	113 EG: 57 CG: 56	L: 24 R: 23
12	(Ada et al., 2003)[31]	Australia	EG: 66 (11) CG: 66 (11)	M: 19 F: 8	2	27 EG: 14 CG: 15	L: 13 R: 14
13	(Barbeau and Visintin, 2003)[36]	Canada	BWS G: 66.5 (12.8) No BWS G: 66.7 (10.1)	M: 59 F: 41	48	100 BWS G: 50 No BWS G: 50	L: 51 R: 49

M: Male, F: Female, SD: Standard deviation, L: Left, R: Right, EG: Experimental group, CG: Control group, G: Group, N/A: Not applicable, NM: No mentioned, BWS: Body weight support

Table 2: Characteristics of Included Studies

Study Author (Latest to old)	Method	Participants	Interventions	Outcomes	Conclusion	Quality of life
(Graham et al., 2018)[28]	RCT Random number generator method	29 EG: 15 CG: 14	HFG: BWSTT without assistance HFG+C: BWSTT without assistance + mobility skills	CWS, FWS, 6-minute walk distance, BBS, ABC	**HFG: BWSTT without assistance** lead to greater improvements in walking and balance outcomes.	N/A
(Ullah et al., 2017)[26]	RCT Coin toss method	50 EG: 25 CG: 25	EG: BWSTT CG: No BWS	10-meter walk test, Dynamic gait index, Time up and go test	**EG: BSWTT** helped in better gait and walking improvements outcomes.	N/A
(Kim et al., 2017)[35]	RCT Sealed envelope method	30 EG: 15 CG: 15	EG: BWSTT CG: Conventional forward TT	The Opto Gait (Machine), DGI, 6-minute walk test	**EG: BWSTT** had a positive influence on gait improvement.	N/A
(Srivastava et al., 2016)[27]	RCT Randomization by random number	G1: 15 G2: 15 G3: 15	G1: Overground task oriented gait training G2: Gait training on Treadmill without BWS G3: Gait training on Treadmill with PBWS	Walking speed and endurance, Functional ambulation category, Scandinavain stroke scale	**G2**: Gait training on Treadmill without BWS **and G3**: Gait training on Treadmill with PBWS better in improving gait parameters after stroke.	N/A
(Gama et al., 2015)[25]	RCT	28 EG: 14 CG: 14	EG: PBWSTT with 10% inclination CG: PBWSTT with no inclination	BBS, FAC, FMA, NIHSS	**EG: PBWSTT with 10% inclination** better in improving balance, gait and walking outcomes.	N/A
(Middleton et al., 2014)[34]	RCT Drawing concealed	50 EG: 27 CG: 23	EG: Over ground gait training	FMA, Time up and go, Stroke impact	**CG: BWSTT** showed improvement in	N/A

	envelops method of randomiza tion		CG: BWSTT	scale, Single limb stance, Activities specific balance confidence scale	10 days for balance and gait, balance in individuals with chronic stroke. But show no further improvement after 10 days.	
(Mackay-Lyons et al., 2013)[32]	RCT Computer based randomiza tion	50 EG: 24 CG: 26	EG: BWSTT + Usual care CG: Usual care	6-minute walk test, 10-meter walk test. Berg balance scale, Motor impairment	**EG: BWSTT** showed better result in term of walking and cardiovascular outcome measure improvement.	N/A
(Duncan et al., 2011)[24]	Parallel group design Randomiz ation into three groups using stratified randomiza tion method	408 Participants	G1 EG: BWSTT (2 months after stroke) G2 EG: BWSTT (6 months after stroke) CG: Home based exercise program	Functional walking ability, Walking speed, Stroke impact scale, Berg balance scale, FMA legs, ASBCS ADL-IADL	**G1 and G2** showed better result than G3 in term of walking and gait improvement.	**All groups** had similar improvements in functional status, and quality of life.
(Ada et al., 2010)[30]	Parallel group design Randomiz ation	EG: 64 CG: 62	EG: Walk on treadmill with supported harness CG: Assisted overground walking	Able to walk 15m	**EG:** Treadmill walking with BWS is safe, effective and feasible for improving walk and gait after stroke.	N/A
(Langhammer and Stanghelle, 2010)[33]	RCT Scaled envelops randomiza tion	39 EG: 21 CG: 18	EG: Treadmill training CG: Walking outdoors	6-minute walk test, 10-meter walk test, Pulse rate at rest and in activity	The results indicate that **treadmill walking** improves gait characteristics in patients with stroke.	N/A
(Luft et al.,	RCT	113	EG:	, Treadmill stress	**EG: Treadmill**	N/A

2008)[29]	Computer based randomization	EG: 57 CG: 56	Treadmill training CG: Stretching sessions	test, 10-meter walk and 6-minute walk test	**training** findings showed more promoting gait recovery of stroke survivors.	
(Ada et al., 2003)[31]	Parallel group design Randomization	14 EG 15 CG	EG: Walk on treadmill CG: Home based exercises plan	Step length and width, Walking endurance, 30 item stroke adjusted sickness impact profile	**EG: Walk on treadmill** showed greeter improvement in walking outcomes.	N/A
(Barbeau and Visintin, 2003)[36]	RCT Subjects stratified according to initial evaluation	100 BWS G1: 50 No BWS G2: 50	G1: BWS G2: No BWS	BBS, Motor recovery	**G1: BWS** resulted in better walking and postural abilities than did gait training in patients no BWS.	N/A

DGI: Dynamic gait index, ADL: Activities of daily living, ASBCS: Activities-Specific Balance Confidence Scale ,ADL–IADL: The Activities of Daily Living–Instrumental Activities of Daily Living Scale, BBS: Berg Balance Scale, BWS: body weight support, BWSTT: body weight-supported treadmill training, PBWSTT: Partial body weight-supported treadmill training, NIHSS: National institutes of Health stroke scale, FAC: Functional ambulation category, EG: Experimental group, CG: Control group, FAC: Functional Ambulation Category, FIM: Functional Independence Measure, FMA: Fugl-Meyer Assessment, RCT: Randomised controlled trial, HFG: Hands free group, HFG+C: Hands free group + Challenge, CWS: Comfortable walking speed, FWS: Fast walk speed, ABC: Activities specific balance confidence

Table 3: Methodological quality of articles: Critical Review Form

Study Author (Latest to old)	Table 3: Methodological quality of articles: Critical Review Form															
	Study Purpose	LR	Design	Sample		Outcome		Intervention			Result				Conclusion	Total Score
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
(Graham et al., 2018)[28]	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	14
(Ullah et al., 2017)[26]	1	1	1	0	1	1	1	1	0	1	1	1	0	0	1	11
(Kim et al., 2017)[35]	1	1	1	0	1	1	1	1	0	1	1	1	1	0	1	12
(Srivastava et al., 2016) [27]	1	1	1	0	1	1	1	1	0	1	1	1	0	1	1	12

(Gama et al., 2015)[25]	1	1	0	0	1	1	1	1	0	0	1	1	1	1	1	11
(Middleton et al., 2014)[34]	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	13
(Mackay-Lyons et al., 2013)[32]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
(Duncan et al., 2011)[24]	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	13
(Ada et al., 2010)[30]	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	12
(Langhammer and Stanghelle, 2010)[33]	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	12
(Luft et al., 2008)[29]	1	1	1	0	1	1	1	1	0	0	1	1	0	1	1	11
(Ada et al., 2003)[31]	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1	12
(Barbeau and Visintin, 2003)[36]	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	13

Table 4: Risk of bias for each included study

Table 4: Risk of bias for each included study

No.	Study Author (Latest to old)	Random sequence generation (Selection bias)	Allocation concealment (Selection Bias)	Blinding of outcome assessment (Detection bias)
1	(Graham et al., 2018)[28]	+	+	?
2	(Ullah et al., 2017)[26]	+	+	?
3	(Kim et al., 2017)[35]	?	+	?
4	(Srivastava et al., 2016)[27]	+	?	+
5	(Gama et al., 2015)[25]	+	?	-
6	(Middleton et al., 2014)[34]	-	-	+
7	(Mackay-Lyons et al., 2013)[32]	+	+	+
8	(Duncan et al., 2011)[24]	?	+	-
9	(Ada et al., 2010)[30]	+	+	+
10	(Langhammer and Stanghelle, 2010)[33]	+	+	+
11	(Luft et al., 2008)[29]	+	?	+
12	(Ada et al., 2003)[31]	+	+	+
13	(Barbeau and Visintin, 2003)[36]	+	-	-

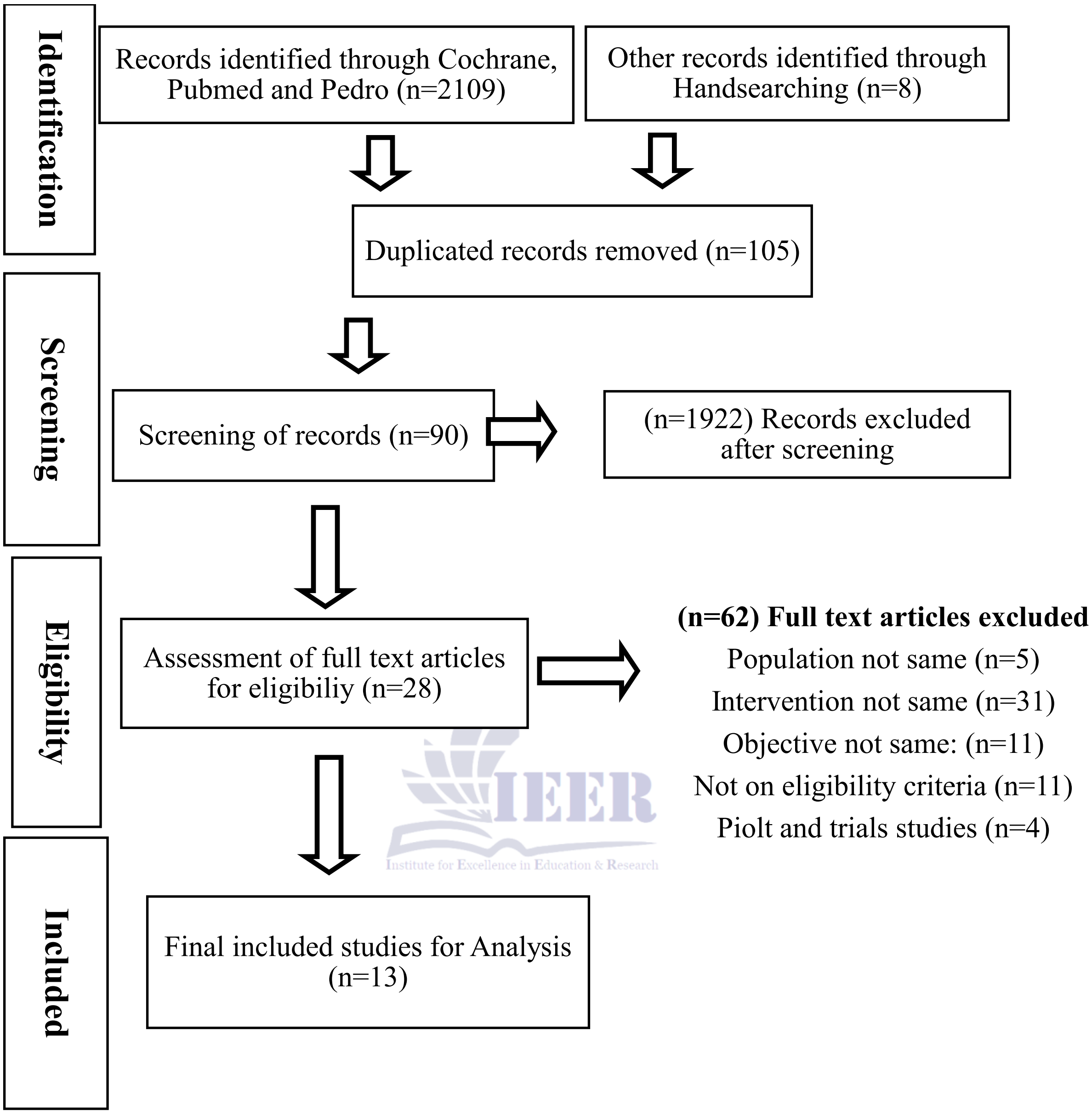

Figure 1: Flow chart showing Preferred reporting item according to PRISMA

Discussion:

The aim of this study was to explore the current evidence for the role of partial body weight support treadmill training (PBWSTT), in combination or individually to improve gait, walking ability and daily living activities after chronic stroke. We included 13 studies with 1077 participants. Overall, the use of TT with BWS increase the chance of walking and gait. This review showed that 13 studies evaluated the gait and walking outcomes of PBWSTT among participants with chronic stroke from 2003 to August 2020 and only one study[24] evaluated the quality of life outcome of PBWSTT, there should be more RCT studies among stroke participants to know the benefit of PBWSTT in improving quality of life. As topic reputation is innovative within the clinical setup, less in publications but showed better result from PBWSTT.

Self-confidence in evidence based physical therapy is increasing as time passing. In our review, using the Critical Review Form methodological quality of studies review for persons with chronic stroke. Overall, high level of evidence for PBWSTT were found as we included only RCT and good quality of studies.

PBSWTT resulted in improvement of walk, gait and quality of life. However, one of study showed more better result with 10% inclination of treadmill than normal.[25] One study showed that BWSTT without assistance lead to more improvements in walking and balance outcome. However from all studies none of them see the functional outcome except one.

To see the effect either treadmill training is better without support or with support, three studies compare the effect and result showed that treadmill training is better with BWS rather than without BWS [26-28] so it is better to use treadmill with body weight support to gain better result for gait and walking skills. Further research is needed to determine the unique effects of PBWSTT for persons with acute and sub acute stage as we only focus on chronic stroke participants.

This review still not strong to find that PBWSTT has an effect on participation on quality of life, functional activities, social role and emotional development of chronic stroke who have not ever skilled walking or gait. None of the studies in our review label or discovered the level of IQ of strokes before and after intervention. Further studied should be consider for the effect of IQ level on performance during PBWSTT.

Some researchers suggest that walking on treadmill is better than home based exercises plan[24], stretching sessions[29], assisted overground walking[30,31], usual care[32] and walking outdoor[33]. It may be essential to add PBWSTT with other treatment protocols for more better result in persons with chronic stroke. Further studies should also be conducted in adult with chronic stroke to relate TT with overground walking which shows evidence for better result.[30]

The use of TT with BWS in walking and gait rehabilitation for persons after chronic stroke increase endurance and velocity of walking compared with other interventions. There should be more studies to compare the effect PBWSTT at different speed and time. These results raise the multiple questions either variation in parameter is better or not. We did not found any benefits that persons walk independently at start of treatment however in one study[34] it was concluded that BSWTT showed better result in ten days for balance, walk and gait in persons with chronic stroke but no further improvement showed. This still questionable why more improvement not seen in them? So further studies should be conducted with variation in parameters.

Conclusion:

This systematic review concluded that all studies support that partial body weight support treadmill training in improving walking ability and gait in persons with chronic stroke. We can't conclude that partial body weight support treadmill training improve quality of life among stroke patients because only one study found in favor other studies not assessing the quality of life with walking and gait outcomes.

Limitations and Recommendations:

Further studies should be conducted with variation in parameters like walking speed, duration and inclination. Further clinical trials should also be conducted to find the effect of PBWSTT in improving quality of life, functional activities, social role and emotional development after gait and walk improvement. Further studied should be consider for the effect of IQ level on performance during PBWSTT. PBWSTT should be used in clinical and hospital setup to improve walking and gait in patients with chronic stroke. Current evidence explain that PBWSTT is better than all other physiotherapy intervention to improve walk and gait.

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References:

1. Murray C, Vos T, Lozano R, AlMazroa MA, Memish ZA. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010 (vol 380, pg 2197, 2012). 2014.
2. Ribeiro T, Britto H, Oliveira D, Silva E, Galvao E, Lindquist A. Effects of treadmill training with partial body weight support and the proprioceptive neuromuscular facilitation method on hemiparetic gait: a randomized controlled study. *Eur J Phys Rehabil Med* 2013; 49(4): 451-61.
3. Manning C, Pomeroy V. Effectiveness of treadmill retraining on gait of hemiparetic stroke patients: systematic review of current evidence. *Physiotherapy* 2003; 89(6): 337-49.
4. Mao Y-R, Lo WL, Lin Q, et al. The effect of body weight support treadmill training on gait recovery, proximal lower limb motor pattern, and balance in patients with subacute stroke. *BioMed research international* 2015; 2015.
5. Langhorne P, Coupar F, Pollock A. Motor recovery after stroke: a systematic review. *The Lancet Neurology* 2009; 8(8): 741-54.
6. McCain KJ, Pollo FE, Baum BS, Coleman SC, Baker S, Smith PS. Locomotor treadmill training with partial body-weight support before overground gait in adults with acute stroke: a pilot study. *Archives of physical medicine and rehabilitation* 2008; 89(4): 684-91.
7. Mehrholz J, Thomas S, Elsner B. Treadmill training and body weight support for walking after stroke. *Cochrane Database of Systematic Reviews* 2017; (8).
8. Hesse S, Konrad M, Uhlenbrock D. Treadmill walking with partial body weight support versus floor walking in hemiparetic subjects. *Archives of physical medicine and rehabilitation* 1999; 80(4): 421-7.
9. Werner C, Bardeleben A, Mauritz KH, Kirker S, Hesse S. Treadmill training with partial body weight support and physiotherapy in stroke patients: a preliminary comparison. *European Journal of Neurology* 2002; 9(6): 639-44.
10. Mudge S, Rochester L, Recordon A. The effect of treadmill training on gait, balance and trunk control in a hemiplegic subject: a single system design. *Disability and rehabilitation* 2003; 25(17): 1000-7.
11. Srivastava A, Taly AB, Gupta A, Kumar S, Murali T. Bodyweight-supported treadmill training for retraining gait among chronic stroke survivors: A randomized controlled study. *Annals of physical and rehabilitation medicine* 2016; 59(4): 235-41.
12. Yen C-L, Wang R-Y, Liao K-K, Huang C-C, Yang Y-R. Gait training—induced change in corticomotor excitability in patients with chronic stroke. *Neurorehabilitation and neural repair* 2008; 22(1): 22-30.
13. Pohl M, Rockstroh G, Rückriem S, Mrass G, Mehrholz J. Immediate effects of speed-dependent treadmill training on gait parameters in early Parkinson's disease. *Archives of Physical Medicine and Rehabilitation* 2003; 84(12): 1760-6.
14. Dobkin BH. An overview of treadmill locomotor training with partial body weight support: a neurophysiologically sound approach whose time has come for randomized clinical trials. *Neurorehabilitation and neural repair* 1999; 13(3): 157-65.
15. Miyai I, Fujimoto Y, Yamamoto H, et al. Long-term effect of body weight–supported treadmill training in Parkinson's disease: a randomized controlled trial. *Archives of physical medicine and rehabilitation* 2002; 83(10): 1370-3.
16. Miyai I, Fujimoto Y, Ueda Y, et al. Treadmill training with body weight support: its effect on Parkinson's disease. *Archives of physical medicine and rehabilitation* 2000; 81(7): 849-52.
17. Visintin M, Barbeau H. The effects of body weight support on the locomotor pattern of spastic paretic patients. *Canadian journal of neurological sciences* 1989; 16(3): 315-25.
18. Wist S, Clivaz J, Sattelmayer M. Muscle strengthening for hemiparesis after stroke: A meta-analysis. *Annals of physical and rehabilitation medicine* 2016; 59(2): 114-24.

19. Kim CM, Eng JJ. The relationship of lower-extremity muscle torque to locomotor performance in people with stroke. *Physical therapy* 2003; 83(1): 49-57.
20. Sarwar R, Faizan M, Ahmed U, Waqas M. Effects of unstable and stable trunk exercise programs on trunk motor performance, balance and functional mobility. *Rawal Medical Journal* 2019; 44(1).
21. Aaslund MK, Helbostad JL, Moe-Nilssen R. Familiarisation to body weight supported treadmill training for patients post-stroke. *Gait & posture* 2011; 34(4): 467-72.
22. Law M, Stewart D, Letts L, Pollock N, Bosch J, Westmorland M. Guidelines for critical review of qualitative studies. *McMaster University occupational therapy evidence-based practice research Group* 1998: 1-9.
23. Higgins JPT, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ* 2011; 343: d5928.
24. Duncan PW, Sullivan KJ, Behrman AL, et al. Body-weight-supported treadmill rehabilitation after stroke. *The New England journal of medicine* 2011; 364(21): 2026-36.
25. Gama GL, de Lucena Trigueiro LC, Simão CR, et al. Effects of treadmill inclination on hemiparetic gait: controlled and randomized clinical trial. *American journal of physical medicine & rehabilitation* 2015; 94(9): 718-27.
26. Ullah MA, Shafi H, Khan GA, Malik AN, Amjad I. The effects of gait training with body weight support (BWS) with no body weight support (no-BWS) in stroke patients. *JPMA The Journal of the Pakistan Medical Association* 2017; 67(7): 1094-6.
27. Srivastava A, Taly AB, Gupta A, Kumar S, Murali T. Bodyweight-supported treadmill training for retraining gait among chronic stroke survivors: A randomized controlled study. *Annals of physical and rehabilitation medicine* 2016; 59(4): 235-41.
28. Graham SA, Roth EJ, Brown DA. Walking and balance outcomes for stroke survivors: a randomized clinical trial comparing body-weight-supported treadmill training with versus without challenging mobility skills. *Journal of neuroengineering and rehabilitation* 2018; 15(1): 92.
29. Luft AR, Macko RF, Forrester LW, et al. Treadmill exercise activates subcortical neural networks and improves walking after stroke: a randomized controlled trial. *Stroke* 2008; 39(12): 3341-50.
30. Ada L, Dean CM, Morris ME, Simpson JM, Katrak P. Randomized trial of treadmill walking with body weight support to establish walking in subacute stroke: the MOBILISE trial. *Stroke* 2010; 41(6): 1237-42.
31. Ada L, Dean CM, Hall JM, Bampton J, Crompton S. A treadmill and overground walking program improves walking in persons residing in the community after stroke: a placebo-controlled, randomized trial. *Archives of physical medicine and rehabilitation* 2003; 84(10): 1486-91.
32. Mackay-Lyons M, McDonald A, Matheson J, Eskes G, Klus MA. Dual effects of body-weight supported treadmill training on cardiovascular fitness and walking ability early after stroke: a randomized controlled trial. *Neurorehabilitation and neural repair* 2013; 27(7): 644-53.
33. Langhammer B, Stanghelle JK. Exercise on a treadmill or walking outdoors? A randomized controlled trial comparing effectiveness of two walking exercise programmes late after stroke. *Clinical rehabilitation* 2010; 24(1): 46-54.
34. Middleton A, Merlo-Rains A, Peters DM, et al. Body weight-supported treadmill training is no better than overground training for individuals with chronic stroke: a randomized controlled trial. *Topics in stroke rehabilitation* 2014; 21(6): 462-76.
35. Kim KH, Lee KB, Bae YH, Fong SSM, Lee SM. Effects of progressive backward body weight suppoted treadmill training on gait ability in chronic stroke patients: a randomized controlled trial. *Technology and health care* 2017; 25(5): 867-76.

36. Barbeau H, Visintin M. Optimal outcomes obtained with body-weight support combined with treadmill training in stroke subjects. *Archives of physical medicine and rehabilitation* 2003; 84(10): 1458-65.