REVIEW ARTICLE

IJPHY

# THE EFFECTIVENESS OF PHYSICAL THERAPY INTERVENTIONS IN ADULTS WITH CEREBELLAR DYSFUNCTION - A SYSTEMATIC REVIEW

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## ABSTRACT

*Background:* Physiotherapy is a well-accepted modality in the rehabilitation process of cerebellar dysfunction. Despite being commonly accepted as rehabilitation measure there is a need for scientific evidence to prove role of Physiotherapy in persons with cerebellar dysfunction. This study is an effort to systematically review the literature investigating the effectiveness of physiotherapy in adults with cerebellar dysfunction and to document treatment strategies currently employed in the physiotherapy management of this patient population.

*Methods:* Four electronic databases were searched to source English language studies published up to 30th April 2014. Secondary searching of reference list was also undertaken. Studies were included in this review if their primary intervention was physiotherapy on adults with cerebellar dysfunction. Three independent reviewers were involved in this study. Each contributed to the study by analyzing data related to participants, interventions received and effectiveness of each intervention as measured in research articles. The relevant outcomes were described adopting a narrative synthesis.

*Results:* Eleven studies were reviewed. Majority of studies (n=10) were case studies or case series. The average quality score was 1.9 (range 1-10). All studies reported positive outcomes of rehabilitation measures both from the scientific point of view and also from participants' perspective. No meta-analysis was undertaken in this study.

*Conclusion:* There is modest evidence that physiotherapy may have a positive effect on the various limited abilities of adults with cerebellar dysfunction. The outcome measures however need cautious interpretations due to otherwise low volume, quality and clinical applicability of the this aftermath as per the available evidences analyzed by the researchers. There is also a need of high-quality researches to be carried out.

*Keywords:* Cerebellar dysfunction, Physical Therapy, cerebellar, dysfunction

Received 6th November 2014, revised 16th November 2014, accepted 21st November 2014

DOI: 10.15621/ijphy/2014/v1i5/55269

www.ijphy.org

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## INTRODUCTION

Cerebellar dysfunction is a group of clinical signs and symptoms which result due to underlying cerebellar pathology both primary and secondary. Lesions of brain may result from developmental abnormality, traumatic, or spaces occupying like tumour, plaque and sclerosis. Cerebellar circuits have been proved to play a crucial role in coordinating motor movements in the extremities and also a significant role in the process of motor learning[1]. Disruption to these circuits in any form of trauma results in severe abnormalities. This includes speech disturbances, in-coordination, abnormal postural sways, ataxic gait, tremor, disequilibrium and poor motor relearning ability.[2] Most of the rehabilitation studies done in the past have dealt with gait, balance and cognition.[3-5]

Physical Therapy has been widely advocated for rehabilitating persons with cerebellar dysfunction. The major reason behind aggressive rehabilitation measures is the unique motor relearning process of the cerebellar parenchyma.[6-7] Physiological studies have proved that cerebellum is capable of rewiring its circuits, in simpler terms the phenomenon of neuroplasticity occurs in cerebellum also. This forms the fundamental basis of various rehabilitation programs to help persons with cerebellar dysfunction.[8,9] The aim of most of the training programs is to improve basic motor components like balance, gait and coordination. However many studies have proved to improve cognitive status, hand function and speech. Despite a good understanding of the basic mechanism with which rehabilitation measures works, there are not many studies to emphatically prove the efficacy of Physical therapy in the management of cerebellar dysfunction. Hence this study was attempted in looking for clinical trials, their background, Physical interventions, measurement tools, and outcomes to further the understanding of Physical therapy in the management of cerebellar dysfunction. The aim of this systematic review is to collate evidences for Physical therapy interventions in the cerebellar dysfunction with focus on outcomes like balance, gait, coordination, postural control and functional independence. The objectives are, to form a detailed search strategy, to search for articles from Physiotherapy databases, Collate the articles and analyse the quality of research and Interpret the strengths and weakness of the studies in a narrative format.

## METHODOLOGY

**DATABASES:** A systematic review of quantitative studies that documented the physiotherapy approaches for adults with cerebellar disease was undertaken. Four databases were searched (PEDro, Pubmed, MEDLINE, CINAHL). The search was limited to articles published in English from 01 January 2004 till 30th April 2014.

**SEARCH STRATEGY:**

**TABLE-1**

| Search set | Search Terms | Boolean operators |
|---|---|---|
| 1 | Cerebellar dysfunction | OR |
| 2 | Cerebellar degeneration | OR |
| 3 | Cerebellar Ataxia | AND |
| 4 | Exercises | OR |
| 5 | Rehabilitation | OR |
| 6 | Physical therapy | NOT |
| 7 | Medical | OR |
| 8 | Surgical management | - |

The following search strategy was applied to collect articles from different databases. ((("physical therapy modalities"[MeSH Terms] OR ("physical" AND "therapy"[All Fields] AND "modalities"[All Fields]) OR "physical therapy modalities"[All Fields] OR ("physical"[All Fields] AND "therapy"[All Fields]) OR "physical therapy"[All Fields]) OR ("rehabilitation"[Subheading] OR "rehabilitation" [All Fields] OR "rehabilitation" [MeSH Terms])) OR Retraining[All Fields]) AND ((("cerebellar diseases"[MeSH Terms] OR ("cerebellar"[All Fields] AND "diseases"[All Fields]) OR "cerebellar diseases"[All Fields] OR ("cerebellar"[All Fields] AND "dysfunction"[All Fields]) OR "cerebellar dysfunction"[All Fields]) OR ("cerebellar diseases"[MeSH Terms] OR ("cerebellar"[All Fields] AND "diseases"[All Fields]) OR "cerebellar diseases"[All Fields] OR ("cerebellar"[All Fields] AND "disease"[All Fields]) OR "cerebellar disease"[All Fields])) OR (("cerebellum"[MeSH Terms] OR "cerebellum"[All Fields] OR "cerebellar"[All Fields]) AND degeneration[All Fields])) AND ("loattrfree full text"[sb] AND ("2004/01/01"[PDAT] : "2014/04/31"[PDAT]) AND "humans"[MeSH Terms] AND English[lang] AND "adult"[MeSH Terms])

**FILTERS:**

The filters used in the searching of databases for relevant articles are,

a. English language
b. Human trials
c. Free full text availability

## SELECTION CRITERIA:

Articles were included in the study if they met following inclusion criteria:

**STUDIES:** All types of quantitative studies were sourced for this review .The study designs included Randomized control trials, Quasi Randomized control trials , Case control trials, Observational trials ,Case series and Quasi experimental designs with or without a comparison group in the review because of paucity of comparative studies on this topic. Reviews on Physical therapy management, Letters to the editors and other conference abstracts were excluded due to insufficient data provided for data extraction for the purposes of a systematic review.

**PARTICIPANTS:** Eligible studies were those of adults patients (18 years or above) with isolated cerebellar dysfunction. Patients with Multiple system involvement, other movement disorders (e.g. Parkinson's disease, Huntington's, etc.) and any other Central Nervous System involvement (cerebral hemisphere or spinal cord involvement) were excluded due to discrepancy of effects of therapeutic regimens for rehabilitation of individuals with isolated cerebellar dysfunction .We also included a similar study which was done for children (14 years) for the narrative synthesis.

**TYPE OF INTERVENTIONS:** Studies were included in this review if their primary intervention was physiotherapy undertaken in Tertiary care centre settings, secondary hospital settings, nursing homes, physical therapy clinics and strategies practiced within home and community dwelling. Examples of eligible physiotherapy interventions include: Proprioceptive neuromuscular training approach, Balance training, Gait training, Co-ordination exercises, Stability training, Range of motion exercises, Activity-based approach, Electrotherapy modalities, Endurance training and Other new/modified physiotherapeutic approach. Laboratory-based experiments in which investigated short term learning effects in individuals cerebellar disorders, studies combined with any other interventions of non-physical therapy measures like exclusive medical or surgical management were not included in this review as they were not considered to be applicable in physiotherapy clinics.

**OUTCOME MEASURES:** Outcome measures were not specified in the inclusion criteria because of the wide variety of measures available and also the varied number of domains that can be possibly evaluated. Hence, the inclusion criteria were restricted to non traumatic cerebellar dysfunction. All the outcome measures of the included studies were analyzed to report the effectiveness of Physiotherapy interventions in adults with cerebellar dysfunction. Three independent reviewers reviewed the full text articles and verified the eligibility and scored them on PEDro scale for quality of research articles (Appendix 1). Studies done on cerebellar dysfunction focussing on medical or surgical management and children population were excluded from the review.

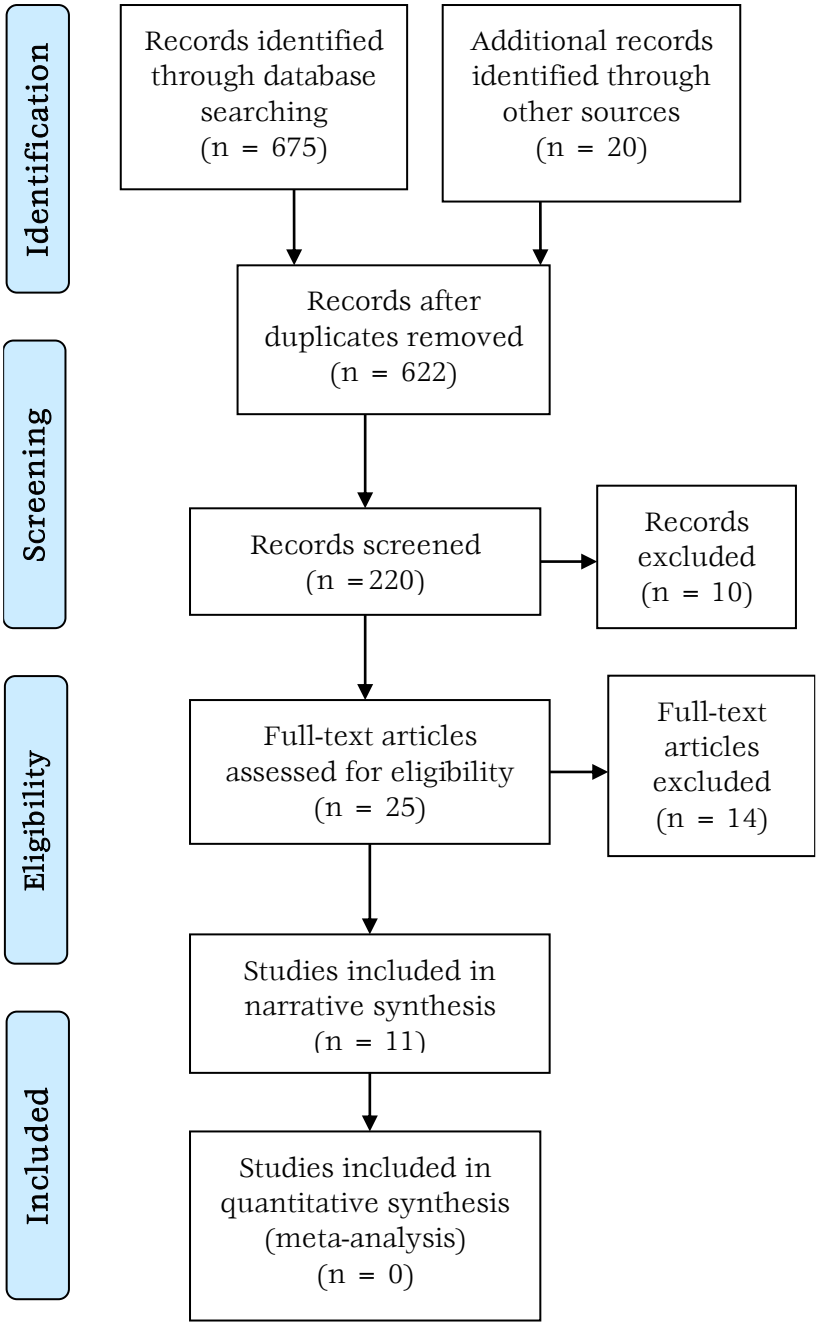
## DATA EVALUATION

**DATA EXTRACTION:** Using a standardized data extraction form the following information was extracted from eligible studies – Participants' characteristics, Physiotherapy interventions (Type and intensity), outcome measures used and the study results. (Table 4)

**QUALITY ASSESSMENT:** Three independent reviewers (SK, DS and NK) critically appraised each study by determining the level on the PEDro quality assessment scale (appendix[1]) for research articles. This enabled the identification of the degree of potential bias associated with each study design. The methodological quality was evaluated using dichotomous quality appraisal criteria (0 = Not fully complied, 1 = Complete mention of the quality variable). The maximum score possible is 11 and that indicates excellent methodological quality.

**DATA ANALYSIS:** Extracted data were analyzed using descriptive statistics to summarize the methodological quality of the studies, their participants, physiotherapy interventions and outcome measures employed. Due to lack of sufficient quality studies, despite having low scores all the relevant studies were included in the systematic review for narrative synthesis.

## PRISMA FLOWCHART




*From:* Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(6): e1000097.

**TABLE 2:** STUDY DESIGN, QUALITY AND RESULTS

| Author | Study design | Hierarchy of evidence | Quality score | Main findings |
|---|---|---|---|---|
| Huiqiong Deng et al[10] | Case study - Cross over design | IV | 1 | No significant difference between fast training and slow training found in the Box and Block test ($p > 0.5$), training effect (1.10 and 1.65). No significant difference in the Jebsen and Taylor test. Training effect high for fast training (-1.39) and low for slow training (0.06). No significant difference between fast and slow training in the finger force extension test. There was a significant difference in decreasing the corticospinal excitation after fast training phase |
| CDR Tom Schroeder, USPHS[11] | Case study | IV | 1 | Dynamic Gait Index scores improved from 18/24 to 21/24. The Dynamic Motion Analysis score decreased from 982 to 584. Hip abductor strength improved to 3/5 bilaterally. Sharpened Rhomberg and The Fukuda Stepping Test (FST) were negative. Patient unable to perform tandem gait. Difficulty in ambulation and head turns (up/down, side/side), stepping around obstacles persisted. |
| C Goulipian et al[12] | Case study | IV | 1 | Self assessment score on perception of pain, fatigability, ankle stability and less likelihood of falls improved. But the gait speed and other parameters of gait like cadence, step length, step width did not improve with orthopedic shoes. |
| Jorge L Jorge-Rodriguez et al[13] | Case series | III | 1 | Significant improvement in Posture and gait disturbance score CI(15.06-22.53) $p < 0.05$, Kinetic functions CI(10.39-15.90) $p < 0.05$, speech disorders CI(1.50-2.29) $p < 0.05$. No significant improvement in the occulomotor disorders domain CI(1.01-2.19) $p > 0.05$. Overall significant change in ICARS score following Neurorestorative approach |
| Miyai et al[14] | Randomized control trial | I | 11 | Short term effect - No significant difference between immediate and delayed entry group in SARA total scores -3.0 (-4.3 to -1.8) $p < 0.01$. No significant difference in the truncal ataxia SARA scores -1.7 (-2.3 to -1.0) $p < 0.01$. No significant difference in the Limb ataxia SARA scores -0.8(-1.4 to -0.2) $p < 0.05$. No significant difference in FIM total and motor scores 1.3 (0.3 to 2.3) $p < 0.5$ and 1.2 (0.4 to 2.0) $p < 0.1$. no significant difference in normalized gait speed 0.157 (0.039 to 0.276) $p < 0.1$, Functional Ambulation Category (FAC) 0.2 (0.0 to 0.4) $p < 0.5$, falls per week -1.0 (-1.7 to -0.3) $p < 0.1$. |
| Winfred Ilg et al[15] | Case series | III | 1 | After 1 year of the 4-week intensive program, Ataxia scores deteriorated $Z = -2.9$ $p = 0.03$* but still better than the pre intervention baseline scores $Z = -2.1$ $p = 0.03$*. Significant decrease in BBS after 1 year 22.9,$P = 0.003$**, slightly but not significantly higher than the pre intervention baseline scores $Z = -1.1$ $p = 0.24$. Goal Attainment Score showed substantial retention of training effects - after initial 4 weeks 2.57 and after 1 year 2.07 (2 = expected outcome, 3 = greater than expected outcome) |
| Cakrt et al[3] | Case series | III | 1 | Closed eyes condition there were significant differences between Pre versus Post ($p < 0.05$) and Pre versus Retention ($p < 0.01$). No significant difference between Post and Retention.<br>Analysis of sway path showed significant main effects of visual condition ($p < 0.05$) and of experimental session and Pre versus Retention ($p < 0.01$) and no significant difference Post versus Retention. |

| Author | Study design | Hierarchy of evidence | Quality score | Main findings |
|---|---|---|---|---|
| Michael O. Harris-Love et al[16] | Case study | IV | 1 | Upper extremity function improved on the Nine-Hole Peg Test (NHPT) from 60.0s to 56.6s. Mild decrease in strength from 112 to 109 (Total score 140 of 7 muscle groups bilaterally). Single Limb stance Time (SLST) increased from 2.7s to 2.9s. Self reported measure on number of falls reduced from 12 at initial phase to 3 at the end of 1 year. Her gait speed decreased from 0.49 m/s to 0.15 m/s, and her double support time increased from 38% of the gait cycle to 66% while using the RWW. However, her gait speed and double support time improved to 0.28 m/s and 53%. Finally, force-control accuracy of her right knee extensors was 0.850 at the initial assessment and 0.874 following intervention, whereas the variability of force increased from 0.245 to 0.352 |
| Stephan Marianne Anke et al[17] | Case series | III | 1 | In the course of the climbing training the movements of the patients seemed to become faster (increase of MVel and PS), smoother (decrease in amount of DCh), and less curved (decrease of PL). Patients 3 and 4 improved their performance for the left as well as for the right hand (P3 left: 27.5 to 40, right: 28 to 45; P4, left: 66.5 to 89, right: 70.5 to 96). Self-perception report:<br>Patient 1 - reduction of tremor and an improvement in handling cups and tying shoes.<br>Patient 2 - reduction of tremor and an improvement in handling cups and tying shoes,<br>Patient 3 - positive effect on body position and stability and on the use of his visual system,<br>Patient 4 - After a temporary deterioration in the second training week, the patient reported an improved ability to perform slow movement sequences and a decrease in tremor |
| Jennifer L. Keller et al[18] | Case series | III | 1 | Post-test<br>TUG and DGI revealed improvements in gait and balance across visits ($P = .02$ and $P < .001$, respectively). Stride length and percentage double-stance time also improved across training visits $p < 0.01$<br>Retention<br>Effects were retained 1 month later in the DGI ($P = .002$) but not the TUG ($P > .05$). The FR, ABC, and ICARS scores did not change across visits for the group (all $P > .05$) Regression Analysis Regression showed that walking speed was affected by challenging in balance and not due to age, ICARS gait, posture subscore, proprioception and duration of exercise. |
| Winfred Ilg et al (2012)[19] | Case series | III | 2 | SARA scores improved across Mid and Post training assessments using Friedman test ($x$ 2515.5, $p < 0.0013$). No improvement comparing pre-intervention examinations (E1/E2, $p < 0.62$), indicating that there is no relevant influence of factors beyond intervention. Scores in the DGI increased, indicating an improvement in dynamic balance ($p < 0.04$*) |

**TABLE 3:** QUALITY SCORES OF REVIEWED STUDIES

| | | AUTHOR | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CRITERION** | Michael O. Harris-Love et al (2004)[16] | C Goulipian et al (2008)(12) | Wifred Ilg et al (2010)(15) | Miyai et al (2011)(14) | Stephan Marianne Anke et al (2011)[17] | Carkt et al (2012)[3] | Wifred Ilg et al (2012)[19] | Huiqiong Deng et al (2013)[10] | CDR Tom Schroeder, USPHS (2013)[11] | Jorge L Jorge-rodriguez et al (2013)[13] | Jennifer L. Keller et al (2014)[18] |
| 1 | Eligibility criteria were specified | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 2 | Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatment s were received) | N | N | N | Y | N | N | N | N | N | N | N |
| 3 | Allocation was concealed | N | N | N | Y | N | N | N | N | N | N | N |
| 4 | The groups were similar at baseline regarding the most important rognostic indicators | N | N | N | Y | N | N | N | N | N | N | N |
| 5 | There was blinding of all subjects | N | N | N | | N | N | N | N | N | N | N |
| 6 | There was blinding of all therapists who administered the therapy | N | N | N | N | N | N | N | N | N | N | N |
| 7 | There was blinding of all assessors who measured at least one key outcome | N | N | N | Y | N | N | Y | N | N | N | N |
| 8 | Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups | N | N | N | Y | N | N | N | N | N | N | N |
| 9 | All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyzed by “intention to treat” | N | N | N | Y | N | N | N | N | N | N | N |
| 10 | The results of between-group statistical comparison s are reported for at least one key outcome | N | N | N | Y | N | N | N | N | N | N | N |
| 11 | The study provides both point measures and measures of variability for at least one key outcome | N | N | N | Y | N | N | N | N | N | N | N |
| | Total score | 1 | 1 | 1 | 11 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |

**TABLE 4:** SUMMARY OF STUDIES ON THE EFFECTIVENESS OF PHSYIOTHERAPY FOR PEOPLE WITH CEREBELLAR DYSFUNCTION

| Author | Participants | | Intervention | | Outcomes | |
|---|---|---|---|---|---|---|
| | N | Characteristics | Treatment | Comparison | Measures | Time of assessment |
| **Huiqiong Deng et al (2013)[10]** | 1 (1 M; 0 F) | 69 year old adult male with left inferior cerebellar hemispheric stroke and left tonsillar ischemic infarct. Duration 101 months. Pre stroke right handedness | Fast training | Slow training | Box and Block test, Jebsen Taylor test, Finger extension force test | Baseline at 0 week-Post fast phase training at the end of 9 weeks followed by baseline. Then Slow training followed by assessment at the end of 8 weeks. Total 20 weeks |
| **CDR Tom Schroeder, USPHS (2013)[11]** | 1 (1 M; 0 F) | 35-year-old active US army male presenting with gait ataxia. H/o episodic dizziness since 8 years. Referred for a severe episode of migraine. Magnetic resonance imaging showed cerebellar atrophy. | Land based resisted exercises, cardio respiratory conditioning exercises, Aquatic exercises | No comparator agent | Rhomberg's test, Sharpened Rhomberg's test, Hallpike-DixManeuver test, The Fukuda stepping test (FST), Dynamic Motion Analysis (DMA) | Baseline at admission for Physical therapy and after 7 months of intervention (total 3 phases) |
| **C Goulipian et al (2008)[12]** | 1 (0 M; 1 F) | 26-year-old lady diagnosed with Friedrich's ataxia, fatigability, frequent falls, ankle instability and pain | Orthopedic shoes | No comparator agent | 1. Self assessment on pain level, fatigability, frequency of ankle sprains.<br>2. Video gait assessment.<br>3. Video gait analysis for gait parameters like cadence, step width step length. | Baseline at 0 day and post intervention evaluation after 1 month interval. |
| **Jorge L Jorge-Rodriguez et al (2013)[13]** | 20 (15 M; 5 F) | Persons with ataxia due to non-traumatic cerebellar dysfunction. | Neurorestorative program including resisted training, coordination exercises, gait retraining, ideomotor retraining, dynamic equilibrium exercises | No comparator agent | International Cooperative Ataxia Rating Scale (ICARS) | Baseline at 0 day and post intervention evaluation after 42 days of intervention. |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Miyai et al (2011)[14]** | 42 (Gender information not given) | Persons with isolated cerebellar ataxia due to cerebellar degeneration-SCA 1, SCA 36, idiopathic cerebellar disease. Able to walk 10 meters independently or with 1 person support. | Physical therapy - General conditioning, range-of-motion exercises, muscle strengthening, static and dynamic balance training, standing, kneeling, quadruped, mobilizing spine in prone position on elbows, walking indoors, outdoors, and climbing stairs. Occupational therapy - ADL, relaxation, hygiene, dressing, eating, toileting, bathing, reaching exercise | Delayed entry group | Primary outcome measures -<br>1. Scale for Assessment and Rating of Ataxia (SARA).<br>2. Functional Independence Measure (FIM).<br>Secondary outcome measures –<br>1. Gait speed,<br>2. Cadence,<br>3. Functional ambulance category (FAC),<br>4. Number of falls. | Baseline at 0 week for both intervention and control groups. Control group (delayed entry) test at 4 weeks. Long term follow up at 24 weeks after initial evaluation. |
| **Wifred Ilg et al (2010)[15]** | 14 (8 M;6 F) | 14 Persons suffering from degenerative cerebellar disease. | 4-week intensive coordination exercise program followed by 1-year home exercises | No comparator agent | Primary outcome measures –<br>1. Scale for Assessment and Rating of Ataxia (SARA).<br>2. Berg Balance Scale (BBS).<br>3. Goal Attainment Score (GAS)<br>4. Quantitative movement analysis for gait parameters and intra limb coordination | Long term follow up measure evaluated after 1 year of a 4-week intensive coordination exercise |
| **Cakrt et al (2012)[3]** | 7 (4 M; 3 F) | 10 In-patients with degenerative cerebellar disease | 2-week intensive Physical therapy program, daily 2 sessions of 20 minutes each, total of 20 sessions over two weeks. | No comparator agent | Posturography - eyes open and eyes closed | Pre - 0 week, Post - after 2 weeks and Retention - after 1 month |
| **Michael O. Harris-Love et al (2004)[16]** | 1 (0 M; 1 F) | 14 year old girl with Friedreich's Ataxia | Patient received Physical therapy once a month (60min per visit) at school. Quarterly PT assessment (60 minutes). Task oriented bimanual reaching activities, functional strengthening, gait training using a walker with wheels and brakes. | No comparator agent | 1. Nine-Hole Peg Test,<br>2. Single limb stance (dominant LE),<br>3. Manual muscle testing (10 point),<br>4. Self-reported falls,<br>5. Isometric force control testing,<br>6. 3-dimensional gait analysis<br>7. Force control using dynamometer. | Long term follow up measure evaluated at 0 day and after 12 months. |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Stephan Marianne Anke et al (2011)[9]** | 4 (0 M; 4 F) | 4 persons diagnosed with Cerebellar ataxia | Climbing training on 2 different walls with different inclinations. Frequency and duration decided on basis of health condition of the subjects. Pointing tasks done by more affected right upper arm and leg. | No comparator agent | Clinical Balance and Motor Skill Tests -<br>1. Berg Balance Test<br>2. Box and Block Test of Manual Dexterity Self-Perception of Motor Symptoms Questionnaire on motivation, performance of daily function on a 5-point scale<br>3-Dimensional motion recording system<br>- Movement Velocity MVel (m/s),<br>- Peak Speed PS (m/s)<br>- Symmetry Index (SI)<br>- End-Point Error EE (cm)<br>- Path Length PL Direction Changes DCh (s−1) | Evaluated 6 times - 2 before intervention (B1, B2), 3 times during therapy (T1, T2, T3) and 1 follow up (FU) |
| **Jennifer L. Keller et al (2014)[10]** | 14 (7 M; 7 F) | Spino Cerebellar Ataxia, Sporadic cerebellar ataxia | 6-week tailor-made home-based exercise program from stabilizing position to more challenging position focused on balance training. Both static and dynamic exercises were done in sitting and standing positions. | No comparator agent | 1. Ataxia severity was measured using the ICARS<br>2. Dynamic Gait Index (DGI)<br>3. Timed Up and Go (TUG)<br>4. Functional Reach Test (FR)<br>5. Activities Specific Balance Confidence Scale (ABC)<br>6. Standing balance using force platform measuring postural sway on a 20-second trial | Pre training at 0 week, Pre training at 2 weeks, Mid training at 5 weeks, Post training at 8 weeks, Follow-up at 13 weeks. |
| **Wifred Ilg et al (2012)[19]** | 10 | 10 Children with Progressive Spinocerebellar Ataxia | 8-week coordinative training with video games to exercise whole body coordination and dynamic balance - Initial 2-week supervised training in lab followed by 6-week home based exercise program. | No comparator agent | 1. Scale for Assessment and Rating for Ataxia (SARA)<br>2. Activity specific Balance Confidence Scale (ABC)<br>3. Motivation Scale<br>4. Motor performance by Motor capture system | E1 - 2 weeks before intervention,<br>E2 - Immediately before intervention,<br>E3 - After 2-week-laboratory training<br>E4 - After 6-week home-training program |

## RESULTS

**HIERARCHY OF EVIDENCE:** The studies included in this review comprised of one level I study - randomized controlled trial[14], six level III studies case series[3,13,15,17–19], and four level IV studies - 3 case series and 1 case series of cross over design [10–12,16](TABLE 3).

**QUALITY SCORES:** There was variable methodological quality within the studies reviewed [average quality score 1.9; range = 1-11(TABLE 2)].Most authors reported reliable outcome measures such Berg Balance Scale (BBS)[15], Dynamic Gait Index (DGI)[11,18], Timed up-and-Go (TUG)[18], Nine Hole Peg Test[16],Single Limb Stance Test[16],Fakuda Stepping Test[11] , Functional Independence measure[14], International Cooperative Ataxia Rating Scale (ICARS)[13,18], Scale for Assessment And Rating of Ataxia (SARA)[14,19], 3-D Motion capture analysis[11,19], Postural sways using force platforms[13]. Many authors have also used self perceived scores by the subjects to evaluate their perception of improvement following Physiotherapy interventions. Assessor blinding, gaining informed consent from participants, justifying the sample size and acknowledging the limitations of the study were infrequently reported (TABLE 4).

**PARTICIPANTS:** The characteristics of the participants reported in the included studies varied widely. Some even lacked gender and age specifications. And they presented with diverse cerebellar pathologies including cerebellar stroke[10], cerebellar atrophy[11,13] , Friedrich's ataxia[12,16], degenerative cerebellar diseases[3,14,15], cerebellar ataxia[11,17], Spinocerebellar[18,19] and sporadic cerebellar ataxias[18] (TABLE 4).

**PHYSIOTHERAPY INTERVENTIONS:** The physiotherapy interventions were directed towards a range of cerebellar impairments and activity limitations. The interventions varied with respect to the type of exercises prescribed, treatment frequency, intensity and duration. In addition a variety of treatment frequencies, intensities and durations were described (TABLE 4).The most frequently reported physiotherapy interventions included: a range of activities aimed at Re-training Balance[14,16,18,19] and Gait[13,16], Strengthening and Resisted Training[13,14,16,18], General Conditioning[11,14] and Co-ordination exercises[13,15,17], Ideomotor Retraining[10,13],Range of Motion Exercises[14], Proprioceptive Neuromuscular Facilitation[16], Posturography[3] and Use of Prosthetic Shoes.[12] The majority of studies lacked details regarding the specific exercises which were practised by the participants and their progressions. Therefore the physiotherapy strategies currently employed in management of individuals with cerebellar dysfunction is unclear.

## EFFECTIVENESS OF PHYSIOTHERAPY

We could only retrieve one study done by Miyai et al(14) which scored 10 on the quality scale using PEDro (10/11). Though other studies lacked rigorous methodology, they were able to bring out improvements in various domains of Physical impairment like balance, gait, postural control, reduced sway and number of falls. Thus this systematic review was able to highlight the fact that Physiotherapy offers a good scope of rehabilitation measures both from the scientific point of view and also the from participants' perspective.

## DISCUSSION

Cerebellum plays a crucial role in motor control and motor learning; hence Physiotherapy management for cerebellar disease has not been well established. This study attempts to review literature available to understand different studies and its strength in establishing the effectiveness of Physiotherapy in the management of Cerebellar dysfunction. In this study we restricted ourselves to pure cerebellar diseases because of the potential influence of other factors like spasticity, rigidity, cognitive status when other conditions like Multiple Sclerosis, Traumatic brain injury and other central nervous system disorders are involved. A search strategy was developed to extract studies that have dealt with Physical therapy and Cerebellar dysfunction from best know Physiotherapy databases like Pubmed, Medline plus, PEDro, Science direct. Filters like full text articles, human trial, clinical trials, and articles published only English language were selected for the review. Most of the studies either case study or case series with only one randomized control trial done by Miyai et al. All the studies have highlighted significant improvements in domains like balance, gait, Ataxia rating scores, functional independence measures, gait including motion captured movement analysis.

The major limitation identified in the strength of the studies is lack of rigorous study design including lack of randomized control studies. Hence, PEDro scale developed by Verhagen et al shows poor quality scores. The limitations of this study include only full text reviews from limited databases and lack of meta-analysis because of availability of single randomized controlled trial. The other limitation includes search for Physical Therapy interventions exclusively for pure cerebellar dysfunction ruling out cerebellar dysfunction associated with other neurological

conditions like Multiple Sclerosis, White matter degeneration etc.

## CONCLUSION

This narrative synthesis has brought out the fact that studies have proved vastly the benefits of Physiotherapy interventions in persons with cerebellar dysfunction although no particular intervention could be highlighted as superior because of the fact that we could not review many randomized controlled trials. There is modest evidence that physiotherapy may have a positive effect on gait, trunk control and activity limitations in adults with cerebellar dysfunction.


## ACKNOWDEGEMENT

We would like to acknowledge the support and encouragement rendered by the Head of Physiotherapy unit, Mr. Andrew Babu, through different phases of research work. The authors in this study contributed equally to the conception of idea, retrieval and analysis of study and manuscript preparation.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## APPENDIX-1

**PEDro scale**

| | | |
|---|---|---|
| 1. | Eligibility criteria were specified | No yes where: |
| 2. | Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received) | No yes where: |
| 3. | Allocation was concealed | No yes where: |
| 4. | The groups were similar at baseline regarding the most important prognostic indicators | No yes where: |
| 5. | There was blinding of all subjects | No yes where: |
| 6. | There was blinding of all therapists who administered the therapy | No yes where: |
| 7. | There was blinding of all assessors who measured at least one key outcome | No yes where: |
| 8. | Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups | No yes where: |
| 9. | All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyzed by "intention to treat" | No yes where: |
| 10. | The results of between-group statistical comparisons are reported for at least one key outcome | No yes where: |
| 11. | The study provides both point measures and measures of variability for at least one key outcome | No yes where: |

*Citation*
Samuel Kirubakaran Durairaj, Divya Singh, & Nishad Kassim. (2014). THE EFFICACY OF PHYSICAL THERAPY INTERVENTIONS FOR ADULTS WITH CEREBELLAR DYSFUNCTION - A SYSTEMATIC REVIEW. *International Journal of Physiotherapy, 1*(5), 286-298.