A scoping review of the nature of physiotherapists’ role to avoid fall in people with Parkinsonism

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Received: 21 July 2019 / Accepted: 18 December 2020 / Published online: 14 January 2021
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Abstract
Background Parkinson’s disease (PD) is considered a neurological disease with a high prevalence rate among population. One of its main problems is recurrent fall which has numerous contributing factors such as history of fall, fear of falling, gait deficits, impaired balance, poor functional mobility, and muscle weakness.
Objective To review and explore the focus/nature of interventions which target the role of physiotherapy preventing fall in patients with PD.
Method A scoping review was led dependent on Arksey and O’Malley as discussed by Wood et al. (2002). This paper based on this structure to perceive intervention studies have been embraced in physiotherapy to prevent fall after Parkinson’s disease. The search included various databases. The referencing arrangements of every pertinent paper were additionally filtered for more studies.
Findings A total of 173 articles were included, 39 of which met the eligibility criteria. Fifteen studies reported on the direct impact of physiotherapy on fall, while the rest examined the impacts of physiotherapy on factors that are associated with fall. Different outcomes, interventions types, and duration were used in these studies. Findings showed a favorable result of physiotherapy on fall and near fall incidence, balance, gait, functional mobility, muscle strength, and fear of falling.
Conclusion Physiotherapy has the possibility to decrease fall incidence and fall risk in people with PD. However, the heterogeneity in the patients’ selection, intervention studies, outcome measures chosen, time since the onset of disease, variation in intensity, and duration of treatment between included studies make the comparisons difficult. Consequently, more studies are needed on best intervention.

Keywords Parkinson’s disease · Physiotherapy · Rehabilitation · Exercise · Falls · Risk factors

Background
Parkinson’s disease (PD) is a common, exhausting, and progressive neurodegenerative disease. The elderly suffers from falls as part of the aging process, and PD patients have this as one of its complications [1].
Studies regarding the issue of falling found that those who are suffering from PD are more prone to falls compared either with healthy people of the same age or with the elderly who have other neurological conditions [2, 3]. A study by Bloem et al. [2] conducted on fall prospectively in people with PD and in elderly people with good health found that PD results in a 9-fold increase in the likelihood of experiencing recurrent falls compared with healthy people of the same age. In Stolze et al.’s study (2004) [3], in comparison to patients with neurological disease “like stroke,” the Parkinson’s patients have two times risk of fall.
The incidence rate of falls through the Parkinson’s patients ranged between 38 and 87% [4, 5]. In a study done by Hely et al. [6], measuring the risk of fall during 20 years of the Parkinson disease, 87% of them will experience falling at least one time. It was additionally discovered that falls in PD are intermittent. Pickering et al. [7] found that roughly 15% of individuals with this disease involvement have at least one fall each week, while different investigations announced that half of those with PD fell twice or more throughout 1 year. In this manner, a high number will experience the complications of falling.
Recognizing the fall risk factors is of vital importance in fall prevention. As of late, a lot of research has been directed into the reasons for falls, and a substantial number of variables have been found.

A systematic review and meta-analysis tried to summarize the evidence regarding fall risk factors in people with PD [7]. However, the authors of this meta-analysis reviewed only six fall studies and found that the most solid factor which could anticipate future falls is a history of fall. However, in spite of the fact that this factor supports the belief that fall in PD is intermittent and individuals with a previous history of fall are at extraordinary hazard and should be dealt with, this factor is not treatable in that knowing the history of fall leads to more falling can help people with PD to take preventative measures and does not show the reason for the first event of fall. Therefore, concentrating on other treatable elements related with fall is of incredible significance in the avoidance of the main fall, and should in this way be viewed as while assessing the impacts of any intervention or when designing an intervention to prevent fall. Studies exploring the reasons for fall have found different factors strongly related with falls and have recommended rehabilitation programs to focus on these components to prevent fall in individuals with PD. The most important factors include reduced balance, impaired gait, muscle weakness, poor functional mobility, or performance on functional tasks, and, in addition to these physical limitations, psychological factors are also found to be risk factors [4].

Physiotherapy is one of the most important approaches of treatment for people with PD. It has continually been observed to be a viable method to alter factors, for example, balance and gait, as to diminish the quantity of falls among the elderly [5].

Various reviews [5, 8–10] have been done to condense the proof and to decide if physiotherapy interventions are useful for individuals with PD. However, most of these reviews did not concentrate on falls, but instead, they researched the general potential advantages of physiotherapy intervention on individuals with PD to the extent that only one systematic review focused on fall. In this specific review, Allen et al. [10] searched the literature up to 2009 and directed a meta-analysis to decide the impacts of physiotherapy on balance and fall rates. The pooled estimate of the impact of physiotherapy in this review demonstrated a significant enhancement in balance. However, the authors did not discover adequate proof to help or discredit the impacts of physiotherapy intervention on diminishing fall rate. In another review, Shen et al. [11] examined the effects of exercise training on balance, gait ability, and falls against no intervention and placebo intervention. The authors concluded that there was no evidence that training decreased the number of fallers over the short or long term (p > 0.05).

Regardless of the deficient proof given by aforementioned research, proof has risen out of a different review that has concentrated on the potential advantages of physiotherapy for individuals with PD, and a few advantages regarding balance and other fall-related variables have been accounted for. For instance, Kwakkel et al. and Goodwin et al. [12, 13] found that the utilization of physiotherapy gave promising outcomes, being valuable regarding balance, gait velocity, and muscle strength. In any case, the poor methodological nature of the studies incorporated into these reviews demonstrations to restrain both these reviews and the developed proof. In this manner, leading a review that centers around fall and incorporates just randomized controlled studies to decide if physiotherapy is gainful for fall chance decrease in individuals with PD is considered poor.

A systematic review is increasingly confined in center and tries to answer specific research inquiries from the available literature. However, the scoping review is a procedure intended to deliberately recognize the expansiveness of writing in a region being researched [1]. The intention of this paper was to scope the physiotherapy practice/role to prevent fall in patients with PD.

Methods

A scoping review was conducted including determining the research question; determining relevant studies and study selection; charting the data; and finally collating, summarizing, and reporting the findings. The main phase of searching included choosing papers based on the title and abstract. When every one of the titles was chosen, duplicates were removed. Irrelevant studies were disregarded. If there was any vulnerability about the significance of a study, the entire paper was read. The search strategy was modified to suit different databases. The following electronic databases were searched in May 2019: Medline, Amed, Cinahl, PubMed, PsychInfo, Cochrane Library, and Physiotherapy Evidence database (PEDro), and the search was expanded with the following references lists from selected articles.

The design of the study (controlled randomized trial), participants (people with PD), type of the treatment (compare the effect of a physiotherapy intervention to any comparable including other physiotherapy intervention), type of outcomes (report the effect of physiotherapy on fall and/or at least one fall risk factor), language (written in English), and availability of the full text were important and needed to be considered to find the most relevant studies.

The researcher independently extracted data from the studies by using a standard data extraction form. An outline of all the included material was condensed in a table that maps the literature. The literature was organized and presented in relation to the author, location, and year of publication; aim; method; outcome measures; and results.
Findings

A total of 173 papers were identified before 25 duplicates were discarded. Following the screening of the titles and abstracts, 66 studies remained. In total, a further 29 papers were excluded after screening of full text and inclusion criteria, leaving 37 papers eligible for inclusion. Two further papers were identified by hand searching; therefore, in total, 39 papers were included in this scoping review (Fig. 1). Fifteen of the included papers reported the direct effects of physiotherapy interventions on fall and furthermore inspected the effects on other risk factors, whereas the rest of the studies did not examine the benefits of physiotherapy interventions on fall directly. Rather, they announced different variables related with fall, for example, balance, functional mobility, and gait as end points.

Studies reporting both fall incidence and fall risk factors

The scoping search yielded 15 considered studies containing data important to the direct effect of physiotherapy intervention on fall rate and near fall incidence (Table 1). Different physiotherapy interventions, duration and outcomes were used in these studies.

The sample sizes reported, with included studies, ranged from 18 [14] to 474 [4]. Eight studies [14–18] included 100 participants or less, and only 4 studies [19–22] had an initial sample size of between 130 and 195 participants. Therefore, the rest 3 studies [4, 23, 24] had an initial sample size of between 210 and 474 participants. Every included study in this part recorded the quantity of falls/near fall incidence or fear of falling. These studies recorded falls utilizing falls diary sheet, which is the best gold standard in view of participants/family [4, 15–17, 20–22, 25, 26], telephone interviews [14, 19, 24–26], or medical record observation [23].

Falls were reported at set of intervals, ranging 1-month [26], 8-week [14], 10-week [19]; 3-month [22], 6-month [15, 17, 20, 21, 23, 25], or over 12-month period intervals [4, 6, 24].

These papers also include a variety of interventions related to the field of physiotherapy including traditional physiotherapy exercises, movement, and strategy training. In this way, this paper may give a far-reaching outline about the advantages of physiotherapy as far as fall risk decreases in individuals with PD. For example, the effect of exercise training [4, 14, 19, 21, 24] and balance training exercise [16, 23, 24] for fall prevention in PD has been tested in some studies.

The results of included studies reported that there are no benefits of exercise training for fall preventions [4, 14, 19, 21, 24].
Table 1: Studies of direct impact of physiotherapy intervention on fall

| Author/Year/Location | Aim | Method | Outcome measures | Result/conclusion |
|----------------------|-----|--------|------------------|------------------|
| Seymour et al (2019) The UK | To investigate the general potential benefits of fall prevention physiotherapy programme on people with PD | RCT 474 PD patients randomly allocated into: Experimental group (n=238): People in this group were taught different home exercises aiming at fall avoidance and improving balance and strengthening exercise. Control group (n=236): Participants in this group received DVD that might have involved instructions on falls rehabilitation therapy 12 supervised sessions of 1-1.5 hours for a duration of Six months. | Primary outcome: • Risk of repeat falling: (self-report diaries). Secondary outcomes: • Mini-BESTest: (balance). • Chair stand test. • FES1 • FOG. Different outcomes related to fall were assessed at three different points, i.e., before randomization, at the end of the study (6 months) and at 12 months after the study to follow up | 1. The results of this study showed that there were significant improvements in terms of repeat falling (p=0.447) and near falling in favour of the intervention group. 2. The exercise group had better balance (p=0.009), better fall confidence (p=0.026) and functional strength (p=0.041). Conclusion: Individual home exercise programme that was tailored to avoid fall with balance and strengthening exercise did not have the potential to reduce falling among people with PD. |
| Thau et al., (2018) Canada | To determine whether or not rhythmic auditory stimulation (RAS) training is beneficial for falls reductions in people with PD | RCT 60 PD patients randomised into: Experimental group (n=30): The subjects were asked to complete the RAS training exercises on a daily basis for 24 weeks. Control group (n=30): Usual care | Main outcome measures: • BBS • TUG • Falls efficacy scale • The fall index. Outcome measures were collected at baseline, 8th, 16th and 24th weeks. | 1. At week 8: No significant improvement was noticed between groups. 2. After 16 weeks: The RAS group gained significant improvements in terms of fall index and FOF. 3. At week 24: There was a significant improvement in RAS training group in term of FOF and number of falls. Conclusion: RAS training program was beneficial to reduce the number of falls in PD. |
| Sparrow et al (2016) | To investigate the benefits of physiotherapy exercise program intervention on fall rate, balance, and fear of falling in patient with PD. | RCT 23 subjects with PD were consequently placed into 3 months of active balance exercise or 3 months of inactivity (usual care) followed by the reserve. The program was held twice weekly 90 minutes/3 months. | Main outcome measures: • Falls • Balance: (Mini-BESTest). • Fear of falling: (FES-I). Assessment: baseline, 3 months, and at 6 months. | 1. There was an evidence to support the effects of physiotherapy interventions on decreasing fall rate (37%) per month. 2. Significant improvements were noted in terms of Mini-BESTest (p=0.037) and FES-I (p=0.059). Conclusion: Progressive exercise programs could demonstrate significant improvement in reducing the number of falls, improving balance and FOF with mild to moderate PD. |
| Wong-Yu and Mak (2015) China | To examine the short/long term effects of balance training on | RCT 70 PD randomly allocated into: Experimental group | Primary outcome measures: • Balance (Mini- | Fall at follow up; 1. No significant improvement between groups was noticed in |
functional performance and number of falls in PD nonfallers. (n=32); received indoor and outdoor balance training over a period of Eight weeks, Four weeks for each. Control group (n=38): Two hours upper limb training sessions/week for a period of eight weeks.

**BESTest**.

**Secondary outcome measures:**
- Functional research (FR) distance.
- 5 times sit-to-stand (FTSTS) time.
- TUG time evaluation: baseline line, 8 weeks, and 6 months.

**Terms of total fall rates or numbers of fallers.**
- A significant improvement in the number of injurious fallers was noticed (p<0.05).

**Short and long term effects:**
1. The balance group demonstrated significant improvement in Mini-BESTest (p<0.001), FR distance (p<0.05), FTSTS times (p=0.01) and TUG time (p<0.05) as compared to the baseline assessments.

**Conclusion:** It seems that balance training program to be effective in terms of dynamic balance and functional activities in people with PD nonfallers for up to 6 months after training.

PD: Parkinson's disease; RCT: Randomized controlled trial; BESTest: Balance evaluation system test; FES-I: Falls efficacy scale—international score; FOG: Freezing of gait; BBS: Berg balance scale; TUG: Timed up and go; TUG: Timed-up- and go; FOF: fear of falling

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**Table 1: Studies of direct impact of physiotherapy intervention on fall (Con).**

| Author/Year/Location | Aim | Method | Outcome measures | Result/conclusion |
|----------------------|-----|--------|------------------|------------------|
| Shen and Mak (2015) China | To investigate the effects of technology-assisted balance and gait training on fall reduction in people with PD. | RCT 51 subjects were randomly assigned to either: Experimental (BAL) group (n=26): technology-assisted balance and gait training. Control group (n=25): strengthening exercise. Both groups receiving training for 12 weeks. | The primary outcomes:
- The number of falls.
- The fall rate.
- The time to first fall.
The secondary outcomes:
SLS: Postural response latency with Motor control test (MCT).
Assessment were performed at baseline, 3-month intervention (Post3m), at the 3-month follow-up month (Post3mf), and 12 month follow up (Post12m).
The number of fall was recorded by subjects. | Primary outcome measurements:
1- There was a significant improvement in the number of falls in the intervention group at Post3m, Post6m, and at Post12m (P<0.05).
2- The intervention group had a significantly lower fall rates than the control group at Post3m and Post12m (P<0.05).
Secondary outcome measurements:
1. The BAL group resulted in a significant reduction in the MCT and increase in the stride length when compared to the stretch group (P<0.05).
2. SLS time was increased in the BAL group throughout the follow-up period: Post3m (P=0.064), Post6m (P=0.041) and at Post12m (P=0.087).
Conclusion: Combining balance and gait training programs with technological devices is more beneficial than the strengthening.
| Morris et al. (2015) | To examine the benefits of progressive resistance strength training (PRST) or movement strategy training (MST) on fall rate in people with PD over 12 months. | RCT | 210 people with PD were allocated randomly into: Group 1 (PRST, n=70): Received progressive resistance strength training with education classes about falls prevention. Group 2 (MST, n=69): Received movement strategy training combined with fall prevention programmes. Group 3 (Control group, n=71): Life skill information. 2 hour therapy per week for 8 weeks | **Primary outcome:**  
- Falls rate.  
**Secondary outcome measures:**  
- UPDRS  
- TUG test  
- VAS  

Outcome measures were collected at baseline, 8th week, 3 months and 12 months after treatment. Falls were taken using interviews with participants. | 1. The results showed that 193 falls were recorded for PRST group, 441 falls for MST group and 913 falls for the control group over the period of 12 months.  
2. The results showed that, compared to the control group, both PRST and MST groups had led to a significant improvements in terms of falls (P<0.001, P=0.012 respectively)  
For the 12-month follow-up test:  
1. Both PRST and MST interventions resulted in significant positive impacts on UPDRS activities compared with control group (P<0.01 and P<0.01 respectively). Also, The MST group led to significant improvement in the UPDRS motor score compared with control group (P=0.017).  
2. No difference between group for TUG from baseline to 12 month.  
**Conclusion:** Fall prevention programmes with strength training or movement strategy training has the potential to significantly reduce the rate of falls among people with mild to moderately PD |
| Martin et al., (2015) | To examine the effects of cueing training program on falls in PD with FOG. | RCT | 29 participants with PD were randomised into: The first group (n=12): received cueing training sessions for six home visits within the first 4 weeks over a period of 6 months, followed by weekly phone calls for the remaining 5 months. The second group (n=9): People in this group of the study were asked to wait 6 months and after the 6 months they immediately started their cueing training. | **Main outcomes:**  
- NFOGQ.  
- Number of fall: daily diary.  
The assessments were taken at 2 weeks after the end of study. | 1. The results showed that the intervention had not led to significant differences in NFOGQ total scores (P=0.70), fall rate (P=0.008) and FOG (P=0.63) between groups after intervention  
**Conclusion:** Cued up intervention is acceptable and may improve falls and FOG in people with PD, however, further investigate is needed with large sample size. |

PD: Parkinson’s disease; RCT: Randomized controlled trial; SLS: Single-leg-stance; NFOGQ: New freezing of gait questionnaire; UPDRS: Unified Parkinson’s disease rating scale; TUG: Timed up and go; VAS: Visual analogue scale.
However, some studies reported significant reduction in falls when exercise containing strength and/or balance exercises [16, 18, 24, 26]. Additionally, two randomized trials [20, 27] analyzed the impacts of tai chi exercise on fall decrease in individuals with PD. The discoveries demonstrated that tai chi exercise had positive effects on reducing future falls.

The effectiveness of rhythmic auditory stimulation (RAS) has been resulted in decreasing the number of falls in PD disease [15, 22, 25]. Two RCTs reported that RAS concluded that RAS training significantly reduced the number of falls in PD [15, 22], whereas one RCT study [25] reported that RAS did not have important changes in falls in people with PD.

Furthermore, the interventions of the above studies led to significant improvement in terms of balance [4, 15–17, 19–22, 27] functional mobility [4, 15, 17–20, 23], Fear of falling (FOF) [16, 19, 23, 26], fall rates [14, 17, 18, 21, 24, 25], serious injuries associated with falls [17, 21], freezing of gait (FOG) [4, 22, 25], and gait parameters [14, 15, 17, 18, 20, 22]. Nonetheless, the resulting measures in most of these studies were assessed following the treatment.

Just a couple of studies had follow-up evaluations. However, these studies had short follow-up periods. In this way, it is difficult to give an end with respect to the long-haul impacts of physiotherapy on fall risk reduction. Only three studies had a 1-year follow-up period, and the results showed that strength movement strategy training and multi-dimensional balance training could reduce the rate of falls in people with mild to moderate PD [4, 18, 24].

### Interventions that reported fall risk factors only

Rather than the studies evaluated in the segment above, there are various studies that neither target fallers nor report fall number or close fall rate as results (Table 2). However, these studies examined the impacts of physiotherapy interventions on several factors that are closely associated with fall in people with PD, such as balance, functional task, gait, and muscle strength.

### Effect of balance

The significance of balance in fall avoidance is featured. In this scoping review, a few studies detailed the impact of physiotherapy intervention on balance [28–44].

Fourteen studies out of the 17 papers that reported on balance showed physiotherapy intervention had led to a statistically significant improvement in at least one of the balance measures as compared to either control or active interventions [28–34, 36, 37, 39, 40, 42–44]. However, only three

### Table: Summary of Studies on Fall Prevention in PD

| Author/Year | Location | Aim |
|-------------|----------|-----|
| Cuming et al. (2015) | Australia | To examine the effect of supervised exercise on fall and a number of fall risk factors, namely balance, muscle strength, and FOG in people with PD. |
| Guo et al. (2014) | China | To compare the effects of group-based tai chi exercise, and a control condition group on fall prevention in PD |
| Li et al. (2012) | US | To compare the effects of Tai Chi exercise with the effect of resistance training or stretching exercise to improve postural control in Parkinson’s disease |
| Goodwin et al. (2011) | UK | To examine the effects of ten sessions of group-based intervention, including strength and balance exercise with regular care, on fall rates and fall risk in people with PD |

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**PD:** Parkinson’s disease, **RCT:** Randomized controlled trial, **FES:** Falls efficacy scale-international, **QoL-SD:** Quality of life, **FOF:** Fear of falling.
Table 2  Studies of indirect effects of physiotherapy on fall

| Author/Year/location | Aim | Method | Outcome measures | Result |
|----------------------|-----|--------|------------------|--------|
| Silva-Costa et al. (2018) Brazil | To examine the effects of resistance training with instability (RTI) and resistance training (RT) on balance and FOG in patients with PD. | RCT 39 subjects with PD randomly allocated into Experimental group (n=26); Control group (n=13); RTI n=13. | Main outcome measures: • Balance: BISTT test. • Gait velocity: during normal- and dual-task (FTT) gait. • Falling: FT-1. Conclusion: Resistance training was more effective than RTI. | 1. A significant improvement in balance and FOG was noticed in experimental group. However, this improvement was more significant in RTI than RTI. 2. Conclusion: Authors concluded that RTI has the potential to significantly improve balance and FOG among people with PD. |
| Condonato et al. (2015) Sweden | To examine the effects of a ten-week balance program in people with PD. | RCT. Participants of PD (n=106) were randomly allocated into Experimental group (n=41); Balance program. Control group (n=40); Usual care. The balance group training was performed 3times/week/60min/session/10 weeks. | The main outcomes: • Balance: BISTT test. • Gait velocity: during normal and dual-task (FTT) gait. • Falling: FT-1. Conclusion: Different outcomes related to fall and fall risk factors were assessed at two different points, i.e., before randomisation and at the end of the study. | 1. The results showed that there was a significant improvement in terms of balance (p<0.01) in favour of the experimental group. 2. As compared to the control group, the experimental group gained significant improvements in terms of FT-1 gait. However, no significant effect of training for concerns about falling. Conclusion: The balance program has the potential to significantly improve balance and gait stability in patients with PD. However, no benefit was found for concerns about falling. |
| Wong-Yi and Mak (2015) China | To investigate the direct effect of multidimensional balance indoor and outdoor (SHO) balance training intervention in balance in people with PD. | RCT. 84 PD patients were allocated to: Experimental group (n=41); Completed 4-week indoor and 4-week outdoor balance training. Control group (n=39); completed 8 weeks upper limb training. | The primary outcomes: • Balance: BISTT. • The secondary outcome measures: • Gait speed. • TUG. Conclusion: Assessments were occurred at baseline, post training assessment, 6 month follow-up assessment and 12 month follow-up assessment. | 1. Short-term effect: There were significant improvements in terms of BISTT total score (p=0.01), gait speed (p=0.05), and TUG (p=0.01) from baseline to improved by the experimental group. 2. Long-term effect: the experimental group had significantly increased in the BISTT total score (p=0.01), gait speed (p=0.05) and TUG (p=0.01) than control group. Conclusion: Multidimensional balance training program has the potential to significantly improve balance and dual-task gait performance up to 12 months among people with PD. |
| Voigt et al. (2014) Italy | To compare the effects of hydrotherapy on balance with regular care in people with PD. | RCT. Experimental group (n=17): Hydrotherapy. Control group (n=17): land-based standard rehabilitation. | The primary outcomes were: • UPDRS. • Falls efficacy scale. • Falls diary. Conclusion: Assessment was occurred at baseline, and one week after rehabilitation. | 1. At the end of rehabilitation, the hydrotherapy group showed a significant improvement in terms of UPDRS (p=0.005), falls efficacy scale (p=0.003), falls diary (p=0.001). Conclusion: Hydrotherapy treatment was beneficial to address balance, postural stability and reducing falls rate in people with moderate-stage of PD. |
| Duncan and Baillie (2012) USA | To explore the effects of a twice-weekly tango programme conducted over a period of one year for individuals with PD. | Subjects with PD divided Intervention group (n=28); Community based Argentine Tango program (2 sessions/week/60 minutes/session for 12 months). | Primary outcomes: • MDSS/UPDRS. • Secondary outcomes: • MDSS-POERSL. • MDSS-UPDRS. Conclusion: After one year, the results revealed that the intervention group gained significant improvements in all outcome measures, as compared to baseline and to the control group (p<0.001). Conclusion: These positive results provide strong evidence for the efficacy of long-term participation in tango in patients with PD. | 1. After one year, the results revealed that the intervention group gained significant improvements in all outcome measures, as compared to baseline and to the control group (p<0.001). Conclusion: These positive results provide strong evidence for the efficacy of long-term participation in tango in patients with PD. |

PD: Parkinson’s disease; RCT: Randomized controlled trial; IRS: Berg balance scale; UPDRS: Unified Parkinson’s disease rating scale; TUG: Timed-up and go; BISTT: Balance evaluation systems test; FT-1: Falls efficacy scale; IQ: Fear of falling; Gait MT: Six minute walk; RHTP: Nine Hole Peg Test; MD6-UPDRS3: Movement disorders society-unified Parkinson’s disease rating scale 3; MD5-UPDRS2: Movement disorders society-unified Parkinson’s disease rating scale 2; MD4-UPDRS1: Movement disorders society-unified Parkinson’s disease rating scale 1

Table 2: Studies reported indirect effects of physiotherapy on fall (cont.)
To evaluate the effectiveness of music cue on treadmill training with idiopathic Parkinson’s disease.

**RCT**
- Group 1 (n=14): The conventional balance group (CB) received a thirty-minute session twice a week for six weeks of balance exercise. Control group (n=14) did not have any type of exercise.
- Main outcome measures:
  - Falls within the past six months.
  - Gait and balance performance (TUG, ETUG, SLST, 6-MWT).
  - Step length and stride length.
  - Walking speed
  - Cadence.
- Results:
  - All outcome measures were assessed three times at the beginning of study, after four weeks of study program and at the end of eight weeks.
  - The results showed that stride length (P=0.031), step length (P=0.079) and the six-minute walking time (P=0.01) improved more in the treadmill with cue group, than in any other group.
  - TUG test improved in group A and B more than C at 4th week (P=0.059).
- Conclusion:
  - Application of music cue may increase the benefit of the treadmill training in PD patients.

**Table 2: Studies reported indirect effects of physiotherapy on fall (cont.)**

| Author / Year/Location | Aim | Method | Outcome measures | Result |
|------------------------|-----|--------|------------------|--------|
| Becker, J. et al. (2011) Germany | To examine the effects of two different over-ground walking programmes and traditional physiotherapy exercises. | RCT | 90 PD patients were allocated into three groups and each group practised different interventions:
- Group 1: Nordic walking (NW) training. (sessions: 40 training sessions with week of NW training for six months)
- Group 2: walking training (30 minutes/6 months).
- Group 3: flexibility exercises and a relaxation training. | Primary outcome:
- Gas speed and gait parameters as assessed using a treadmill.
- Secondary outcome:
- Gait and balance test and the balance maintain task respectively. | The results of the study showed that, compared to the baseline assessment, all groups gained significant improvements in terms of balance. However, only the walking and Nordic walking groups gained significant improvements in terms of gait velocity, stride length and double stance time compared to the baseline. These improvements were also significant when compared to the traditional physiotherapy group. 2. The results revealed that the Nordic walking group improved more than the walking group in all outcomes. Conclusion: The authors concluded that all programmes are beneficial to improve balance. However, only the walking programmes are beneficial to improve gait velocity and gait patterns. |
| Eibensohl, B. et al. (2016) Germany | To compare the effects of four weeks of a once-onto high-allowance movement programme (LSVT: BBG), | RCT | Sixty patients with PD were randomly divided across three groups:
- Group 1: Once onto training (LSVT BBG).
- Group 2: Training of Nordic Walking (NW).
- Group 3: Session of short-allowance exercises (HSW) (1 session/60 minutes). | Primary outcome:
- UPDRS.
- Secondary outcome:
- PDQ-39.
- TUG: Time to walk 10 m. | The results indicated that all groups showed statistically significant improvements in all outcome measures as compared to the baseline. However, people in the LSVT BBG improved better than those in the Nordic walking group in terms of UPDRS and TUG (P=0.003) and 10 m walking. 2. There were no significant group differences for PDQ-39 Conclusion: The study showed that LSVT BBG is an effective technique to improve motor performance in patients with PD. |
| Allen et al. (2010) Australia | To examine the effects on fall incidence and fall risk factors of a semi-supervised exercise programme containing a cueing component in people with PD. | RCT | 48 participants with Parkinson’s disease (PD) were randomized into:
- Intervention group (n=24): progressive balance and strengthening exercise Control group (n=24): usual care. (3 times/week/5 months). | Primary outcome measure:
- PD falls risk score.
- Secondary outcome measures:
- FOG questionnaire.
- Physical ability: the short physical performance battery (SPPB) (balance standing: sit to stand test, walking velocity).
- FES-I questionnaire PDQ-39. | The results showed that the intervention group demonstrated a better improvement in all outcomes. 2. The only significant between-group differences were noted in terms of fall incidence, FOGQ (P=0.03) and the sit-to-stand task (P=0.03). Conclusion: Exercise program for PD who have a history of recurrent falls or who had been classified as being at high risk of falls may reduce overall risk of falling and can improve FOG, sit-to-stand, and endurance. |
| Saga and Almeida (2009) Canada | To compare the effects of movement strategy training (PD SAFEX), aerobic programmes and a control group. | RCT | 55 participants with PD were randomly allocated into:
- Intervention group (n=18): PD SAFEX training programme. This programme was delivered via a group-setting approach, three times a week, over a ten to twelve week period.
- Aerobic group (n=15): lower limb aerobic programme. Thirty-six classes over a period of twelve weeks.
- Control group (n=12): no-exercising. | Primary outcome measures:
- UPDRS.
- TUG.
- 6MWT.
- Secondary outcome measures:
- FOG questionnaire.
- All outcome measures were evaluated before and after the end of the study(16 weeks).
- Motor function: there was a significant improvement in PD SAFEX group (P<0.006) and aerobic (P<0.006). groups had improved in their performance on TUG, step length, double support time, UPDRS score and gait velocity. However, none of these improvements were significant when compared to the control group.
- Conclusion: Authors concluded that functional movement control could be altered by SAFEX training programme in people with mild to moderate PD. |

**Table 2: Studies reported indirect effects of physiotherapy on fall (cont.)**

| Author / Year/Location | Aim | Method | Outcome measures | Result |
|------------------------|-----|--------|------------------|--------|
| Hackney and Farhat (2009) USA | To compare the benefits of thirteen weeks of tango and waltz/foxtrot interventions and no physiotherapy treatment on functional motor control in people with PD. | RCT | 30 people with PD were subsequently randomly allocated into the three groups:
- Group 1 (n=17) tango or waltz/foxtrot (tango)
- Group 2 (n=17) tango/foxtrot (tango/foxtrot)
- Group 3 (n=17) no intervention (control group). People in the tango and waltz/foxtrot groups attended twenty classes over the 13-week period. | Primary outcome measures:
- UPDRS.
- TUG.
- 6MWT.
- FOG questionnaire. | After completion of 20 training sessions:
- The results revealed that although all groups had been comparable at the pre-trial tests, both tango and waltz/foxtrot groups had improved more than the control group in all outcomes. 2. Compared to the control group, both tango and waltz/foxtrot groups had significant improvements in balance, gait endurance and backward stride length. 3. All groups had increased with regard to FOG and the TUG tests, only the tango group had... |
Brown et al. (2009) UK

To compare the effects of treadmill training in association with visual and auditory cues and traditional over-ground gait training programmes.

RCT

- 40 Parkinson’s patients were randomly and equally divided into two groups:
  - Group 1 (n=20): Twenty minutes of treadmill training associated with auditory and visual cues over four weeks on a daily basis
  - Group 2 (n=20): Over-ground gait training for the same duration using only auditory and visual cues.

**Main outcome measures:**
- UDPS
- TUG
- 6MWT
- Gait speed
- Gait stride

**Conclusion:**
- Both groups had gained significant improvements in all areas.
- The gait achieved after the treadmill training appeared to be superior to those achieved after the over-ground training (P<0.001).
- Treadmill training associated with visual and auditory cues could be more effective than traditional rehabilitation with auditory and visual cues alone.

Fish et al. (2008) USA

To assess the effects of gait training on a partial weight support treadmill system and a conventional physiotherapy programme consisting of a wide range of exercises for people with PD.

RCT

- 18 PD patients were recruited and randomly assigned to one of three groups:
  - Group 1 (n=6): Treadmill training over a period of two months
  - Group 2 (n=6): Conventional group: Low intensity exercise (twice a day for six weeks)
  - Group 3 (n=6): No intervention

**Main outcome measures:**
- Gait speed
- Balance
- UPDRS
- Walking test: 10m
- STIR test
- CSF

**Conclusion:**
- The results showed that all groups gained slight improvements.
- However, there were no significant pre-post programme changes in all outcome measures across any of the groups.
- Some improvements have been recorded in the high intensity exercise regarding self-selected gait speed (4 4%), stride length (4.7%), step length (5.8%), hip and ankle and lengthening in CSF.

Morita et al. (2008) Australia

To compare movement training and conventional physiotherapy programme in hospitalized patients with PD.

RCT

- 28 PD patients were equally assigned to either:
  - Group 1 (n=14): Movement training programme
  - Group 2 (n=14): Musculoskeletal exercises

**Main outcome measures:**
- Disability (UPDRS)

**Secondary outcomes:**
- Balance
- Walking speed
- Endurance
- Quality of life

**Conclusion:**
- The movements groups gained significant improvements in all outcome measures including UPDRS score (P<0.0001), balance (n<0.042), 16 metr walk (P<0.003) and PDQ9. However, these improvements had declined by the third month follow-up.
- The conventional exercise group, did not show any significant improvement.
- The results showed that two weeks of cognitive motor training led to short-term benefits in terms of static balance, walking velocity, walking endurance and disability level.
- Conclusion: Movement training programme led to short-term benefits in terms of static balance, walking velocity, waking endurance and disability level.

Table 2: Studies reported indirect effects of physiotherapy on fall (cont.)

| Author /Year/location | Aim | Method | Outcome measures | Result |
|-----------------------|-----|--------|------------------|--------|
| Kattan et al. (2008) Turkey | To investigate the effects of gait training on the treadmill on different functional tasks, gait velocity and static balance in patients PD. | RCT
- 30 patients with PD were consecutively divided into two groups: Interventions group (n=13): Treadmill walking (3 times/week for 4 weeks).
- Control group (n=17): No intervention. | **Main outcome measures:**
- Functional tasks
- Balance
- Assessments of patients were carried out at baseline and at the end of the treatment. | Results showed that people in the treadmill group gained significant improvement in functional lower extremity tasks as compared to the control group.
- Conclusion: Treadmill training in PD patients may improve functional ability and static balance. |

| Mak and Tsai-Chan (2008) China | To examine the effects of a movement training programme and conventional physiotherapy intervention on an important functional task, sit-to-stand. | RCT
- 51 PD patients were randomly allocated into:
  - Group 1 (n=21): receive AV (2 times/week for 4 weeks)
  - Group 2 (n=21): conventional exercise (2 times/week for 4 weeks).
- Control group (n=18): did not receive any treatment | **Main outcome measures:**
- Three dimensional kinematics data of STS was recorded using a VICON motion analysis system with 6 cameras.
- Measurements were carried out twice before the study, at the end of the study and during the weeks. | 1- The AV group significantly increased with the Ts. Group.
2- Only the exercise group showed significant improvements in terms of sit-to-stand time compared to the baseline (P<0.01). These improvements were also statistically significant when compared with the control group. The improvements were also maintained at two weeks after the end of the study.
- Conclusion: AV could task-specific training may play an important role in improving performance in patients with PD. |

| Hackett et al. (2007) USA | To compare the effects of thirteen weeks of two movement programmes: Argentine tango dance lessons (tango) or a strength-flexibility exercise (classic exercise) on gait, functional mobility and balance. | RCT
- 19 PD patients were allocated randomly to either:
  - Group 1 (n=6): Tango
  - Group 2 (n=6): Exercise
- Control group (n=7): No exercise.
- 1 hour/week/20 sessions for 13 weeks | **Main outcome measures:**
- Functional status: UPDRS
- Balance: BBS
- Gait velocity: 5m walking
- FOG questionnaire: The performance on these scales was recorded on a videocassette both before and after the intervention. | **Main outcome measures:**
- UPDRS
- BBS
- Gait velocity
- FOG questionnaire: The performance on these scales was recorded on a videocassette both before and after the intervention. | 1- The results showed that the people in the tango group improved better than the control group in the UPDRS (P<0.001), BBS (P<0.001), low back and walking velocity, gait stride and also in terms of gait endurance. |
2- Tandem gait improves. |
| Mak and Tsai-Chan (2008) China | To examine the effects of eight weeks of gait training on the treadmill on postural instability, balance and FOG with PD patient. | RCT
- 54 with PD were equally separated into:
  - Experimental (treadmill training) group (n=27): received speed dependent treadmill training, combined with range of motion and stretching exercises.
  - Control group (n=27): did not receive any training. | **Main outcome measures:**
- Functional status: UPDRS
- Balance: BBS
- Gait velocity: 5m walking
- FOG questionnaire: The performance on these scales was recorded on a videocassette both before and after the intervention. | The result showed statistical significance for the outcomes between the groups at baseline and eight weeks. The intervention group had significant changes in walking distance (2.66-4km to 278.3km) and reduced maximum speed on treadmill (3.9km/h to 2.6km/h), BBS balance test, Dynamic Gait Index (P=0.001) and Falls Efficacy Scale. |

| Cabi et al. (2007) Turkey | To evaluate the immediate and sustained effects of Qigong on motor and non-motor symptoms of PD. | RCT
- 56 patients with PD were distributed randomly into:
  - Intervention group (n=26): Two courses of Qigong exercise (50min sessions with 4 weeks pause in between). | **Main outcome measures:**
- Quality of life
- MADRS
- Measurements were repeated at four months. | The result showed that the improvement in balance (UPDRS-III) was only significant at six months (P<0.05) in favor of the Qigong group (P<0.064). |
- No significant differences were noted between the groups. |
studies did not report significant effects [35, 38, 41]. One of the three studies that did not report a remarkable difference between-group used exercise in the comparison intervention [38]. However, this study reported a significant difference compared to the baseline data within the same group. The second study [41] compared the effects of physiotherapy intervention to a control and found a trend towards improvement in the intervention group, while the control group showed a tendency for deterioration. The third study, by Hackney et al. [35], compared the effects of tango dance or strength/flexibility exercise. The study also reported that balance may be beneficial to address balance and gait problems specific to PD.

**Effects of functional mobility/performance on functional task**

Various studies have analyzed the impact of physiotherapy on functional performance. In this paper, seven studies were reliable in giving the outcomes that physiotherapy interventions lead to a significant improvement in performance on functional task measures as timed up and go (TUG) test, sit-to-stand test, and climbing stairs [34, 37, 38, 41, 45–47]. In light of the after effects of these trials, it gives the idea that physiotherapy is advantageous as far as enhancing functional mobility. However, different physiotherapy programs and different durations were used in these studies. This makes it hard to propose the best kind of physiotherapy to address this issue.

A few authors have contended that, notwithstanding, the motor symptoms associated with PD sufferers are still typical ready to perform complex movements in specific circumstances [36]. Therefore, they suggest using movement strategies training to compensate for and bypass the deficits in the basal ganglia. Three studies used movement strategies training either as a stand-alone intervention or combined with other exercise, and each showed positive results [38, 44, 46]. However, other studies examined the effects of programs that do not include movement strategies and showed positive results [34, 37]. These programs include tango or treadmill. Thus, it makes it difficult to pinpoint which type of physiotherapy is more effective.
**Effect on gait/muscle strength**

Fifteen studies included in this part of scoping review reported outcomes related to gait deficits and showed promising results [29, 34–40, 42, 46–51]. The most result measure used to assess gait quality in these studies is gait velocity over a short distance. Ten of which indicated significant enhancement on account of the physiotherapy [29, 34, 36–38, 40, 42, 47, 48, 51]. Other gait results, for example, stride length and walking endurance, were additionally assessed in a few studies and were found to enhance with physiotherapy [34, 36, 48, 49].

Findings emerging from the results of the reviewed studies, related to gait and fall risk, are that people suffering from fear of gait (FOG) are likely to benefit from physiotherapy. However, this finding rises out of a predetermined number of studies. Just six trials provided details regarding gait freezing [34–36, 40, 44, 48]. Three out of the six trials demonstrated positive results for physiotherapy when contrasted either with control or with some other active intervention [40, 44, 48]. The lack of significant improvements in the other three studies does not necessarily indicate the absence of the benefits of physiotherapy. To illustrate, all of these studies did not target FOG specifically and did not include such a problem as an inclusion or exclusion criterion.

**Effect of muscle strength**

It appears that muscle strength may likewise enhance after physiotherapy in individuals with PD [44]. Hirsch et al. [31] compared the benefits of two physiotherapy interventions on two fall risk factors, namely balance and muscle strength. In this study, Hirsch et al. [31] compared the effects of 10 weeks of a program consisting of a combination of balance and resistance training with a control group who received balance training only. The results of this study were promising and showed that both groups gained significant improvements in all outcomes, and these gains were maintained for at least 4 weeks. However, the program of this study mainly focused on muscle strength, whereas strengthening training, in another study, represents a small portion of the programs. For example, Allen et al. [44] used resistance training as a component of a program that included cueing strategies and balance training. Therefore, it might be argued that the dose of the strengthening exercise was not sufficient enough to produce change in muscle power.

**Discussion**

**Direct impact of physiotherapy interventions on fall**

Even though falling is predominant among those experiencing PD, little work has been done to prevent this issue. Only 15 studies examined the direct effect of physiotherapy in fall in this specific population. The sample size was small in most of the inspected studies. Besides, the subsequent periods in the included studies were moderately short, with most of the studies looking at the impacts of physiotherapy immediately after the end of the interventions.

However, this paper represents the accessible studies that inspect the advantages of physiotherapy for individuals with PD. The immediate effects of physiotherapy in fall were estimated in these studies in terms of fall number and near fall incidence. These results were gathered fundamentally utilizing a self-reported fall diary sheet that was finished by participants themselves or medical staff. However, although fall diaries are considered valid and a reliable way to record fall incidence, factors such as participants’ ability to recall fall incidence, education level, and native language may affect the accuracy of the recording of fall in such diaries, and this should be considered when using this approach [52]. Despite this, the consequences of this scoping review propose that physiotherapy intervention may be useful in decreasing the quantity of falls and near fall incidence in individuals experiencing PD [15–17, 20, 21, 23, 25, 26]. This suggestion is based on limited evidence. Eleven studies showed that physiotherapy resulted in a reduction of fall rate [14, 15, 17–21, 23, 24, 26]. Yet, this reduction was significant only in seven studies [4, 15, 18, 20, 23, 24, 26]. Also, one study reported near fall incidence as outcomes and showed significant reduction [21]. The absence of the significant decrease in the number of falls in this study does not really demonstrate the absence of the impacts of physiotherapy. Rather, it may indicate the lack of adequate sample size to detect this change statistically, as noticed in the studies conducted by Protas et al. [14] and Martin et al. [25]. Another conceivable explanation behind the absence of significant improvement in terms of fall rates is the absence of incorporating appropriate intensity and type of training. Observably, every one of the interventions that did not reveal remarkable improvement involved interventions of moderately brief length or exercises that did not challenge balance, while the proof rising up out of studies concerning the older population in general recommend a higher dose of exercise and activities that challenge balance to achieve a positive impact on fall rate [5, 44]. Sherrington et al. [5] conducted a systematic review and meta-analysis and indicated that approximately half of the fall incidence among old people can be prevented by a well-designed program with a dose of at least 50 h over the trial period. Additionally, they brought up that intervention, including exercise, that challenges balance capacities are bound to counteract fall more often than those intervention comprising of different sorts of activities, for example, walking or strengthening exercises.

Therefore, it is not surprising when a significant reduction in fall number was noticed in the studies [20, 26, 27] that
incorporated a tai chi exercise program with a high dose (1 h, twice weekly for 6 months, > 50 h). The tai chi exercise is also considered a balance-based exercise.

Similarly, Smania et al. [26] used a variety of exercises that greatly challenge balance in different situations including standing, walking, and when doing functional activities, and a significant reduction in fall numbers was demonstrated. However, the dose of this program was 1 h twice weekly for 7 weeks, which was lower than the recommended dose (< 50 h). Thus, it might be argued that interventions consisting of only balance exercises that exceptionally challenge postural control in various circumstances may be a decent system to prevent fall in individuals with PD, even with the portion lower than the suggested dimension. However, this needs further examination. Another related finding is that programs, for the most part contain and fortify preparation, appear to be not viable in terms of fall rate decreasing in individuals with PD. Some included studies exploring the advantages of a strengthening exercise program and demonstrated that the strengthening activity had not caused any significant decrease in fall occurrence in correlation with the control group [20, 24, 25].

It is consistent with several systematic reviews concerning fall in general in older people. For example, Sherrington et al. [5] conducted a systematic review of 44 controlled randomized trials and showed that strengthening exercise alone is not beneficial for old people who suffer from recurrent falls. Other review has been conducted by Shen et al. [11] who showed that no clear evidence that training exercise decreased the number of fallers in PD over the short- or long term.

In addition, due to the limited number of trials reviewed in this paper which report the direct impact of physiotherapy on fall, these findings should be interpreted with caution. Furthermore, more control randomized trials with large sample sizes are required both to affirm these discoveries as well as to locate the intensity and type of exercise. Additionally, it should be clarified that all these trials included individuals with PD who did not have other neurological conditions and who were mentally and medically stable. In this way, generalization of these findings to other populations is not advisable.

**Indirect effects of physiotherapy on fall effect on composite score**

Recruiting many people can prove difficult to achieve, especially when researchers target a specific population such as people with PD [44]. For this situation, composite score is a decent technique to be used [44]. Composite score can be utilized to demonstrate the risk of falling, and the consequence of the reviewed trials shows that physiotherapy may positively affect such a measure. In this paper, two studies used a composite score (PIGD) that includes items related to gait and balance [22, 46]. These two studies exhibited that physiotherapy interventions lead to significant positive effects on such a score, when contrasted with usual care. Nonetheless, there is no one study that examined the sensitivity of this measure to foresee future fall. Then again, one study focused on fallers utilizing a composite score, PD fall risk score, that incorporates commitment that includes weight from muscle strength, balance, and FOG [44]. The authors in this study cited the validity and reliability of this measure. However, they found that physiotherapy did not result in any significant improvement in this score when compared to usual care.

**Effect on balance**

Considering the consequences of the studies included in this paper, it appears that different types of physiotherapy can possibly enhance balance. These types include traditional balance training, virtual reality balance training, resistance exercise, tai chi, movement training strategies, treadmill training, and multi-dimensional interventions. In any case, because of the various number of measures utilized, and the limited number of studies that analyze the impacts of various physiotherapy intervention on balance, it is not clear what sort of physiotherapy is the most beneficial for balance. A systematic review conducted by Addison et al. [53] contend that the type of physical activity may lead to an improvement in balance performance. Although this discovery supports the use of physiotherapy, the degree of the advantages is not known. Accordingly, future studies should address this impediment and focus on identifying the best intervention to target balance impairment in people with PD.

**Effects on functional mobility/performance on functional tasks**

Difficulty in performing functional tasks is one of the problems associated with PD and is strongly associated with fall. Measures intended to assess functional performance can be utilized to assess either balance or fall risk in individuals with PD. Consequently, various studies [4, 19, 20, 26, 29, 34, 37, 45] have analyzed the impact of physiotherapy on such results. In view of the results of these trials, it gives the idea that physiotherapy is advantageous regarding enhancing functional mobility. However, distinctive physiotherapy programs and diverse duration were utilized in these studies. This makes it hard to propose the best kind of physiotherapy to address this issue.

**Effects on gait**

Abnormal gait is, with no uncertainty, one of the elements that is unequivocally connected with fall and balance in individuals with PD. In this paper, distinctive interventions related to
gait deficits were utilized in the included studies and showed promising results. These interventions were various, going from movement strategies training to daily walking at home. Therefore, extracting a message about the best method to improve gait speed, stride, and endurance is difficult. Be that as it may, it creates the impression that interventions involving walking exercise or movement strategy training are more valuable than those without [36, 51]. Additionally, the results of the reviewed studies suggest that treadmill training, nordic walking, and amplitude movement training are better than traditional over-ground gait training [38, 46, 48]. However, these recommendations depend on a set number of studies and need further investigation.

**Effects on muscle strength**

Lower limb muscle strength is an important fall risk factor. It has been found that there is a strong relationship between lower extremities’ muscle strength and fall risk in people with PD [15]. This is normal because these muscles play a role in maintaining static and balance in people [44]. Moreover, there is a connection between muscle strength and gait patterns and walking ability which are also considered fall risk factors in people with PD [50]. In view of the consequences of the studies incorporated into this paper, it appears that muscle strength may likewise enhance after physiotherapy in individuals with PD [4, 16, 20, 28, 31]. In any case, it ought to be viewed that the aftereffects of the included studies were conflicting and future examinations may change this case. To illustrate, four studies reported on muscle strength, two of which found significant improvement as compared to either no physiotherapy treatment or an active intervention [20, 31], while two studies did not find significant gains [21, 44]. These studies had programs containing resistance training. Nonetheless, intensity was different among the trials. The studies that showed critical enhancement had programs mainly focusing on muscle strength, while strengthening training, in alternate studies, represents a small portion of the programs. Consequently, the effect of physiotherapy on muscle strength should be further investigated.

**Effects of physiotherapy on FOF**

Fear of falling, or FOF, is additionally one of the fundamental contributing elements to the beginning of fall in individuals with PD, and the discoveries of this paper support the use of physiotherapy to target the fear of falling. Four studies analyzed the effect of physiotherapy intervention on this fear, and these studies demonstrated critical positive outcomes for physiotherapy [19, 22, 26, 33]. Distinctive interventions were utilized in these studies, including cueing training, balance exercise, and treadmill training. Detectably, every one of the trials revealed enhancement in fear of falling and furthermore indicated enhancement in balance. This may show that impaired balance is a fundamental driver for the beginning of the fear of falling, and along these lines, any enhancement as far as balance would prompt a lessening in this fear. In this way, it tends to be contended that any intervention is gainful because of a paranoid fear of falling if it enhances balance. This finding is like the evidence emerging from systematic reviews that concern the effects of physiotherapy on elders in general. For instance, Zijlstra et al. [54] reviewed 11 controlled randomized trials and indicated that different kinds of exercise programs, such as tai chi exercise and balance training, have the potential to improve the fear of falling in elderly people living in the community, although these studies were not planned explicitly to treat the fear of falling.

**Conclusion**

Falling is one of the complications related with PD that effects up to 83% of sufferers. It creates the impression that this issue is likewise repetitive. Subsequently, a generous number of studies have been led to distinguish the factors that contribute to the onset of fall in this population and consequently several factors have been illustrated. These factors include previous fall history, impaired balance, gait problems, muscle weakness, and poor performance in functional activities, depression, and FOF. However, little work has been done in terms of fall prevention. The result of this study is promising. In any case, it appears that few controlled randomized trials have not been done to examine the direct impacts of physiotherapy on fall. Despite this, there is proof that physiotherapy intervention may be useful in diminishing fall rate and near fall incidence among individuals with PD. However, the components of the interventions play a main role in the outcomes. According to the results of these studies, interventions that highly challenge balance are likely to have positive impacts on fall. However, more research is needed to support or refute this finding. Furthermore, the results were also promising in that physiotherapy interventions have a positive impact on fall risk factors. Factors such as balance, functional mobility, FOF, and muscle strength may improve by physiotherapy. However, precisely the best interventions to focus on these factors stay questionable as do the long-term impacts of physiotherapy. One of the limitations in this paper is that most of the included studies barred individuals with other mental and neurological infections. In this manner, the generalizability of the discoveries cannot be accomplished for those with PD and other cognitive impairments or different diseases. Furthermore, this scoping review aims of displaying trends in the literature without giving distinction to methodological quality or empirical “weight” [55].
Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of authors.

Informed consent This paper does not need informed consent.

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