

Original Research Article

## Effect of Pilates Training Program on Balance in Participants with Idiopathic Parkinson's Disease - an Interventional Study

Dr. Shailja Pandya<sup>1</sup>, Dr. T. Nagendran<sup>2</sup>, Dr. Avni Shah<sup>1</sup>, Dr. Vittal Chandrabharu<sup>3</sup>

<sup>1</sup>Assistant Professor, C U Shah Physiotherapy College, Surendranagar, Gujarat, India.

<sup>2</sup>Senior Physical Therapy Practitioner, PMR Hospital, Kuwait

<sup>3</sup>Clinical Physiotherapist, General Hospital, Deesa, Gujarat, India.

Corresponding Author: Dr. Shailja Pandya

### ABSTRACT

**Background and Purpose:** Parkinson's disease is a chronic progressive neurodegenerative disorder of insidious onset, characterized by the predominantly motor symptomatology associated with a diversity of non-motor symptoms together with late-onset motor symptoms. Various approaches and advances in treatment for improving balance are viz. Pilates, Yoga, Tai-chi, Feldenkrais, etc. This study is to determine the effectiveness of Pilates Training over Conventional Balance Training on balance in participants with Idiopathic Parkinson's Disease.

**Study Design:** An Interventional Study.

**Materials and Methodology:** 30 subjects with Idiopathic Parkinson's Disease of age group <65 years. Participants who were willing to participate and fulfill the selection criteria were included and they were divided in 2 groups with Convenient Sampling followed by Systematic allocation. Group A was treated with Conventional Physiotherapy and Group B was treated with Pilates exercises with Conventional Physiotherapy. Subjects were assessed at baseline and 7<sup>th</sup> week (post- intervention). Outcome measures were taken for BBS, ABC and TUG for assessment and analysis.

**Result:** A statistical significant (<0.05) difference between both the groups were identified over the period of 7 weeks for functional balance, confidence level and functional activities. The results showed a higher significant improvement in experimental group (Group B) compared to control group (Group A).

**Conclusion:** Pilates Intervention with Conventional Balance Training is more effective than Conventional Balance Training alone to improve functional balance, confidence level and functional activities in participants with Idiopathic Parkinson's Disease.

**Keywords:** Parkinson's Disease, Basal Ganglia, Conventional Balance Training, Pilates.

### INTRODUCTION

Parkinson's Disease [PD], the second most common neurodegenerative disorder after Alzheimer's disease, was originally described in 1817 by James Parkinson in the classic "Essay on shaking palsy".<sup>[1]</sup>

Parkinson's disease is a chronic progressive neurodegenerative disorder of insidious onset, characterized by the presence of predominantly motor

symptomatology associated with a diversity of non-motor symptoms together with late-onset motor symptoms. (WHO)

Statistically, men are slightly more likely to develop the condition than women. Between the age of 55 and 85 years, 4.2% of all women and 6.1% of all men develop PD.<sup>[2]</sup>

Two distinct clinical subgroups have been identified:- one group includes individuals whose dominant symptoms

include postural instability and gait disturbances (PIGDI) and another group includes individuals with tremors as the main feature (tremor predominant).<sup>[3]</sup>

The risk of developing PD increases with age, and symptoms often appears after the age of 50. Some people may not be diagnosed until they are in their seventies or eighties. However, in some cases, Parkinson's is diagnosed before the age of 40, and this is known as young-onset Parkinson's disease. If Parkinson's is diagnosed before the age of 18, it is known as juvenile Parkinson's, although this is extremely rare.<sup>[4]</sup>

Current theories on the etiology and pathogenesis of PD consider it to be multifactorial and the result of a genetic predisposition possibly interacting with environmental factors viz. age, sex, dietary habits, environmental toxins, trauma, etc.<sup>[5]</sup>

PD has classically been viewed a disease of the basal ganglia,<sup>[6]</sup> characterized primarily by damage to accompanied by associated receptor destruction.<sup>[7]</sup> The pathological basis for the symptoms is loss of nerve cells in pigmented substantia nigra, pars compacta, the locus coeruleus of the midbrain and Globus pallidus. The loss of dopaminergic cells in the SNc leads to striatal dopamine depletion. Dopamine activates the direct pathway to the motor cortex and represses the indirect pathway (via the thalamus). Depletion of dopamine leads to decreased activity in direct pathway and increased activity in indirect pathway, reducing thalamic stimulation of the motor cortex which results in inhibition.<sup>[4]</sup>

Parkinson's affects functional activities such as balance, walking, speech, handwriting, typing, fastening buttons, driving, and many other simple, or complex but familiar and routine activities, as they are usually controlled by the mechanisms of dopamine and the basal ganglia.<sup>[8]</sup>

A combined approach of physical therapy & pharmacological intervention plays a key role in management of patients with PD. A variety of interventions used to manage PD include direct interventions,

supervision of assistive personnel, patient/family/caregiver instruction, environmental modification & supportive counseling. Interventions focus on improvement of motor function, exercise capacity, functional performance and activity participation. Education of patients, family members, and caregiver is critical to attaining optimal outcomes.<sup>[3]</sup>

Varieties of advances available for physiotherapy in Parkinson's disease are as yoga, whole body vibration, Tai-chi, Pilates, Feldenkrais etc.

PILATES, is a method of exercise developed by Joseph Pilates in 1926. It is a physical movement program designed to stretch, strengthen, and balance the body. Pilates exercise focuses on postural symmetry, breath control, abdominal strength, spine, pelvis and shoulder stabilization, muscular flexibility, joint mobility and strengthening through the complete range of motion of all joints. Instead of isolating muscle groups, the whole body is trained, integrating the upper and lower extremities with the trunk.<sup>[9]</sup>

Pilates aims at better integrating the individual into his or her functional challenges in daily life, involves the whole body as a functional unit, tries to correct postural deficits, and develops corporal stability.<sup>[9,10]</sup> Special emphasis is given to the "powerhouse," denoting the abdominal and peri pelvic muscles, which are especially responsible for postural control and corporal stability. Pilates exercises appear to have a great potential to improve various motor abilities, and there is a common consensus that the Pilates Method is effective in improving body stability and balance.<sup>[11,12]</sup> Since the Pilates Method does not offer any risk of lesions due to the mild character of the exercises,<sup>[13]</sup> it should be the ideal method to be applied to subjects with IPD within preventive programs against falls.

Smith & Smith (2005) reviewed integrating selected Pilates based core-strengthening exercises and principles into rehabilitation treatment plans and

community- and home-based programs for older adults. Older adults may benefit from Pilates in many ways: core strengthening, improvements in posture, postural stability, joint mobility, balance and coordination. Moreover, Pilates exercises can easily be integrated into traditional resistance and balance training programs. Pilates can improve physical features such as flexibility, proprioception, balance and coordination. Johnson, Larsen, Ozawa, Wilson, Kennedy et al., (2007) studied the effects of Pilates based training on balance in healthy adults and found positive effects. Hall et al. (1999) determined that Pilates-based exercise improved static balance in an elderly population.

Thus, there is a clear need for well-controlled Pilates research to provide benefits of exercise in an elderly population and population with Parkinson's disease. So, we will investigate the effects of a Pilates training program on postural instability and balance in a group of patients with IPD with a history of falls or near-falls.

**NEED AND SIGNIFICANCE OF THE STUDY:**

Morries ME and Ashburn A et al. 2007 states that most rehabilitation studies in PD address on the treatment of bradykinesia. Whereas Protas EJ and Toole T et al, 2008 says that recently there are a very few number of studies that assessed the effect of balance rehabilitation. Also the previous studies concentrated on impairment rather than the functional level of the patients with PD.

**SAMPLING CRITERIA:**

Thus, need of the study is to determine the effectiveness of Pilates training over conventional balance training on balance in participants with Idiopathic Parkinson's Disease.

**MATERIAL AND METHODOLGY**

**Research Design:** Interventional Study

**Sample Design:** Convenient Sampling with Systematic Allocation (Odd: Even)

**Study Population:** Participants with Idiopathic Parkinson's disease.

**Sample Size:** 30 patients GROUP A [15] GROUP B [15]

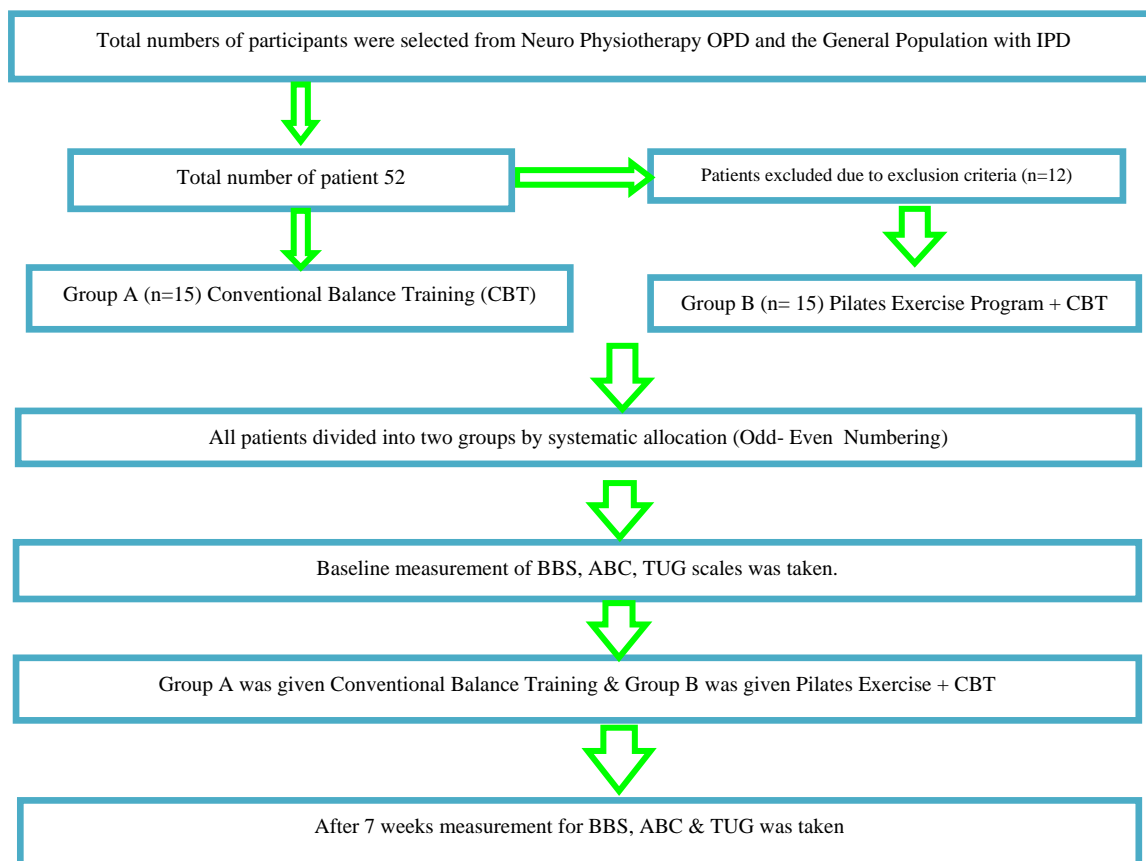
**Study Setting:** Neuro- Physiotherapy Outpatient Department.

**Study & Treatment Duration:** 10 months (January – October'14)& 7 weeks.

**Sampling Technique:** As the study was ethically approved by the Institutional Ethical Committee, total of 52 participants with Idiopathic Parkinson's Disease were screened for study. Amongst the 52 participants, 30 participants fulfilling the inclusion criteria were selected. The purpose and procedure of the study were explained to the participants and signed consent form was obtained from them. Prior to the study all participants were examined neurologically and the participant's demographic data were noted. Disease duration and severity were recorded and scored with Modified Hoehn & Yahr. According to consecutive sampling method, participants were allocated into 2 groups; Group A and B with 15 patients in each group.

INCLUSION CRITERIA [14,16]	EXCLUSION CRITERIA [14,15]
Idiopathic Parkinson's Disease ( diagnosed by a neurologist)	Participants were excluded if the disease was too advanced (Modified Hoehn&Yahr> 4)
Age Group :- < 65 years	Experienced severe dyskinesia and/or motor fluctuations
Gender :- Both Males and Females.	Had previously been diagnosed with stroke or dementia
Individuals who were diagnosed with IPD before a year or more and were on Stable Pharmacological treatment.	If they had any other medical conditions or physical disabilities interfering with their mobility
Had a prior history of one or more falls and/or near-falls in the preceding two years.	If patient did not agree to participate in the study.
Patients who have never received any other physical therapy or performed any other regular exercise activities.	
No serious cognitive disorders (score ≥24 on the Mini Mental State Exam)	

## CLASSIFICATION OF SUBJECTS:



### Outcome Measures <sup>[17]</sup>

All the outcomes were taken at the baseline i.e. at the time of assessment itself and after 7 weeks of the treatment intervention.

- Berg Balance Scale
- Activity Specific Balance Confidence Scale
- Timed- Up- And Go Test

**Berg Balance Scale:** The BBS is a widely used clinical test (interval scale) used to assess an individual's static and dynamic balance abilities. For functional balance tests, the BBS is generally considered to be the gold standard. It's a 14 item objective measure designed to assess static and dynamic balance and fall risk in adult population. The activities of varying difficulties are to be performed. Item level score range from 0-4, determined by ability to perform assessed activity. Item scores are summed. Maximum score is 56. Leddy et al. (2011) conducted a study on population with Idiopathic Parkinson's Disease using the BBS as primary outcome.

### Activity Specific Balance Confidence

**Scale:** The ABC is one of the several tools designed to measure an individual's confidence in his/her ability to perform daily activities without falling. This scale was designed for use with older adults. Fear of falling is important to assess because it is a likely confound in measuring postural performance. Deterioration in balance may result from activity restriction mediated by the fear of falling. It is a Ordinal Scale having 16 items (score 0-1600 possible). The score is recorded as a percentage (%), with 100% the highest level of confidence. Max score of 1600 divided by 16 items = 100% Clinical application of this would include working on the patient's confidence in their balance as well as objective balance activities. Pertez C et al. (2006) carried out a study on participants with Parkinson's disease and Participants with high level gait disorders (HLGD).

**Timed- Up- And Go Test:** The TUG is used to measure mobility, balance, walking

ability and fall risk in older adults. Initially it was designed for elderly population but it is also used for individual's with Parkinson's Disease, Multiple Sclerosis, Hip fracture, Alzheimer's disease, CVA etc. the participant sits in the chair with his/her back against the chair back. On the command "GO", the participant rises from the chair, walks 3 meter (10 feet) at a comfortable and safe pace, turns, walk back to the chair and sits down. Turning begins at the instruction GO and stops when the patient is seated.

**Data collection procedure:**

All the participants who fulfill the selection criteria will be evaluated clinically

and will be signed the consent form and they will be divided into 2 groups. Group A will be given conventional therapy for received 21 treatment sessions of 60 minutes each, 3 days a week (Monday, Wednesday, Friday) for 7 consecutive weeks, Group B will be given Pilates training for 7 weeks thrice weekly one hour training sessions. [18] The remaining days the participant's or the care taker was taught exercises to be carried out at home to maintain continuity in the treatment session. Results will be compared and analyzed statistically.

GROUP A (CONTROL GROUP)		GROUP B (PILATES GROUP)	
a. Relaxation Exercises	a) Hundred	a) Ball leg lift	a) Theraband seated Hip Abduction- Adduction
b. Flexibility Training	b) Shoulder bridge	b) Ball wall squat	b) Theraband seated Rowing
c. Strength Training	c) Single leg circle	c) Shoulder Bridge with swissball	
d. Functional Training	d) Alternate toe tap	d) Leg pull front (beginner)	
e. Motor Co-ordination Exercises	e) Spine twist		
f. Balance Exercises	f) Swan dive		
g. Locomotor Training	g) Side kick series (front & back)		
	h) Cat Stretch		

**RESULT AND INTERPRETATION**

For the statistical analysis, data were obtained before the treatment and after the 7 weeks of treatment from both the group.

The analysis was done for age, gender, BBS, ABC and TUG test for pre and post values. The mean and Standard Deviation were analysed for pre and post values.

The statistical analysis was carried out using both parametric tests and non-parametric tests. For the BBS and TUG test being Interval scale the parametric tests were performed and the ABC scale being Ordinal scale non-parametric test was performed.

The parametric tests being highly sensitive were selected for the analysis. For the parametric tests, paired t test was carried out for intra-group comparison while independent t test was done for inter-group comparison.

The non-parametric test used was Wilcoxon Signed Rank Test for intra-group comparison and Mann-Whitney U test for inter-group comparison.

The significance level adopted for the statistical tests was < 0.05 and confidence level was set as 95%.

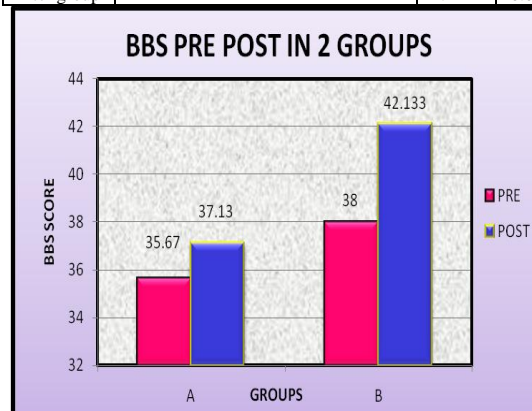
All statistical tests were performed using SPSS Version 16 software.

Table shows the mean values of the demographic data.

Group	Age	Gender		Modified H & Y	Duration of Disease
		Male	Female		
A	58	10	5	2.8	2.273
B	58.46	9	6	2.766	2.07

**Inter & Intra group comparison of Berg Balance Scale**

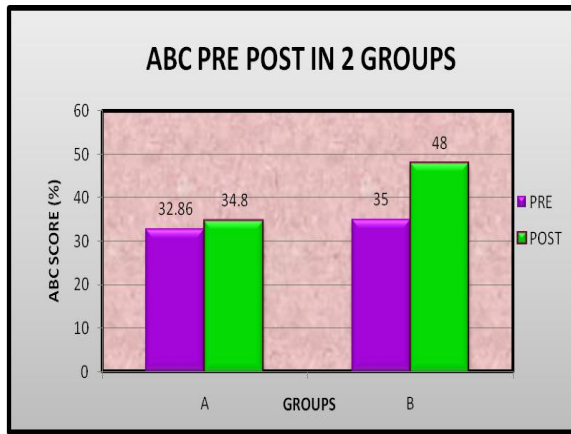
Groups	Pre		Post		Intra-group	
	Mean	SD	Mean	SD	t value	p value
Group a	35.667	4.353	37.066	5.133	3.500	0.004
Group b	38	3.207	42.133	5.566	4.303	0.001
Inter group					2.441	0.021





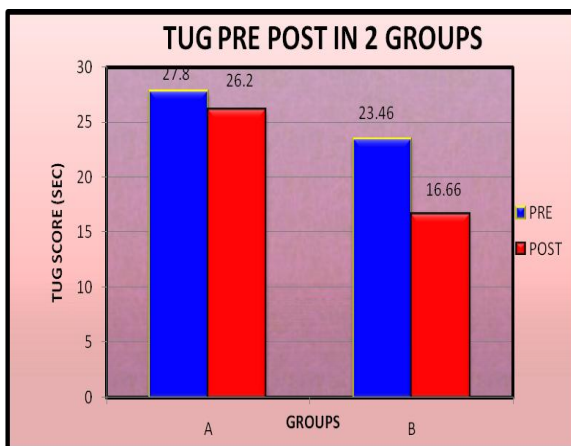
**Inter & Intra group Activity Specific Balance Confidence Scale**

Groups	Pre		Post		Intra-group	
	Mean	SD	Mean	SD	Z value	p value
Group a	32.86	9.999	34.80	9.726	2.802	0.005
Group b	35	9.449	48.66	12.882	2.575	0.010
Inter group					2.667	0.008



**Inter & Intra group Timed up & Go Test**

Groups	Pre		Post		Intra-group	
	Mean	Sd	Mean	Sd	T value	P value
Group a	27.8	3.211	26.53	3.642	2.738	0.016
Group b	23.46	4.155	18	8.847	3.193	0.007
Inter group					3.406	0.002



**DISCUSSION**

This study provides the evaluation of the effect of 7 week Pilates training program on the variables functional balance, confidence level and functional activities with the outcomes BBS, ABC and TUG in ambulatory population with IPD. The overall finding shows that Pilates intervention as well as Conventional Balance Training program leads to significant improvement in functional balance which in-turn improves the Quality

Of Life, however participation in Pilates Intervention lead to statistically significant and clinically greater improvements compared to CBT. This study further adds to the existing literature regarding the importance and benefits of Pilates exercise intervention in improving balance in IPD population.

Postural Instability or loss of balance is the cardinal features in IPD leading to impaired QOL of participants. The participants also have difficulty in initiation of movements, have resting tremors, perform slow movements, have mask like face and a stooped posture. The initiation problem along with the slowness leads to gait disturbances too. Thus, due to basal ganglia dysfunction the IPD participants have loss of balance and postural instability as their hindering factor in the ADL.

Results indicate that there is significant improvement in Balance, Functional ability and Postural Instability in participants with IPD at the end of 7 weeks in both the groups viz., Conventional Balance Training in Group A while Pilates Exercises and Conventional Balance Training in Group B. Both the groups obtained successful reduction in the outcomes as measured by the significant reduction in TUG and increase in BBS and ABC assessments at the end of 7 weeks. There is significant difference in interval scores for BBS and TUG and Nominal scores of ABC showing improvement in the functional ability and balance between the groups.

In this study efforts were made to compare the effectiveness for CBT and Pilates for improvement of balance in treating IPD participants. Physical therapy as a conservative treatment is found to be effective but with less evidences. The patients were divided into 2 groups according to Convenient Sampling followed by Systematic Allocation.

Pilates Intervention leads to significant and greater improvement in some key balance variables when compared with CBT. One factor that might have

contributed to more improvement in the Pilates Intervention group was the pattern of exercise. The exercises include maintaining a stable posture while concentrating in the rhythm of respiration thereby providing a multi task intervention with increased awareness of kinesthesia, proprioception and movement co-ordination. [19,20]

There are four aspects of Pilates that make the method noteworthy: (Kopitkze, 2007).

**First**, it offers a mind-body connection and philosophy towards function in everyday living. Joseph Pilates created this method based on his studies of eastern religion and derived some of the concepts from yoga principles (Siler, 2000). The Pilates method asks participants to be aware of their “powerhouse,” or postural control muscles, in everyday activities in order to increase body awareness during movement (Pilates & Miller, 1998).

**Second**, the method is performed on specialized Pilates apparatuses that utilizes spring resistance to increase strength and muscle lengthening to improve flexibility. The spring resistance builds strength through eccentric and concentric contraction, and promotes lengthening of muscles (Coleman-Brown & Haley-Kanigel, 2003). The main pieces of apparatuses include the reformer, Cadillac and ladder barrel. The design of Joseph Pilates' apparatuses allows for changing the center of gravity, shortening the length of levers, changing the base of support and instructor assistance (Anderson, 2001).

**Third**, the entire system of 500 exercises focuses on the trunk or postural muscles. The postural muscles are the basis for all movement in the Pilates method (Anderson & Spector, 2000). The postural muscles are called the “powerhouse” and consist of the trunk muscles that extend from the lower ribcage to the upper pelvis, anterior, lateral and posterior spine (Siler, 2000). In a study by Bird, Hill and Fell (2012) strengthening postural control muscles by participating in Pilates was an effective strategy to improve static and dynamic balance for older adults.

**Fourth**, Pilates is becoming popular and studios are providing private instruction and group mat classes, making this form of exercise available in many neighborhoods. Lange, Viswanath, Larkam, and Latta (2000) note that there has been a significant increase in the popularity of Pilates-inspired exercises. The increased popularity of Pilates has allowed the industry to be applied in rehabilitation, physical therapy and other medical areas. STOTT Pilates, offers a “Rehab Program Specialty Track” that includes post rehabilitation conditioning in spinal, pelvic, scapular, and peripheral joint stabilization (STOTT Pilates, 2012).

Kaesler et al. (2007) examined the effectiveness of a novel Pilates inspired exercise program specifically designed to improve balance in an upright position, referred to as postural stability, in older adults. Participants for this pilot study were 8 community-dwelling men and women ages 66–71 years. The exercise regimen was undertaken twice a week for 8 weeks. Pre and post subject assessments included postural sway (static and dynamic), the timed get-up and go test (TGUGT), sit-to-stand (timed one repetition and repetitions over 30s) and a four stage balance test. They reported that there was a significant improvement in some components of static and dynamic postural sway, 8-27%, as well as the TGUGT, 7%, following training. They suggested future studies consider the variation of specific balance training techniques, primarily movement re-education as compared to speed and reaction time, to improve postural stability and reduce the risk of falls.

Using Pilates as an exercise method may specifically benefit disease management for people with PD or any other movement disorder by providing a tool for an efficient way to strengthen proximal trunk musculature. Proximal strength, in turn, may facilitate distal control and allow for improved use of arms and hands in manipulative and purposeful activities (Case-Smith, Fisher, & Bauer, 1989). The Pilates method allows

movements to be broken down into components using mat, Theraband, swissball, reformers and changing body orientation to gravity. By successfully evaluating a client's needs and accessing the desired movement outcome, exercises were adapted to the appropriate level. (Anderson, 2000).

Experience-dependent changes in motor control have been documented to occur within the central nervous system at multiple levels, from changes within synaptic connections to rearrangement of cortical maps. [21]

The participants have a stooped posture leading to impairment with the postural muscles and further chances of deformity. The muscles found to be affected are the core muscles. The muscles of the anterior abdominal wall (rectus abdominis, external oblique, internal oblique, and transversus abdominis) play a fundamental role in providing stability to the trunk. The Pilates concentrates on the powerhouse i.e. mainly the transversus abdominis. In clinical settings it has been observed that a normal cognitive contraction of the transversus abdominis is accompanied by a contraction of the lumbar multifidus and, conversely, a normal cognitive contraction of the lumbar multifidus accompanied by a contraction of the transversus abdominis. Along with the transversus abdominis and multifidus, the pelvic floor muscles and the diaphragm also contract, which likely maintains the intra-abdominal pressure at a critical level, allowing the greatest spinal support.

In subjects with IPD, Pilates encourages the slight forward flexion of the cervical vertebra, the stabilization of the scapula, the "connection" of the rib cage to the hips and the posterior pelvic tilt. [22] Shirado et al showed that a similar position provides the most optimal posture for decreasing lumbar lordosis and for activating trunk flexors and extensors most effectively. [23] The best circumstances for trunk muscles to produce maximum EMG activity are when the thoracic cage is fixed

and the cervical spine is maximally flexed and the pelvis is maintained in a neutral, stabilized position. [23] Efficient organization of head, neck, and shoulder girdle as cued with each exercise, allows the Pilates participant to coordinate the placement of the lower body to achieve maximal muscular contraction.

In another recent report, researcher's recruited 34 adults aged 60 and over to participate in a study investigating sagittal spinal posture after Pilates-based exercises. Results of their training indicated that immediately after the Pilates-based exercise program, older adults stood with slightly decreased thoracic flexion and sat with slightly increased lumbar extension. The authors concluded that the individually designed Pilates-based exercise program was feasible for healthy older adults, and the high attendance rate supported the suitability of the exercise program over a long period. [24]

The fundamental principles of Pilates are: Concentration, Control, Centering, Following Movement, Precision and Breathing.

Thus, apart from the centre the other principles we also implemented and further it improved the concentration, precision and control of the participants. This helped them leading to a feeling of well being.

However, Pilates may be better in many ways like: One factor was the pattern of exercise i.e. the exercise system that focuses on stretching & strengthening the whole body to improve balance, muscle-strength, flexibility and posture. The exercises include: Maintaining a stable posture; Concentrating in the rhythm of respiration with increased awareness of kinaesthesia, proprioception and movement co-ordination; Provides a multi task intervention; Heightens concentration, relieves tension and improves mood; Actively engages the body and mind which may have a positive impact in QOL; Attendance and adherence is also an important factor that influences the effectiveness of PI.



In participants with IDP of the body components the main parts to be involved are the neck, trunk (upper and lower abdominal) and the lower limb. Being more specific, there is reduction and slowness of the emotional facial movements giving appearance to mask like face. There can also be a loss of movement and flexion of neck with infrequent blinking. The next component, a mild degree of flexion of the trunk is common. Posture and balance are disturbed. There is impairment of righting reflexes, and difficulty in moving the body. The muscles that control respiration are defective and lead to a reduction in breathing capacity. Stooped, forward- flexed posture. In severe forms, the head and upper shoulders may be bent at right angles relative to the trunk; difficulty in rolling in bed or rising from seated position. Difficulty in turning rather than the usual twisting of the neck and pivoting the toes, PD patients keep their neck and trunk pivoting on the toes, PD patients keeps their neck and trunk rigid, requiring multiple small steps to accomplish a turn. The rigidity and loss of movement in the legs causes difficulty in walking and running especially in first few steps. At first walking is slower, steps become shorter, feet are often dragged developing into a shuffling or complete inability to walk or stand without assistance. Flexion can occur in knee, toes and also ankle which can become inverted. Gait and posture disturbances: Shuffling gait characterized by short steps, with feet barely leaving the ground, producing an audible shuffling noise. Small obstacles tend to trip the patient. Gait freezing is characterized by inability to move the feet, especially in tight, cluttered spaces or when initiating gait. Postural Instability is characterized by failure of postural reflexes which leads to impaired balance and falls.

Of the Pilates intervention the exercises concentrated on the above problems and were carried out in the way the participant had features. The Cat stretch helps mobilizes the spine and help in stabilization benefitting the spine, neck,

shoulders and abdomen. The Swan Dive aims at strengthening and stabilizing the shoulder girdle & spine; work on the spine extensors benefitting the spine, transversusabdominis, hamstring and gluteus maximus. The Spine Twist aims to strengthen the spine benefitting the obliques, transversusabdominis and shoulder girdle. The Forward Leg Series aims to strengthen the lower abdomen; mobilizing the hip and work on buttocks and hamstring and benefits the hip flexors, transversusabdominis. The Hundred aims to flex spine, stabilize the shoulder girdle and pelvis, strengthen the central core and promote breathing which benefits the neck, shoulders, spine, abdominal and also breathing. The Shoulder bridge aims to lengthen the body and articulate through the spine which benefits the transversusabdominis and hamstring. Ball wall squat is used for strengthening of knee musculature. The Theraband seated rowing aims at strengthening the ankle and stabilize the spine benefit the spine, hamstring, ankle, and knee.

When considering the mechanisms resulting in the improvement of body balance after Pilates exercise, strengthening of the trunk and peripelvic muscles in the sense of the “powerhouse” [25] is certainly an important measure to stabilize posture and gait pattern, with the concomitant effect on maintaining equilibrium. [26] Only looking at muscle strengthening, however, appears an oversimplified mechanistic approach, as the functioning of other systems might also be positively influenced by the Pilates exercises. Since the correct execution of the movements requires skills like, e.g., movement fluidity, control, and precision, [26] the proprioceptive analyzers are potential candidates to contribute to the correct execution of the Pilates exercises. The improved integration of their information about joint positions or muscle length and tension should enable an elevated kinaesthetic quality, thereby allowing the subjects to better control posture and movements.

### LIMITATION OF THE STUDY:-

Blinding was not done. No long term follow up was taken. The study consisted of a small quantity of subjects.

### SUGGESTIONS AND

**RECOMMENDATIONS:-** Further study can be carried out with large samples. Duration of study can be increased to obtain long term follow up.

Further study can be carried in some other neurological conditions. Further study can be taken up with some other intervention to improve balance, confidence and ambulatory level in participants with Idiopathic Parkinson's disease.

### CONCLUSION

In conclusion, the treatment program consisting of Pilates Intervention with Conventional Balance Training is more effective than Conventional Balance Training alone to improve functional balance, confidence level and functional activities in participants with Idiopathic Parkinson's Disease.

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