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Literature review

Home-based exercise programs for disabilities of walking activity caused by neurological disorders: Systematic Review with Meta-Analysis

Programas de exercícios domiciliares para incapacidades da atividade de caminhar causadas por distúrbios neurológicos: Revisão sistemática com metanálise

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RESUMO | INTRODUÇÃO: Na medida em que a expectativa de vida aumenta, também são necessárias soluções para melhorar a independência funcional em condições cronicamente alteradas, comuns nas disfunções neurológicas. **OBJETIVO:** Avaliar o efeito de programas de exercícios domiciliares (PED) sobre prejuízos na atividade de caminhar devido a acidente vascular cerebral (AVC), doença de Parkinson (DP), esclerose múltipla (EM) e mielopatia associada ao HTLV-1 ou paraparesia espástica tropical (HAM/TSP). **MÉTODOS:** As fontes de dados incluíram PubMed, SciELO, Pedro e Cochrane Library e artigos disponíveis em inglês, português, espanhol, alemão ou francês. Nenhuma restrição de tempo foi aplicada e a seleção foi feita por dois pesquisadores independentes em três etapas. Ensaios clínicos com intervenções dos programas PED para adultos com dificuldades de marcha ou equilíbrio decorrentes das condições neurológicas acima foram incluídos. As variáveis foram velocidade ou distância da marcha, força, equilíbrio, mobilidade, funcionalidade e independência funcional. A qualidade metodológica foi avaliada com a escala PEDro, e uma estratégia PICOS orientou extração de dados. Diferenças das médias ponderadas (DMP), intervalos de confiança de 95% (IC) e heterogeneidade foram avaliadas pelo teste I2 com o programa RevMan 5.3. A GRADE foi aplicada na avaliação da qualidade da evidência. **RESULTADOS:** O PED foi eficaz na melhora do equilíbrio (DMP 2,8; IC 1,5; 4,1) e da capacidade cardiorrespiratória (DMP 29,3m; IC 8,3; 50,2) para pessoas com AVC. Para pessoas com EM, o PED levou a uma melhora no perfil fisiológico (DMP -1,3; IC -0,5; 2,0) e mobilidade (DMP -3,3; IC -5,1; -1,4). **CONCLUSÕES:** O PED é eficaz na melhora da atividade de caminhada, desempenho e mobilidade funcional das deficiências neurológicas. Sugerimos a aplicação do PED na saúde pública e o uso de escalas funcionais para comparar a mesma incapacidade em diferentes distúrbios neurológicos.

PALAVRAS-CHAVE: Terapia por exercício. Disfunção neurológica. Caminhar. Maneira de andar.

ABSTRACT | INTRODUCTION: As increase life expectancy, the searches for conducts to improve functional independence in chronically altered conditions as is common in the neurological dysfunction. **OBJECTIVES:** To evaluate the effect of therapeutic home based exercise programs (HBE) on impairment of walking activity due to stroke, Parkinson's disease (PD), multiple sclerosis and HTLV-1 associated myelopathy or tropical spastic paraparesis (HAM/TSP). **METHODS:** data sources PubMed, Scielo, Pedro, Cochrane Library; available in English, Portuguese, Spanish, German or French languages; no time restrictions; selection made by two independent researchers, in three stages; included Clinical Trials with interventions of HBE Programs for adults with gait or balance disabilities arising from the above neurological conditions; gait speed or distance, strength, balance, mobility, functionality and functional independence were the variables; methodological quality with PEDro scale; PICOS strategy guided the extraction date. Weighted mean differences (WMD), 95% confidence intervals (CI), and the heterogeneity assessed by the I2 test with RevMan 5.3 program. **RESULTS:** In balance (WMD 2.8; CI 1.5; 4.1) and in cardiorespiratory capacity (WMD 29.3m; IC 8.3; 50.2) for people with stroke are effectiveness. For people with Multiple Scleroses there is improvement in physiological profile (WMD -1.3; CI -0.5; 2.0) and mobility (WMD -3.3; CI -5.1; -1,4). **CONCLUSIONS:** The HBE is effective on walking activity, improve performance and functional mobility in neurological impairments. Is suggested HBE on public health to includ elements for management of disabilities on the programs and the use of functional scales such as WHODAS to compare the same disability in different neurological disorders.

KEYWORDS: Exercise therapy. Neurologic dysfunction. Walking. Gait.

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Introduction

Disabilities in walking activity caused by neurological conditions, usual involves body dysfunctions such as gait and balance what increase the risk of falls, reduce social participation and decrease the quality of life on the affected persons[1]. They can also, as a consequence, lead the individual to face barriers that hinder access to outpatient treatment[2], what has being a subject of growing worldwide concern and of high socioeconomic impact[3].

Among neurological conditions that cause disability in gait, balance and walking impairments the following stand out: Stroke, Parkinson's Disease (PD), Multiple Sclerosis, and HTLV-1 Associated Myelopathy or Tropical Spastic Paraparesis (HAM / TSP)[4]. Although the progression of these health conditions is variable, the chronic disabling conditions, functional dependence[4,5], and progressive vulnerability to fall[5,8], is a reality that is present in all cited cases.

They all also usually present common needs such as walking and balance training, improvement of the cardiorespiratory capacity, requiring therapeutic programs that , however, with an individualized attention[9]. Walking deficit, in a functional diagnosis can bring together individuals with common functional loss within distinctive neurological conditions and assess variations on levels of impairment[10]. Is required a feasible clinical solution for the maintenance or improvement of functional activities coupled with the elements of disability management on these situations[3].

Implementation of therapeutic home based exercise (HBE) programs, has being pointed as a feasible solution, with effectiveness clinical results and low cost[11,13]. These programs can help overcome mobility of walking difficulties by minimizing secondary complications such as sedentary lifestyle while promoting functional independence[14]. A HBE program is characterized to include therapeutic exercises independently performed, at home or at local community, also individualized oriented to be performed alone or in a group, what may hold the potential of strengthening health service access, as it can be offered nearby their homes being a facilitator of community-based rehabilitation[3,14].

In order to achieve good results on the implementation of these programs it is necessary strategic plans, including a correct selection of the exercise to warrantee the attendance and the good performance of the practices[15], protection against the risks during the sessions of the participants[16], to be in attention of the caregivers[17] and to contribute on their social participation[14]. Therefore to provide a safe basis in clinical practice with prescriptions scientifically based it is necessary as it may add value to the development of public health policies in favor of this population[18], what is in agreement with the World Health Organization (WHO) Global Disability Actions Plan[3].

The primary aim of the present study was to evaluate the effect of HBE on disabilities of walking activity related to neurological conditions, specifically Stroke, PD, Multiple Sclerosis and HAM/TSP. A second aim was to explore comparable data on the HBE programs for rehabilitation on disability of waking activities, gait and balance such as: the exercise protocol (the frequency, duration, progression, type of exercise and others); the parameters investigated, instruments and tests used on the studies; what are the exercise types and kind of the monitoring applied; and if any aspect of educational, motivational or others approach explored, evaluating the possibilities of managing disabilities within these variables.

Methods

The present study was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (http://www.prisma-statement.org/)[19].

Protocol and registration

This systematic review was early registered in the PROSPERO Center: CRD42014015085 (http://www.crd.york.ac.uk/prospero), as it is recommended.

Eligibility criteria

Types of Studies and Participants

Was included Randomized Clinical Trials, Controlled Clinical Trials or Pilot Studies with the same characteristics of clinical trials. Studies of adults (over 18 years old), with gait and balance disabilities arising from the neurological conditions of Stroke, PD, Multiple Sclerosis and HAM/TSP were included. Studies with dementia were excluded.

Interventions

Home-Based Exercise Programs (HBE) were the main intervention. We excluded studies with interventions that adopted any heavy equipment for the practice (such as treadmills, robotics and others), use of electro stimulation along with exercise, and interventions compared to medications or electro stimulation.

Comparisons

It was included studies with one intervention group and at least one other control group to comparison. The control could involve usual care, spontaneous recovery, maintenance of conventional treatment or other type of therapy.

Outcomes

Outcomes measures should include at least with one of the following variables: gait (speed or distance), strength, balance, mobility, functionality and functional independence.

Information sources

Was searched studies from PubMed, Medline, Lilacs, Scielo, Pedro, The Cochrane Library, PsycINFO up to February 2017, available in full, in English, Portuguese, Spanish, German or French language. No time restriction was applied. Also identified studies on the references of bibliographies.

Search Strategy

Search Strategy was defined for PubMed database as a parameter for the others searched databases. In the category of participants the basic term "home exercise program" from which was found their synonyms with Mesh, DeCs and articles. In the intervention category, it was used the term "neurological diseases" and its synonyms, reaching the following strategy: PubMed search strategy: ((((((((((((((exercise therapy) OR exercise movement techniques) OR exercise program) OR exercise protocol) OR physical therapy program) OR physical therapy protocol) OR home exercise program) OR physiotherapy exercise program) OR physiotherapy exercise protocol) OR self care program) OR self management program) OR home health care approach to exercise) OR home based program) OR self-administered program) OR self administered program)) AND ((((((((((((nervous system disease) OR neurologic disorders) OR neurological manifestations) OR neurologic disorder) OR neurological disorders) OR nervous system disorders) OR nervous system disease) OR degenerative neurologic disease) OR (spinal cord injures NOT traumatic)) OR neurological disease) OR spinal cord disease)) NOT dementia).

Study Selection and Risk of bias in individual studies

Irrelevant studies were firstly removed based on their titles according to eligibility criteria. From the remaining primary studies identified, the selection was conducted by two researchers who independently applied the elaborated protocol and tested to identify potentially relevant studies. They performed the searches selection in three stages. The first stage based on titles and abstracts, the second selected from full text read and the third stage was based on the quality criteria performed with PEDro scale score[20,21]. At the end of each stage, the two reviewers met and submitted their results to the comparison. Disagreements were discussed and in cases the disagreements were not resolved, a third reviewer was consulted to solve doubts. When there was a need for further clarification, the author correspondent of the study was contacted.

PEDro scale has 11 items that identify through risk of bias and statistical consistency of the quality level of the studies. Item one corresponds to the investigation of the risk of external bias, but this item does not include the score of points, so the total of points was a maximum of 10. In this study, we counted at high risk of bias studies whose sum of scores was three or fewer points. Aspects of issues at number five and

six could not be considered since it is not possible to proceed with blinding in this type of intervention so it would be considered the highest score of eight and not 10 as in the original. However, we decided to maintain the usual way were cutoff point of > 4 was adopted for moderated or high quality studies.(21) Otherwise was considered as a poor quality and was excluded for analysis.

Data collection process and summary measures

Two independently researchers extracted data from the published reports using a standardized data extraction forms based on PICOS information on a first stage of collection. This first stage focused on information and findings of studies evidences: aspects of the study population, types of intervention performed, expected outcome measures were of continues measurement summarized by difference in means. The subsequent stage focused in the descriptive data mapping the elements findings about planning the HBE program that may configure the disabilities management. Disagreements were solved by a third researcher. Any additional information required from the original author was requested by e-mail.

Synthesis of data and method of statistical analysis (Meta-analysis)

Individuals studies were pooled when it was identified at least two comparable studies having among them the same control group. Pooled effect estimates were obtained by comparing the least square mean percentage change from baseline to the end of the study for each group, and were reported in the weighted mean difference between groups. An alpha value of 5% was considered significant.

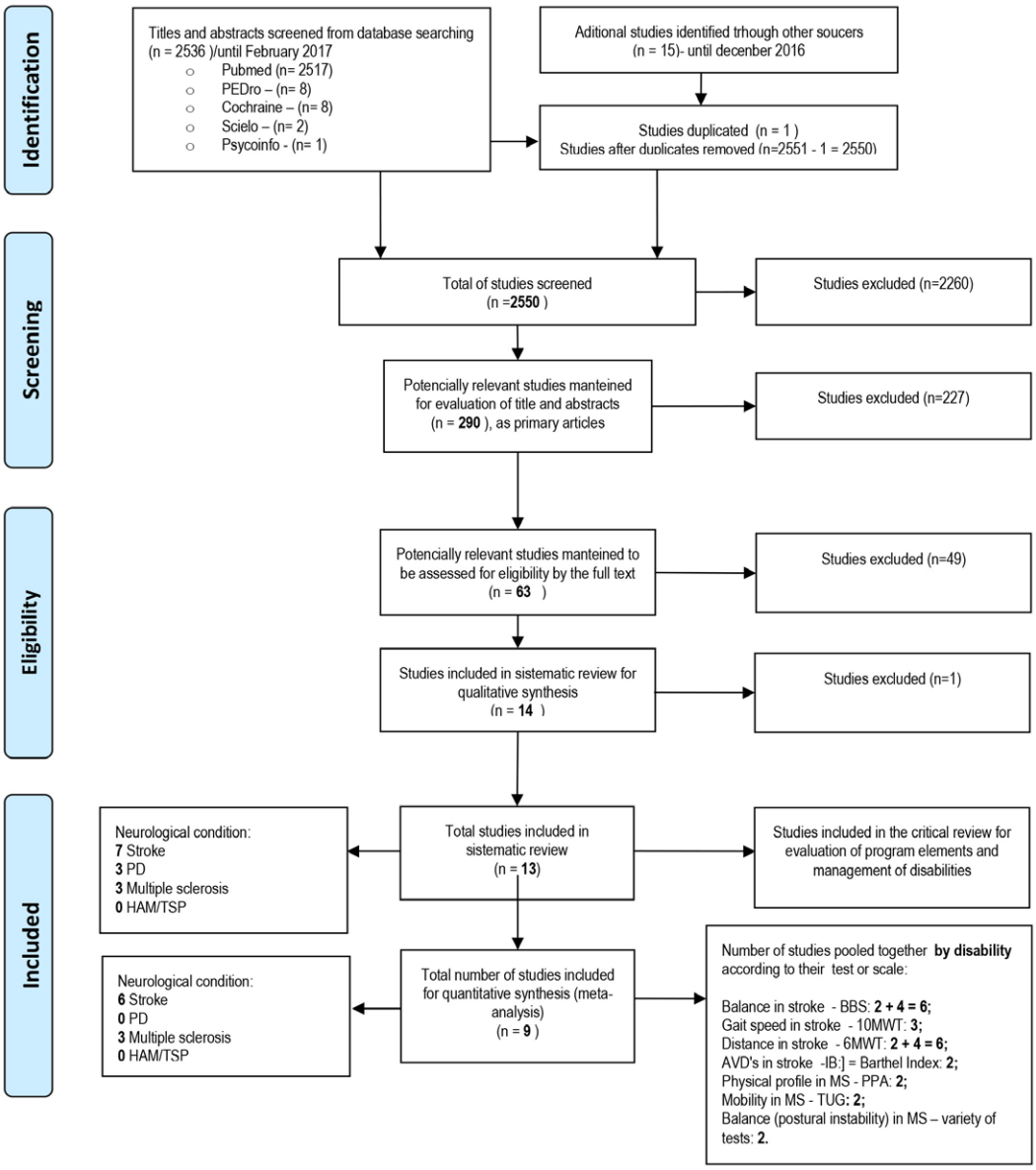
Statistical heterogeneity of the treatment effect among studies was assessed using Cochran's Q-test and the inconsistency I2 test. Substantial heterogeneity was defined in case I^2> 50% and in that case a random effect model was applied. Otherwise the result indicated insignificant heterogeneity and it was applied the fixed effect model. The individual effect size with 95% confidences interval (CI) were calculated as using the Cochran's Q Test. The values were then pooled to determine the summary effect size (SES), and calculated the SD. A significant positive SES indicated that HBE was beneficial for the participants when compared to control group or to what can be generally called of Usual Care (UC). All analyses were carried out using Review Manager (RevMan) [Computer program]. Version 5.3. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014.

Results

Study selection

The search process and the identification of the relevant studies are summarized in Figure 1. The electronic search strategy identified 2517 from PubMed (up to february 2017), and 19 studies on the other databases (PEDro, Chochrane Library, Sciello and Psycoinfo). From the total of 2536 electronic search included were added 15 studies identified by others sources resulting in 2550 studies as ultimate search after one duplicated study has been removed. From them, 2260 was excluded due to theme inadequate. From those, 290 studies were screened based on their titles and abstracts, while 64 potential relevant full texts were evaluated (reviewed). Only 14 studies satisfied the criteria and were incorporated into review on the second stage of selection. Results from third stage is described below.

Figure 1. Flowchart of search processes and identification of studies



Based on: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement.* PLoS Med 6(7): e1000097. doi: 10.1371/journal.pmed1000097.

Methodological Quality and Risk of Bias

The mean methodological quality of the 14 studies was 6.5 within the maximum score of 10 and ranging from 3 to 10. The total of PEDro scores for each study included are summarized in table 1. Only one study was below the cutoff of with less than 4 points according to the PEDro score which one was excluded from the analyzes. The final selection consisted of 13 studies that were pooled according to the equal disorders, resulting in seven studies of stroke condition, three of PD, three of Multiple Sclerosis and none of HAM/TSP.

Table 1. Characteristics of included trials in the in systematic review and results from methodological quality assessment. For home exercises programs in neurological health conditions (to be continued)

Study **Authors, Journal, Year**	**Participants** **The analyzed sample (n); Age (A); Neurological Condition (NC); Time on that condition in months or days (T); Scale or situation used to mesures condition (S)**	**Intervention** **Type of Exercise, Weekly Frequency (Fr), Session Duration (Dr) and Progression (Pr)**	**Comparison** **IG = Intervention Group** **CG = Control / Comparative Group**	**Outcomes** Measures of Pre and pos test	**Study Design**	**PEDro Scale** Total Score
Moore *et al*, Archives of Physical Medicine and Rehabilitation, 97:596-603, **2016**	n=40 → 40 A= 69±9 anos NC= **Stroke** T= 19±26 months S=NIHSS	A mixed community exercise program to improve capacity aerobic, strength, balance control, flexibility. The classes it was developed in a community leisure Center. Fr: 3xWeek Dr: 45-60min. Pr: the intensity of the exercise was gradually increased, working within a heart rate zone. Repetition and resistance were used to progress strength and balance exercises	IG= a functional exercise adapted from FMEP CG= Matched duration home stretching program .	**BBS** p<0.01 IG:50±4; 55±2 CG: 50±5.6; 52±5 **TUG** p<0.05 IG: 11±9; 8.4±6 CG: 9.8 ±5; 9±5 **10MWT_p**<0.01 IG: 1.2±0.4; 1.5 ±0.3 CG:1.2±0.3; 1.3 ±0.3 **6MWT** p<.01 IG: 428±131; 513±131 CG:419±127; 441±126	RCT Pilot **19 weeks**	8/10
Wang *et al*, Neurorehabilitation and Neural Repair, Vol. 29(1) 3–12, **2015**	n=51 → 51 A= GI:65.4 GC:62.0 NC=**stroke** T= IG:18 CG:18.5 meses (média) S= Brunnstron recovery stages III a V and SIS	CHI program to improve functions and structural body componentes; the ability to undertake everyday activities and to reintegrate into the society. With individualized training and Illustrations for to record the frequency. Fr: ≥2xweek Dr: 50-60min. Pr: into three fases and as the therapist examine the activities practiced weekly.	**IG=** CHI program = caregiver-mediated, home-based intervention. **CG=** usual care	**BBS** p=.006 IG:32.1 ± 10.0; 36.6 ± 6.7 CG: 31.9 ± 13.0; 31.1 ± 12.1 **10MWT_FWV** p: .006 IG: 43.2 ±29.2; 51.0 ±30.0 CG:47.4 ±31.1; 46.0 ± 31.7 **10MWT_MWV** p:.052 IG: 51.6 ± 36.3; 61.3 ± 35.1 CG: 55.4 ±36.1; 56.8 ± 37.3 **6MWT** p=.003 IG:152.6 ±119.8; 168.4 ± 114.8 CG: 167.2 ±121.8; 156.7 ±117.3	RCT **12 weeks**	6/10
Gordon *et al*, Rev.Stroke, 1179-1181, **2013**	n=128 → 116 A= (IG:63.4/GC:64.9) A m= 64.14 NC= **Stroke** T= IG:12.8/GC:11.8 months S=	Aerobic exercise training based in their home or community. Fr: 3 x week Dr: 30 min. Pr: by 5 minutes per week up to 30 minutes. Also carried out by increasing speed.	**IG=** to walk briskly along a prescribed course **CG=** light massage to the affected limbs	**6MWT** p <0.001 IG: 247.1±141.50; 290.5 ±152.4 GC: 228.0 ±138.70; 237.2±146.4.	RCT_SB **12 weeks**	8/10
Gavin *et al*, Stroke aha 681-86, **2011**	n=40 → 40 A= IG:69.95/CG:63.15 NC= **Stroke** T=IG:18.9/CG:19.7 **in days** S= first stroke unilateral (MRC ou CT)	FAME Family Mediated Exercise, at the bedside with the assistance of their nominated family Member (*in the hospital or the home Setting*) *designed according to the participants' ability* Fr: daily Dr: 35 min. Pr: according to the participants' ability	**IG=** "routine" physiotherapy Plus Individualized FAME programs **CG=** "routine" physiotherapy	**BBS** p: 0.7 IG: 22.3 ±17.6; 46 ±14.2 CG: 26.8 ±18.1; 37.6 ±16.2 **6MWT** p: 0.01 IG: 67.7 ±81.2; 271.6 ±154.5 CG: 118.4 ±119.6; 162.1 ±143.4 **LL-FMA** p: 0.12 IG: 21.1 ±11.3; 32.2 ±5.4 CG: 25.7 ±11.9; 28.8 ±10.4	RCT (8 weeks and) **12 weeks**	8/10
Pang *et al*, J J Am Geriatr Soc; 53(10):1667–1674, **2005**	n=63 →60 A= IG:65.8/ CG:64.7 NC= **Stroke** T=IG:5.2/ CG:5.1 years S= AHASOC	Fitness and Mobility Exercise (FAME) program including aerobic exercises, leg strengthening and balance training in the a multi-purpose room of a community hall. Fr: 3x weeks Dr: 60min. Pr: increased as tolerated. exercise intensity 5 min each week up to 30 min., 10% HRR each 4weeks and and duration	**IG=** FAME exercise, in a use of a hip protection in each session. **CG=** an exercise program for upper .extremity	**BBS** p: 0.85 IG: 47.6 ±6.7; 49.6 ±4.4 CG: 47.3 ±6.1; 49.2 ±5.8 **6MWT** p:0.025 IG: 328.1 ±143.5; 392.7 ±151.1 CG: 304.1 ±123.8; 342.4 ±133.4	RCT **19 weeks**	8/10
Duncan *et al*, **Stroke 34:2173-2180,** 2003	n=100 → 92 A= IG:68,5/CG:70,2 NC= **Stroke** T= IG:77.5 CG:73.5 days S= Orpington Prognóstic Scale	Exercise program designed to improve strength, balance, and endurance. Also to encourage more use of the affected extremity (endurance) Fr: 3xweek Dr: 90min. Pr: onthe protocols there was the criteria for progression.	**IG:** terapeutics exercises with protolcols tasks **GC:** usual care with home visits every 2 weeks	**BBS** (p) IG: 2.8 ±7.2; 7.16 ±7.91 CG: 43.1 ±9.0; 44.8 ± 9.52 **10MWT** (p) **(m/sec)** IG: 0.7 ±0.3; 0.88 ± 0.33 CG: 0.6 ±0.3; 0.71 ± 0.32 **6MWT** (p) IG: 238.0 ±103.9; 299.61 ±113.87 CG: 215.6 ±94.8; 249,19 ± 102.13 **LL- FMA** (p) IG: 24.1 ±3.7; 26.84 ±4.16	RCT 12 a 14 weeks (until 36 sections)	7/10

Table 1. Characteristics of included trials in the in systematic review and results from methodological quality assessment. For home exercises programs in neurological health conditions (conclusion)

Study Authors, Journal, Year	**Participants** The analyzed sample (n); Age (A); Neurological Condition (NC); Time on that condition in months or days (T); Scale or situation used to mesures condition (S)	**Intervention** Type of Exercise, Weekly Frequency (Fr), Session Duration (Dr) and Progression (Pr)	**Comparison** IG = Intervention Group CG = Control / Comparative Group	**Outcomes** Measures of Pre and pos test	**Study Design**	**PEDro Scale** Total Score
				CG: 23.7 ±3.5; 25.46 ±4.06		
Duncan *et al*, Stroke 29:2055-2060, **1998**	n=20 →20 A= IG:67.3/CG:67.8 NC= **Stroke** T= 56 – 66 days mild and moderated levels. S=Orpington Prognóstic Scale (**OPS**)	Home-based exercise program. Objective to improve strength, balance and endurance Also to encourage more use of the affected extremity. Fr: 3x week Dr: 90min. Pr:	IG=home-based exercise program CG= usual care as prescribed by their physicians.	**BBS** p> 0.2 IG: 38.3; 46.1 CG: 40.8; 45.8 **10MWT** p: 0.05<0.1 IG: 0.42; 0.67 CG: 0.57; 0.65 **6MWT** p> 0.2 IG: 491; 686 GC: 556; 671 **LL- FMA** p: 0.001<0.02 IG: 21.7; 26.3 CG: 23.2; 22.3	Controled Pilot Study 12 to 14 weeks (8 weeks with Physio Therapist) + 4 weeks (by owns)	6/10
Ashburn *et al*, J Neurol Neurosurg Psychiatry;78:6 78–684, **2007**	n=142 → 133 A= IG:72.7 CG:71.6 NC= **PD** T=IG:7.7 CG:9.0 S= Hoehn and Yahr and UPDRS and SAS	Home-based exercise for muscles strengthening, range of movement (stretches), balance training and walking, with cognitive strategies. There was an exercise menu to difining the level for each individual. Fr: daily Dr: 60 min. Pr: at each visit (weekly), increasing practice repetition or increasing practice repetition. And the six levels of exercise progression.	**IG**= personalised Home-based exercise **CG**= Conventional Physiotherapy	**BBS** (p=0.120) IG (44.3 +9.8) (45.8 +9.2) CG (43.6 +10.5) (45.2 +9.9)	RCT **8 weeks** *There was a 6 months followup*	8/10
Caglar *et al*, Clinical Rehabilitation; 19: 870 -877, **2005**	n=30 → 30 A= IG:67±5 CG:64±3 NC= **PD** T=IG:5.5±2.7 CG:5.2±2.7 S= Hoehn and Yahr	Home-based exercise . Trained in hospital and continued at home. Objectve to improve rango 0f motion funcional activity, balance and gait. Fr: 3 x week Dr: 60 min Pr:	IG=home-based exercise program CG= control group.	**10MWT** IG: 10.6± 5.3; 9.46± 3.9 CG: 14.3± 7.7; 15.3± 8.7 **20MWT** IG: 28.2 ± 12.4; 19.3± 3.9 CG: 29.7± 15.8; 33.9± 20.5	Prospective blinded controled trial **8 weeks**	10/10
Lun *et al*, Movement Disorders Vol. 20, No. 8, pp. 971–975, **2005** -	n=21 → 19 A= IG:66±8 CG:67±11 NC= **PD** T= IG:9±4 CG:8±4 S=UPDRS and Hoehn and Yahr	Excercise self supervised balance and strength-traning program Fr: 2x week Dr: 60 min Pr:	IG=home-based exercise program CG= control group was a physiotherapist- supervised balance and strength-traning program	**BBS:** IG: 51 ± 5; 51 ± 5 CG: 54± 1; 55± 2 TUG IG: 10±1; 11± 3 CG: 9±1; 9± 2	Prospective clinical trial **8 weeks** **+8 weeks** (to verify adherence)	4/10
Sosnoff *et al*, Clinical Rehabilitation 1–9, **2015**	n= 20→18 A= IG:63.3 CG:62.3 NC= **MS** T= 16,3 years E= EDSS	Home-based training with assessments at research laboratory focused on improving balance, and lower limb/core muscle strength Fr: three times a week in their home as outlined in a manual Dr: Pr:	**IG**= Home-based exercise **CG**= control group. Instructed to continue their normal activities.	**PPA**: composite score IG: 2.1 ±0.7; 1.4 ±1.2 CG: 0.95 ±1.1; 1.6 ±1.0	Pilot Study for RCT **12 weeks**	8/10
Sosnoff *et al*, Clinical Rehabilitation, Vol. 28(3) 254–263, **2014**	n= 27 → 22 A= GI:60.1 GC:60.1 anos (média) NC= **MS** T= E= EDSS	home-based exercise focused on improving balance, walking, lower limb/core muscle strength, and anti-spasticity Fr: 3xweek Dr: 45-60min. Pr: with levels of difficulty, depending on individual ability and tolerance levels. Increasing exercise intensity and/or minimizing the base of support.	**IG**= home-based exercise **CG** waiting list continued normal activity	**PPA** composite score p:0.05 IG: 1.1; 0.6 CG 1.9; 2.2 **BBS** p: 0.07 IG: 48.6 ±4.1; 50.2 ±3.2 CG: 42.6 ±14.6; 40.3 ±15.7 **TUG** p: 0.5 IG: 10.0 ±2.1; 10.3 ±2.1 CG: 10.9 ±2.9; 15.6 ±3.9 **6MWT** p: 0.83 aqui em pés IG: 1366.3 ±279.4; 1377.5 ±383.7 CG: 1058.9 ±430.6; 1080.6 ±367.0	RCT phase one 3 months = **12 weeks.**	5/10
DeBolt *et al*, Arch Phys Med Reabil vol85; 85:290-7, **2004**	n=35 → 35 A= IG:51,63 CG:47,78 NC= **MS** T= 1 to 35 years S= KFSS, EDSS, and MAS	Home-based resistance exercise program on balance, power, and mobility. Fr: 3xweek Dr: 60 min	**IG**: resistance training program + walking training **CG**: maintained current level of physical activity.	**TUG** p: 0.092 IG: 11.28 ±4.71; 9.15 ±2.26 CG: 11.09 ±4.74; 11.08 ±5.21	Experimen tal group design **2 weeks** instruction+ **8 week** intervention	5/10
TOTAL on PEDro score ---- -						91/130 7,0%

Participants:. **OPS** -Orpington Prognóstic Scale; CBS: caregiver burden scale; **NIHSS**: National Institute for Health Stroke **BRS** -Brunnstron recovery stages III a V; **KFSS**- Kurtzke Funtional sistem scales; EDSS: Expanded Disability Status Scale; **MAS** - Modified Ashworth Scale. **Intervention:** Fr: frequency weekly; **Dr**:duration of the section , **min**.: minutes; **FMEP –** Fitness and mobility Exercise Program; **FAME**= Family-Mediated Assisted Exercise; **UPDRS**= Unified Parkinson's DiseaseRating Scale; **Hoehn and Yahr**:; **FMEP** - Fitness and Mobility Exercise **Comparison:** **GI**: o grupo intervenção; **GC**: o grupo controle. **Outcomes:** **BBS**: Berg Balance Scale; **6MWT:** 6-minute walk test; **LL-FMA**: lower limb section of the Fugl-Meyer Assessment; **10MWT:** The 10-meter walk is a measure of gait velocity; **FWV**, free-walking velocity a variations on 10MWT; **MWV**, maximum walking velocity a variations on 10MWT; **TUG** Time up and go; **PPA –** Physiological Profile Assessement is a standardized test battery that assesses vision (edge contrast sensitivity via the Melbourne edge detection test), lower limb proprioception, strength (isometric knee extension), postural sway, and cognitive function (simple hand reaction time); **T25W** - timed 25-foot walk; **BARTHEL:** índice de Barthel. **Study design: RCT**: randomized controlled trial

From the 13 studies, 12 was randomized allocated and six of them were not blinded in allocation. Regarding the most important prognostic indicators, as measures of the severity on the neurological condition or key outcome measure, 10 studies were similar at baseline. Only one from 13 total studies was blinded to participants and none of them was blinded to the therapists, while 11 studies were blinded for assessors. The reason for that is the almost impossibility to blind participants or therapists with the intervention of exercises. In the majority of them (11 studies) there were more than 85% of subjects initially allocated to groups for at least one key outcome. The analyses were performed in an intention to treat basis on 11 studies. Statistical comparison was reported between groups while at the same time at least one key outcome was presented as well the measure of the size of the treatment effect and measures of variability appeared in 13 studies. High quality studies overall what means a low risk of bias on the majority of the studies.

Study Characteristics

Table 1 summarized the descriptive characteristics of the 13 studies included. Publication years ranged from 1998 to 2016. The studies involved 717 participants at baseline, reporting data for 676. In stroke were 419 (Age in IG: 66.95/CG: 65.96), 182 in PD (Age in IG: 68.56/CG: 67.53) and 75 on multiple sclerosis (Age in IG: 58.34/ CG: 56.7). None of them include HAM/TSP participants. Interventions varied widely across the 13 studies. Each study had different: types and composition for the protocols exercise; procedures for the management of HBE program; and variations on measures for the effect of intervention.

Type and composition of exercise protocol

There is different combinations of types of exercise for each protocols. For the majority of them it is included exercise of endurance, strengthening or stretching exercise, while only two cited walking training. Variations on the objective exercise was: for increasing force in lower limbs, to promote flexibility, for optimize the core muscles or training of breath, coordination and mobility. The protocol also varied on duration of intervention, frequency and duration of sessions, and progression of exercises.

The frequency of sessions varied from more than twice a week up to daily. Most of them were three times a week. The duration of each session ranged from 30 to 90 minutes. Three studies varied between 30 to 35 minutes (two in stroke, one in multiple sclerosis), seven between 45 to 60 minutes (three in stroke, two in PD, two in multiple sclerosis), two had the duration of 90 minutes (stroke) and one study did not described the duration of sessions (multiple sclerosis). Variations on the progression of the exercises occurred by increasing the time, intensity or repetitions, and also to growing difficulty of execution as minimizing the support base every week or enhancing the heart rate every four weeks.

Procedures on the management of the program

The duration of intervention varied from four to 19 weeks, the majority of them in 12 weeks duration. Only one had a follow up assessing outcome measures at six months after the end of the protocol. Monitoring was conducted in three time points: a delivery phase at the baseline, during interventions, and the moment of feedback from the progression. Personalized/individual or fixed/general were the two kinds of protocols identified. To deliver exercises, it seems necessary a training period by a professional in charge of the exercise protocol. Protocol training was applied by a physiotherapist alone or in a team with other professionals that included occupational therapists, athletic trainers or a specialized instructor. For the second phase along the period of the intervention major studies gave instructions with a booklet, manual or video and in a few cases none of these instruments was necessary because the physiotherapist kept visiting the participants at homes.

Feedback from how the protocol was performed also varied. Five protocols applied a diary as a data form to record the exercises done and their difficulties (frequency, kind or task). In one case diary plus telephone calls were done. In another study, telephone calls were made every two weeks only to verify the risk of falls. In two other studies it was requested the caregiver to record the details. Professional in four studies recorded dates (three studies to verify the heart rate, in the other physiotherapist decided the kind of exercise to do next based in a menu), and there was one case participants should take a not in a “treatment log”.

It was identified as the intervention groups in addition to HBE, HBE associated with conventional physiotherapy (CPT). As comparison groups were identified the CPT, usual care (UC) (keeping your usual treatment), just control, or other kinds of therapy also were identified.

Measures for the effects of the treatments

The main measures for the effects of treatments on functional activities disabilities were performed mainly using Berg Balance Scale (BBS) for balance, six minutes walking test (6MWT) for walking capacity, 10 meter walking test (10MWT) for gait speed, Timed Up and Go (TUG) scale for mobility, Barthel Index (BI) for functional independence and physical profile assessment (PPA). Also assessed the lower limb session of the Fugl-Meyer Assessment (LL-FMA) for strength. The continuous measurement was the most frequent on the studies presented by mean.

Effect of intervention

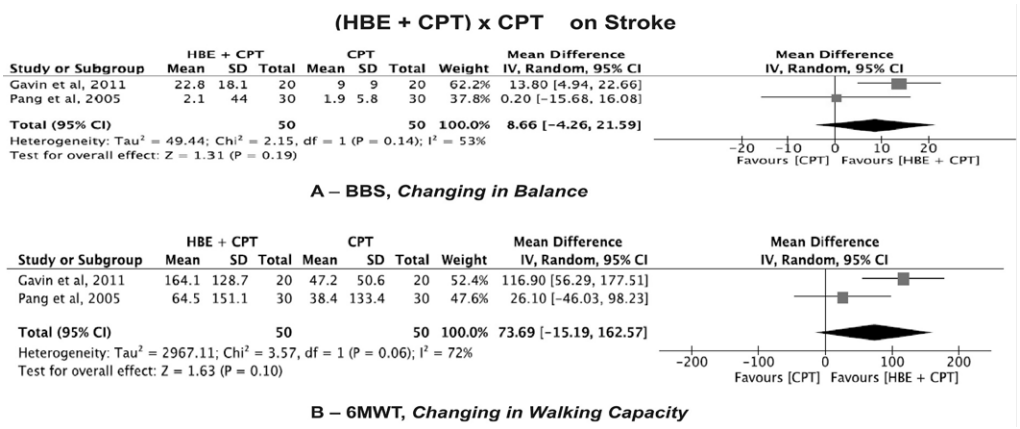
Nine studies were eligible for meta-analysis purpose. Six different meta-analysis were conducted on stroke conditions: two for balance, two for gait distance, one for functional independence, and one for gait speed. Three meta-analyses were conducted on Multiple Sclerosis condition, for the outcome of physiological profile assessment (PPA), mobility and postural sway. It was not possible to pool studies in PD or HAM/TSP conditions because it was not found homogeneity or additional study to compare. The results of the meta-analysis are showed in figures 2, 3 and 4.

(HBE+CPT) x CPT on Stroke

Figure 2. Forest Plot - Summary effect sizes for home based exercise intervention

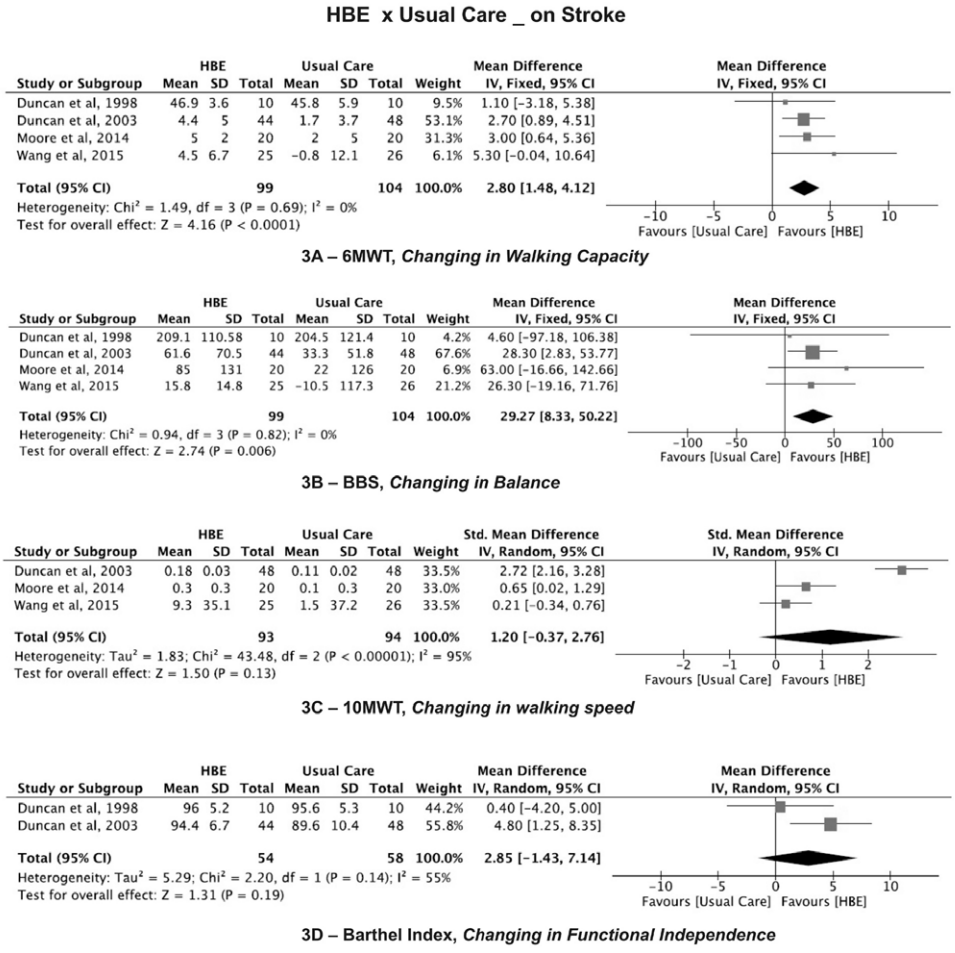
Critérios / Estudo	1- Origem e critérios de elegibilidade	2. Randomização	3. Cegamento na alocação	4. Similaridade na linha de base	5. Cegamento do participante	6. Cegamento do fisioterapeuta	7. Cegamento do analisador	8. > 85% medições	9. Intenção de tratar	10. Comparações intergrupo	11. Medida de variabilidade.	Pontuação TOTAL (0 a 10)
Moore et al, 2016(19)	sim	1	1	1	0	0	1	1	1	1	1	8
Wang et al, 2015	sim	1	0	0	0	0	1	1	1	1	1	6
Gordon et al, 2013(7)	sim	1	1	1	0	0	1	1	1	1	1	8
Gavin et al, 2011(11)	sim	1	1	1	0	0	1	1	1	1	1	8
Pang et al, 2005(12)	sim	1	1	1	0	0	1	1	1	1	1	8
Duncan et al, 2003.(17)	sim	1	1	0	0	0	1	1	1	1	1	7
Duncan et al, 1998.(4)	sim	1	1	1	0	0	0	1	1	1	0	6
Ashburn et al, 2007(14)	sim	1	1	1	0	0	1	1	1	1	1	8
Caglar et al, 2009(16)	Sim	1	1	1	1	1	1	1	1	1	1	10
Lun et al, 2005(??)	Sim	0	0	1	0	0	1	1	0	0	1	4
Sosnoff et al, 2015(20)	sim	1	1	1	0	0	1	1	1	1	1	8
Sosnoff et al, 2014(18)	sim	1	1	1	0	0	0	0	0	1	1	5
DeBolt et all, 2004(15)	Sim	1	0	0	0	0	1	0	1	1	1	5
Total		Média do Geral = 7,0 pontos								TOTAL de pontos =		91

Figure 3. Summary effect sizes for home based exercise intervention on Stroke condition



Legend: HBE: home based exercise; CPT:Conventional Physical Thearapy; 95%SD: 95%Standard deviation; IV: inverse variance; CI confidencial interval; BBS: Berg balance scale; 6MWT: six minuts walk test.

Figure 4. Forest plot of home-based exercises versus control group in Multiple Sclerosis



Legend: HBE: home based exercise; HBE: is the intervention group; Control: is the control group;SD: standard deviation; IV: inverse variance; CI - confidencial interval; Std. Mean difference: standard mean difference. PPA: physical profile assessment; TUG: timed up and go test.

Change in balance (BBS)

Two studies assessed the balance as an outcome, involving 100 participants (PEDro score mean=8). The meta-analyses showed (Figure 2A) a non-significant improvement in the balance of 8.7 (95% CI-4.3; 21.6) for participants in the HBE+CPT group when compared to CPT group.

Changing in walking capacity (6MWT)

Two studies assessed walking capacity as an outcome, involving 100 participants (PEDro score mean=8). The meta-analyses showed (Figure 2B) a non-significant improvement in 6WMT of 73.7m (95% CI 15.2; 162.6) for participants in the HBE+CPT group when compared to CPT group.

HBE x UC on Stroke

Change in balance (BBS)

The overall effect on HBE related to balance was an examination by pooling post intervention data from four studies that were using BBS, involving 203 participants (PEDro score range from 6 to 8, mean=6,75). The meta-analyses showed (Figure 3B) a significant improvement in the balance of 2.8 (95% CI 1.5; 4.1) for participants in the HBE group when compared to usual care group.

Changing in walking capacity (6MWT)

Four studies (including 203 patients) assessed 6WMT as outcome. (PEDro score ranges from 6 to 8, mean=6,75). The meta-analyses showed (Figure 3A) a significant improvement in 6WMT of 29.3 (95% CI 8.3; 50.2) for participants in the HBE group when compared to the usual care group.

Change in gait speed (10MWT)

Three studies (including 183 patients) assessed gait speed as outcome. PEDro score mean=7.0. The meta-analyses showed (Figure 3C) a non-significant improvement in gait speed of 1.2 (95% CI -0.4; 2.8) for participants in the HBE group when compared to the usual care group.

Change in functional independency (BI)

Two studies (including 112 patients) assessed functional independency as outcome. PEDro score mean=6.75. The meta-analyses showed (Figure 3D) a non-significant improvement in functional independency of 2.9 (95% CI -1.4; 7.1) for participants in the HBE group when compared to the usual care group.

HBE x UC on Multiple Sclerosis

Change in physiological profile (PPA)

Two studies (including 40 patients) assessed physiological profile as outcome. PEDro score mean=6.5. The meta-analyses showed (Figure 4A) a significant improvement in physiological profile of -1.3 (95% CI -2,0; 0.5) for participants in the HBE group when compared to the usual care group.

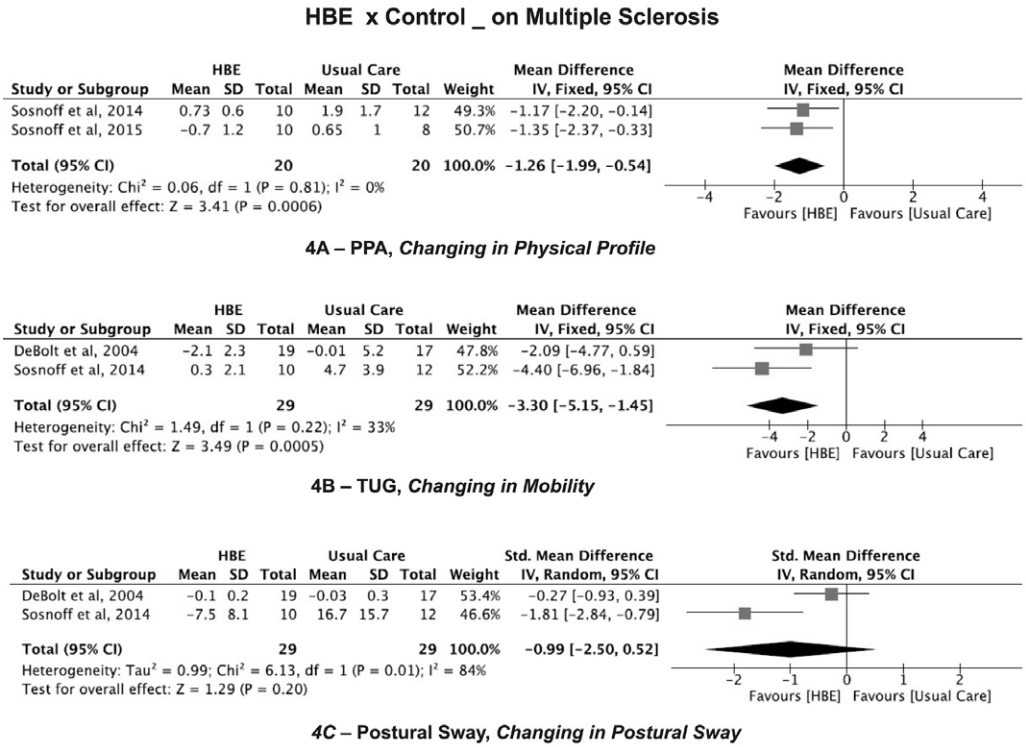
Change in mobility (TUG)

Two studies (including 58 patients) assessed mobility as outcome. PEDro score mean=5. The meta-analyses showed (Figure 4B) a significant improvement in mobility of -3.3 (95% CI -5.1; -1.4) for participants in the HBE group when compared to the usual care group.

Change in postural sway (AccuSwayPLUS force platform)

Two studies (including 58 patients) assessed postural sway as outcome. Postural sway was tested hand reaction time and with the. PEDro score mean=5. The meta-analyses showed (Figure 4C) a non-significant improvement in postural sway of -1.0 (95% CI -2.5; 0.5) for participants in the HBE group when compared to the usual care group.

Figura 5. Florest plot of PED versus control group in Multiple Sclerosis



Discussion

The main results of our systematic review indicate that HBE was efficient in increasing balance and walking capacity in stroke patients when compared to usual care. HBE was also effective in increasing functional mobility and for physiological profile in Multiple Sclerosis patients when compared to usual care. However, it is unclear the superiority of HBE in balance (BBS) and walk capacity (6MWT) in Post-Stroke participants, when the HBE is associated with conventional physiotherapy and compared to conventional physiotherapy alone. Postural sway in people with Multiple Sclerosis had a non-significant improvement for participants in the HBE group when compared to the usual care group.

To the best of our knowledge, this is the first systematic review evaluating the effect of HBE regarding neurological health conditions. It reveals HBE may be effectively applied in neurological conditions such as stroke (fig.3a and b) and multiple sclerosis (fig.4a and b) to improve balance and gait. More studies are needed to assess the impacts of HBE in PD and HAM/TSP populations. Notwithstanding, although we did not find in HBE on HAM/TSP, it is possible to have the multiple sclerosis studies as reference, since they both have similar clinical conditions regarding disability. HBE interventions as demonstrated are important to improve health conditions on disability people. Disability people leave in a vulnerable conditions and represent around 15% of the world population[1] with difficulties in their daily lives. Once they face widespread barriers in accessing health services, difficulties with transport and have worse socioeconomic outcomes[2] community-based rehabilitation interventions as the HBE explored here, demonstrates to have great value. Besides to reveal effective, this review demonstrate HBE seems to have also a low cost once does not involve transport costs, the needs for large equipment and has a minimum spending with professional services. HBE may minimize accessibility barriers, and improve social participation and autonomy[14].

To detail strategies on implementing exercises programs is a worry among researches to help clinical and health systems leaders[15,16]. To implementing a HBE program it is necessary a well-planned design including to preview stages, processes, to study feasibility and acceptability to the specified population, choose the tests for estimate of effectiveness[11,14,16]. Others details are regarding the peculiarities of the exercise to be performed at home or in the

community[14], to be supervised or not[22] and in case of neurological conditions to be alert of their situation as to have a care giver[23,24]. This review by exploring data for planning the HBE program reveals some important strategies as well as detected missing ones that could be included in the implementing process for HBE as part of their plan design for controlled trials.

The studies of this review were based on the age between 58.34 to 68.56, were included on the protocols, variations of exercise: 7 studies included exercises of endurance, 11 were with strengthening of muscles on lower limbs and abdominals, 5 with stretching. Also was included specific exercises: for balance 11 studies and walking training on 7 studies. Most recommendation was for duration of 12 weeks programs, with frequency of three times a week, and with session ranging from 45 to 60 minutes. The progression of the exercise was according to the participants ability or as planned on the protocols with increase of: difficulty, of the repetition, of intensity or on resistance. Special care were taken: to avoid fatigue in multiple sclerosis; to proposals of stretching on PD; and carefully increase of the heart rate if aerobic exercise were included in the protocol.

Special attention should be made for monitoring the protocol of the program on the different moments as to provide correct instruments of instructions (booklet, manual, video or other) and instruments for supporting the records (phone calls, forms to report what occurred) besides the usual instruments of analysis of the results. Also it is important for a physiotherapist to co-ordinates the whole program including the exercise, agreeing with Clegg study[15]. For neurological conditions it is important to be considered caregivers as a partner on the rehabilitation intervention, as seen in different studies[17,22,24]. It is possible a tailored or general protocol for the whole group as seen on the studied protocols. The programs also can be directly supervised[25,27] or unsupervised[28,30], agreeing with Olney[22], but always monitored along with a professional with adequate instruments. Yet it can be delivered indirectly by a health professional supervising a caregiver[17,31] with different advantages in each case, what means for each situation should be realized a criterion study of feasibility and individuals necessity[11,30]. Can even have a mixed on both situations, considering progression on obtained outcomes[32].

Heterogeneity between the exercises protocols in this study is the same as in others review investigating the effect of exercise on gait and balance for stroke and it may have small influence in our findings. Nevertheless others differences among designs of protocols of study must be reviewed as demonstrated Chen et al.[33]. In our study limitations on evaluation of gait speed (10MWT) could explain results on the overall effect size be not significant for the HBE intervention(figure 13c). While one study seems to be applied 14 meter[34,35], others applied 10 meter in total as is appointed for the regular test[17,25,36]. these lightly difference on the application of standard scale among the studies may explain the contrast among our and others systematic reviews, one assessing intervention of exercise with gait-oriented[37] and other assessing gait training with cadence indication[38] that had in both cases, positive effect on gait speed.

The different protocols designs and the local of it applications among the studies may influence results. Customized protocol applied individually, at home and a caregiver included as part of the program to conduct the exercise as proposed by Galvin et al.[31] or fixed protocol applied in group, in a multi-purpose room of a community and conducted by an multidisciplinary team as proposed by Pang et al.[27], indicates the diversity of elements and the interaction between them, what confirm that the exercise on domiciliary basis has a complex nature, as described by Clegg et al.[12] in your study. All these elements must be verified case by case, what can work well in one case, may not work in another one, it depends on the elements and interactions with the individuals and with the environment conditions according to purposed of intervention. At the same way that local of the exercise delivery may be distinct from the intervention made autonomous as proposed Galvin et al.[31] with training of the exercises in the hospital, and later the intervention at home autonomously as tested Gjelsvik et al.[39], and Olney[22].

The findings of the present study point to the application of simple and low cost tests, suitable for application in scientific studies as facilitates research's and also clinical practice, applied on evaluation of clinical conditions or for rehabilitation responses such as BBS[40], 10MWT[41], 6MWT[42], TUG[43], LL-FMA[44], BI[45], AccuSway[46,47], that seems to be the most accurate measures related to assess the outcome of

exercise protocols for the functional activities: balance, gait speed, gait velocity, mobility, strength, functional independency and balance sway. Nevertheless it were not used measures of disabilities as the core sets of ICF[48] or the WHODAS 2.0[49] probably because they are recent scales. The use of these measures may allow assesses disability among the four neurological disorders studied and to include environmental factors.

One of the foundations for recover mobility functions is the gain of walking capacity, within it the possibility to move around on a community environment. A well planned HBE for people with chronic neurological conditions should include strategies for community-based rehabilitation, and preview the processes for the management of disabilities, what may contribute in a health system in favor of this population.

Study Limitations

The study is distinguished by the peculiarity of including the investigation of the several important aspects of the rehabilitation of the chronic incapacities in a single intervention, the HBE programs. However, it does have its limitations despite to have good methodological quality, the selected studies, do not clearly describe the procedures related to the intervention on control group protocols. Would be important in health chronically conditions investigate the follow-up but the trial did not allow for it. We have a lack of studies in PD and in HAM/TSP this does not allow possibility to comparing between their own results. Likewise, this review study did not allow us to investigate similarities and differences between the four neurological conditions studied through the expanded view of disability analysis for lack of appropriate scale application. All factors therefore preventing a larger investigation on implementations procedures of these programs, what can be also seeing as aspects to be better explored on a RCT.

Conclusions

HBE programs are therefore recommended to stroke and multiple sclerosis people. It is highly recommended studies of clinical trial on HBE for people with HAM/TSP, and it is necessary more homogeneous studies of HBE for people with PD. We suggest for future studies research comparing different types of HBE, investigating the superiority among each other. To implement HBE programs should be better explored details such as motivational, health education, burden diseases, the use of functional scales such as WHODAS and others aspects regarding to the management of disability on walking activities. To build a guide for intervention of HBE on neurological disorders could facilitate implement the program on community and the development of clinical trials in order to have the homogeneity requested in studies looking for evidence. Also are recommended a cost effectiveness study to confirm HBE as a low cost intervention on public health.

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Author Contributions

Libório AML conceived the project, registered it with PROSPERO, collected data, reviewed the literature on the subject, drafted the manuscript and approved the final version. Santana G collected the data, drafted the manuscript and approved the final version. Macêdo MC conceived the project, revised the manuscript and approved the final version. Gomes Neto M developed the meta-analysis, revised the manuscript and approved the final version. Baptista AF critically reviewed the project, the analyses, the manuscript and approved the final version. Sá KN conceived the project, guided all stages of its development, reviewed the analysis and the entire manuscript, and approved the final version.

Competing interests

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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