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Title Page:

‘PDSAFE’ - a multi-dimensional model of falls-rehabilitation for people with Parkinson’s. A mixed methods analysis of therapists’ delivery and experience.

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ABSTRACT

Objective: To explore the clinical reasoning of physiotherapists using PDSAFE; according to disease severity and their experiences of treatment delivery in a large fall-prevention trial for people with Parkinson's (PwP).

Design: A descriptive study of delivering PDSAFE. Semi-structured interviews explored therapists' experiences.

Setting: A two-group, home-based, multi-centred, single-blinded, randomised controlled trial showed no overall effect on fall reduction between groups but demonstrated a significant secondary effect relating to disease severity with benefits to balance, falls efficacy and near-falls for all.

Participants: Physiotherapists with a background in neurology and older-person rehabilitation were trained in the delivery of PDSAFE

Intervention: A multi-dimensional, individually tailored and progressive, home-based programme.

Results: Fifteen physiotherapists contributed to the 2587 intervention sessions from the PDSAFE trial and six of those physiotherapists took part in the interviews. The personalised intervention was reflected in the range of strategies and exercises prescribed. Most commonly prescribed fall-avoidance strategies were 'Avoiding tripping', 'Turning' and 'Freezing Cues' and all possible combinations of balance and strength training within the programme were selected. PwP with greater disease severity were more likely to have received less challenging strategies, balance and strengthening exercises than those with lower disease severity.

Therapists considered the focus on fall events and fall avoidance strategies an improvement on 'impairment only' treatment. The presence of cognitive deficits, co-morbidities and dyskinesia were the most challenging aspects of delivering the intervention.

Conclusion: Falls management for PwP is complex and compounded by the progressive nature of the condition. Physiotherapists both delivered and positively received PDSAFE. (248 words)

The trial registration number is ISRCTN 48152791

Contributions of the paper:

- The clinical reasoning process for falls prevention rehabilitation in people with Parkinson's is complex and multidimensional.

- PDSAFE can be considered as appropriately designed for people with moderate Parkinson's disease but care should be taken with people in the more severe disease group including those who freeze.
- The use of multi-dimensional treatment including fall avoidance strategies related to specific falls mechanisms, in combination with exercise, is preferable to the treatment of isolated impairments such as balance and strength alone.

Keywords: Parkinson's, Fall, Rehabilitation, Clinical reasoning, Physiotherapy

Background

Falling is a common and disabling consequence of Parkinson's with 40-70% of patients falling each year[1] and one third falling repeatedly[2]. These figures are double those reported for comparative older populations[3] and although the incidence of falling increases with disease severity, falls are common even in the early stages of the condition[4]. The risk of injury resulting from a fall is high, 65% injuring themselves (from a sample of 1000) and 33% sustaining a fracture[5]. Falling among PwP presents a major health challenge, which at current standards is estimated to cost the NHS in excess of £212million a year[6].

The general role of exercise for the treatment of both physical and cognitive/behavioural symptoms of Parkinson's has been advocated and supported in the development of the European Physiotherapy Guidelines for Parkinson's[7]. In reviewing 70 clinical trials, the guidelines suggest strong evidence for the role of specific physiotherapy intervention for improving transfers, balance, gait, physical capacity and movement functions[7], all of which have been identified as isolated falls risk factors[8].

Published trials aiming to reduce falls in Parkinson's[9] have increased in recent years, although results are inconclusive with many of the largest trials failing to show a significant impact on falls prevention. Synthesis of evidence[10] suggests a multi-dimensional

intervention to reduce falls incorporating balance, strength and strategy training with motor, cognitive and behavioural training may be more effective than interventions focusing on independent risk factors such as balance and/or strength alone.

The 'PDSAFE' intervention forms the focus of this paper. The full analysis of this randomised controlled trial has been published[11]; the data indicated that PDSAFE did not reduce falls in the overall heterogeneous sample of PwP. Secondary subgroup analyses suggested a different response to the intervention between moderate (Hoehn & Yahr (H&Y) 2 & 3) and severe disease severity (H&Y 4) groups with a reduction in falls for the moderate group but an increase in falls for those with more severe disease, including those with cognitive impairment and freezing. Further secondary outcomes demonstrated improvement across the whole sample in balance, functional strength, falls efficacy and a reduction in near falls.

To better understand the overall main trial findings, we have examined the intervention provided in this trial, something that has not been possible before on such a large scale. The aims of this paper are to describe the clinical reasoning choices made by physiotherapists using PDSAFE for PwP and to highlight differences according to disease severity.

Method

Participants in the trial: Physiotherapists and PwP were recruited from eight centres across England. PwP were eligible if they had a clinically confirmed diagnosis of Parkinson's, living in the community, independently mobile with or without an aid, fallen at least once in the previous 12 months, scored 24 or more on the Mini-mental State Examination [12], had

cognitive ability to give informed consent and considered able to participate in the intervention.

Senior physiotherapists on the trial received comprehensive training (2-days) in the intervention with continued professional development through monthly master classes and presentations of case studies. To ensure fidelity of the intervention according to protocol the lead therapist observed therapists' practice.

Intervention outline:

The PDSAFE treatment programme was built on evidence, the conceptual design is described in Hulbert et al[10]. The theoretical underpinning was mapped over the World Health Organisation International Classification of Function model (WHO 2001) to ensure all domains were addressed. The programme comprised; a high intensity, strength and balance exercise programme (Body functions and structure domain), underpinned with strategy training (activity and participation domain), specific to the falls mechanism of the participant and delivered in a functional, home environment (environmental and personal factors domain).

The programme included 12 home visits to participants with reducing frequency over 6 months, aiming to progress a personalised programme at each session and encourage self-monitoring and delivery. Each session included a brief review of any falls; warm-up exercises; review, practice and progression of individual exercise programme; and strategy training in functional scenarios selected from the content of Figure 1. Careful records were kept of the strategies and exercises prescribed and individuals were encouraged to keep

records of self-practice. The data were captured using a bespoke database for therapists to input their treatment remotely. Trial management, data monitoring and statistical analyses were coordinated at the PDSAFE trial office, University of Southampton, UK and supported by the Oxford Clinical Trials Unit (OCTRU).

Intervention delivery: Individual fall history (falls questionnaire[13]), mapping the house for areas of fall risk and physical assessment (mini-best[14] & falls efficacy[15] & near-falling[16]) formed the basis to treatment by determining the PwP's most likely cause of falling (fall mechanism) and their need for improving movements and fall-avoidance strategies. A list of eight pre-set strategies were composed: freezing cues, avoiding tripping, turning, moving in tight spaces, stepping backwards, picking up an object, dual tasking and reaching (see Figure 1). These strategies were utilised in the following way; eg, a participant who reported catching their foot and falling in frequent situations would most likely have a tripping fall mechanism, thus avoiding tripping would be selected as a fall-avoidance strategy by the therapist. More than one strategy could be selected. Impairments and fall-risk factors[8] were subsequently identified. For example; catching the foot may be due to weak foot muscles, not transferring weight onto the supporting leg due to hip weakness, reduced limits of balance stability or not gaining enough clearance from the ground due to weakness in the hip flexors. Through assessment the therapist determined which was the most likely impairment and designed a personalised balance and strength exercise programme from the available exercise menu (see Figure 1). Each programme was complemented with functional, 'real life' strategy training tasks. Exercises included balance training with a gradual decrease in area of support and use of foam standing pads.

Strengthen training used body weight resistance and if appropriate weighted vests, during functional exercises (sit to stand).

Figure 1 about here

Data collection and analysis: Frequency data (number of times an exercise or strategy was used by a therapist during the intervention delivery) are presented in bar charts as percentage of people selected to use each strategy and exercise. Strategies were recorded at the initial session and exercises were recorded weekly according to their prescription. These frequencies are given within H&Y groups, and within those who freeze or do not freeze.

Semi-structured interviews exploring the experiences of the first six appointed physiotherapists were recorded and transcribed verbatim by a researcher (AR) independent of the intervention provision. A second researcher (RS) analysed the data using a framework approach[17], developed by the National Centre for Social Research (supplementary table).

Results

Participants: Eighteen physiotherapists were trained in the PDSAFE intervention protocol, fifteen contributed to the trial intervention (three were trained as reserves). All therapists were in the National Health Service, female, senior and experienced in rehabilitation

(neurological and older adults). The first six therapists recruited to the trial contributed to the semi-structured interviews.

Out of the 474 PwP randomised in the clinical trial, 238 were allocated to the physiotherapy programme with a range of disease severity from 1-4 Hoehn & Yahr (H&Y), age range 51-91, mean 71 (7.7), 147 (62%) were male and average duration of disease was 8 years [10].

Therapy content:

Of the 238 PwP randomised to receive PDSAFE, 201 contributed to this therapy data.

Reasons for non-contribution were withdrawal before receiving intervention (n=2) and one therapist's failure to release data for this analysis (n=35). Participants had PDSAFE if they received seven or more sessions (n= 154); the majority received the desired 12 session (mode =12).

Based on the therapists' assessment findings, the most relevant strategy to address the potential falls mechanism for the patient was selected. This was used throughout the treatment period. Sometimes the initial strategy was progressed/replaced by another. For the programme, strategies were selected a total of 440 times and used in treatment session a total of 3447 times over all participants, across the period. The mean number of strategies selected for each participant was 2 (range 1-6).

Avoiding tripping' was the most widely used strategy. It was selected for 26% of programmes (n=116 participants) and used 1110 times during the treatment sessions for these participants. This is also comparable to 'turning 'being selected for 24% of programmes (n= 107 participants and used 938 times during their treatment sessions).

'Freezing cues' strategies were selected for 18% of programmes (n=79 participant used 365 times during treatment sessions,). 'Avoiding Tripping' strategy was the most selected for both moderate and low disease groups while 'Turning' was the most selected for both the severe disease group and those PwP with freezing. 'Dual tasking', 'stepping backwards', 'picking up objects' and 'reaching' were more likely prescribed for people with moderate or low disease severity than those with severe Parkinson's, with or without freezing (see fig 2 & 3).

Figures 2 & 3

A total of 1693 exercises were selected over the intervention period with an average of six (range 1-8) exercises prescribed per participant across the period. Overall, standing balance, sit to stand and compensatory stepping and lunging were the most frequently prescribed. See figs 4 & 5 for the examination of the exercises delivered according to disease severity; standing balance, heel toe walking and sit to stand were the most commonly identified exercises for those with the most severe disease. People with freezing had compensatory stepping, heel toe walking and sit to stand as the most likely. Compensatory stepping and lunging, heel toe walking and sit to stand were the most frequently prescribed for the moderate group. Exercises such as 'tandem walking' or 'side stepping up and down' were more likely prescribed for those with moderate or low disease severity and not those with severe disease.

Figures 4 & 5

In summary, common patterns of prescribing PDSAFE exercise and strategies were identified; people with moderate (H&Y 2 & 3) or low disease severity (H&Y 1) were more likely to be given more dynamic activities than those with more severe Parkinson's (H&Y 4).

Interviews: Five themes emerged from the semi-structured interviews with physiotherapists.

Theme-1 – Views of the concept

The clinical reasoning approach, for identifying the underlying falls mechanism with strategy and exercise selection was positively received, this differed from usual practice of impairment only treatment within the NHS,

"I suppose approaching it from strategy training..... was quite hard to embrace to start with but now I've got the hang of it, I absolutely love it and I think it's a really different way of actually looking at how therapists approach the treatments to their patients. I've really, really enjoyed it" [Therapist3].

Theme-2 – Benefits and limitations of PDSAFE

A number of therapists commented on how helpful the programme structure was, not only for them but also for their patients, giving clear instructions whilst maintaining a requirement for advanced clinical reasoning.

".....you had a clear progression and a clear way to lead but you also had a huge amount as a therapist of decision making yourself and using your clinical reasoning to come to the

decisions of what strategy you chose or exercises you chose so again it didn't dumb you down" [Therapist3].

Theme-3 – Influences on intervention success

Most of the therapists associated minimal or no cognitive difficulties as a key element for intervention success. Cognitive issues were explained as potentially reducing motivation (due to reduced understanding of intervention intent) and preventing carry over from treatment. This latter issue then limited the patient's ability to progress.

"I think the whole thing worked very well as long as they had the cognitive capacity to understand how it all knitted together which aided their motivation"[Therapist4].

However, the belief that cognitive acuity was important for intervention effectiveness was not universal.

"Everybody progressed, everybody really enjoyed it, all the people I had, even the ones with cognitive impairment, were very compliant..." [Therapist1].

Those described as 'motivated' to exercise and to integrate PDSAFE into their daily lives were thought more likely to derive benefit. Those with mild-moderate Parkinson's, who were functionally independent, were seen by some as ideal candidates in terms of potential to benefit and those concerned about personal risk of falls was considered by one therapist as important for facilitating the required lifestyle changes.

Theme-4 – Therapists perceptions of the 'patient experience'

Most therapists perceived the majority of patients enjoyed and were engaged with the PDSAFE intervention, exceptions were those with co-existing musculoskeletal conditions.

Elements that were reported as enjoyable were: 1) issues relevant to the individual patient

2) clear structure 3) intensity and level of input/contact with therapists for support 4) novel focus on strategy training 5) chance to exercise and build confidence.

“I think it’s having somebody supervise them...somebody coming in and they are not being left with a piece of paper, doing a list of exercises... something that they can relate to and for us it was falling but it might have also been getting up out of a chair, rolling over in bed, getting their food out of the boot of the car from shopping you know” [Therapist6].

“The intensity of the programme was centred around them as an individual and the strategy training practice which was different to what they had received before”[Therapist3]

All therapists raised uncertainty and likelihood of participants’ long-term independent adherence to the home exercise on exit from the programme.

Theme-5 – Usability and transferability into usual care

Therapists were positive about the intervention from the concept, training and support received and continual development whilst being part of the research trial; joint visits and supervision sessions were praised.

“...once you go out and start to deliver it you come up with questions but the support was really good because we had regular fidelity checks, peer support sessions and phone calls and things [Therapist5].

Therapists found the patient booklets with personalised programmes and individual video feedback very helpful. Unanimously they found the pre-recorded DVD’s of exercises for

patients to practice with, the weighted vests and metronome unhelpful with infrequent use and would have liked more flexibility in the intervention protocol.

All therapists felt it would be possible to deliver PDSAFE within the NHS but acknowledged the twelve sessions delivered were greater than current practice. The value of home delivery for participants to learn strategies and attain carry over was stressed by all, the involvement of therapy assistants and group activities were suggested.

Discussion

With ever growing financial and societal needs for managing falls, an understanding of the delivery and content of therapy becomes a requirement and should form a key component of clinical trials. The PDSAFE randomised controlled trial, the largest physiotherapist-delivered fall-prevention trial for PwP created a unique opportunity for exploring the intervention provided for participants [10, 11]. Details of the actual delivered interventions are rarely published [9]. Descriptive data of the PDSAFE treatment for participant groups plus therapists' views and opinions have been presented in this paper and collated to form a basis for future hypothesised trials on the content of therapy.

Our descriptive data showed the majority of PwP received the planned 12 treatment sessions, all strategies were selected at some point with a range of corresponding exercises. Although our eight sites were geographically spread and participant numbers large, it was possible to train therapists to deliver a personalised, patient-centred, falls prevention programme with a high degree of fidelity; therapists' comments demonstrated the intervention was liked and enjoyed.

Falls in this group of people are complex and compounded by a deteriorating condition, co-morbidities and age related factors. Recent work to understand participation by PwP in a Parkinson's, specific physiotherapy programme, highlighted the importance of complex non-motor impairments including apathy and fatigue in influencing a person's decision to take part [4,7]. Consistent with the decision-making by the physiotherapists in this trial, the impact of these negative features must be considered as a feature in effectiveness of exercise programmes for PwP. Therapists in this study reported those most likely to benefit from the intervention worked at a high intensity, accommodated changes to their routine and lifestyles, had the cognitive capacity to complete independent practice and could follow the programme and comprehend the personalised fall programme to their fall history. Those with more severe disease including co-morbidities and cognitive deficits were perceived to benefit less and found engagement in the programme more challenging.

From our semi-structured interviews therapists commented on the importance of independent clinical reasoning in selecting fall-avoidance strategies and prescribing exercise as opposed to being given a standard protocol. Despite this freedom there were clear preferences to specific strategies and combinations of exercises. This suggests that despite falls being multifaceted and unique in presentation for each person and environment, the underlying mechanisms may either be similar or perceived by the therapists to be similar, as common patterns in the treatment programme emerged. The most common strategies were avoiding tripping, turning or freezing and the most common exercises, compensatory stepping and lunge and heel/toe walking and sit to stand. Compensatory stepping and lunging is interesting because of the multi-components. It addresses high dynamic stepping to increase motor control, compensatory stepping to regain an appropriate base of support

from a loss of balance or a trip; increasing stepping amplitude for those that freeze; expanding limits of stability for those that fall when reaching; practice stepping backwards with appropriate postural control and weight distribution for those that fall stepping backwards, all of which could explain its high level of use.

An important secondary finding of the main trial was the diverse response to the intervention with the moderate disease group experiencing a reduction of falls while the more severe disease group and those with freezing of gait had an increase in falls[11]. For that reason we examined the delivery of the intervention to identify differences between disease severity groups. Those with more severe disease did less dynamic balance exercise and more static balance. From clinical experience, the static balance exercises are more likely to build a balance reserve and show an improvement on balance assessment but less likely to help with dynamic reactive balance scenarios in saving a fall. Enabling individuals to prevent a near-fall thus building a greater capacity before reaching their limits of stability may be better. This may also explain why those with greater disease severity fell more following PDSAFE –it can be assumed that quick, dynamic reactions continue to decline but the static reserve meant they may have tried more functional activities without having the ability to maintain safety. A similar pattern is seen in strength exercises, those with greater disease mostly doing static strengthening exercises. In contrast, as the lower disease severity group did more dynamic strengthening exercises they may have trained a better reactive response.

Similarly, people with freezing characteristics had more static balance exercises which may have had little impact on freezing, a dynamic symptom. For example, only a small percentage of this sub-group practiced the figure of eight exercise – designed as complex

dynamic exercise to improve freezing during turning and complex environments.

Interestingly, the freezing strategy was third in priority selection to the avoiding tripping and turning strategies in this group (Fig 3), despite all being identified as freezers. Freezing is a key determinant of falling [6] but therapists may have attributed a fall mechanism to avoiding tripping or turning in this group when in fact freezing may have been the primary underlying reason. It could also be argued that turning, moving in tight space and dual tasking are also associated with freezing [18] due to the complexity of the action and cognitive challenge and therefore could also be the true fall mechanism. In such a context these individuals may not have received the most appropriate programme for their specific fall mechanism with a reduced effect of the intervention. This leads to an important question for future research; was the reduced effect due to the disease severity or were participants with more disease severity under challenged by therapists who perceived a restricted ability which in turn influenced their prescription of exercises and strategies? Further work is required in this area to fully understand the complexity of exercise prescription for those with freezing and severe disease. Hypothesised clinical trials into the content of intervention across disease severity is needed.

Limitations

Despite the large sample size of the PDSAFE trial and fidelity of intervention delivery the following limitations should be considered:

- The selection of strategies was based on therapists' clinical reasoning via their own assessment. Due to trial restrictions to maintain blinding it was not possible for the Therapists to communicate with the trial Assessors for measures of disease severity,

symptoms and full falls history, this probably restricted the comparisons between measured symptoms and programme prescription.

- Due to timing of the data collection for this study, not all therapists in the trial could be included in the qualitative component and it was not possible to conduct integrative analysis. Therefore mixed methods approach is presented as two data sets for enhanced understanding but not as combined analysis.
- The study was not designed to evaluate statistical difference in the selection of strategies and exercises for different participant sub-groups. It is therefore not possible to determine if it is the sub group (ie freezing or greater disease severity) or the selection of the exercises for that group made the difference to the overall outcome of falls prevention using PDSAFE.

Conclusion

PDSAFE can be considered appropriately designed for people with moderate Parkinson's disease, care should be taken with people in the more severe disease group including those who freeze. The complexity of Parkinson's and its management are highlighted, illustrating the importance of specialist knowledge and staff dedicated to providing targeted care across the spectrum of the condition.

[3599 words]

Conflict of interest, Authors have nothing to disclose.

References

1. Silva de Lima A L, Smits T, Darweesh S L, Valenti G, Milosevic M, Pijl M, Baldus H, de Vries N M, Meinders M J, Bloem B R, Home-Based Monitoring of Falls Using

- Wearable Sensors in Parkinson's Disease. *Movement Disorders* 2019; DOI: 10.1002/mds.27830
2. Balash Y, Peretz C, Leibovich G, et al. Falls in outpatients with Parkinson's disease: frequency, impact and identifying factors. *Journal Of Neurology*. 2005;252(11):1310-1315. PubMed PMID: 15895303.
 3. Canning CG, Paul SS, Nieuwboer A. Prevention of falls in Parkinson's disease: a review of fall risk factors and the role of physical interventions. *Neurodegenerative Disease Management*. 2014;4(3):203-221. doi: 10.2217/nmt.14.22. PubMed PMID: 25095816.
 4. Lord S, Galina B, Yarmall A, Coleman S, Burn D, Rochester L. Predicting first fall in nearly diagnosed Parkinson's disease: insights to primary prevention in a fall-naïve cohort. *Mov Disord*. 2016; Dec 31(12):1829-1836. doi:10.1002/mds.26742. Epub 2016 Sept 13.
 5. Wielinski CL, Erikson-Davis CE, Wichmann R, et al. Falls and injuries resulting from falls among patients with Parkinson's disease and other parkinsonian syndromes. *Movement Disorders*. 2005 Apr;20(4):410-415. doi: 10.1002/mds.20347. PubMed PMID: WOS:000228540300003.
 6. Parkinson's UK. What is Parkinson's? London: Parkinson's UK; 2013 [cited 2016 May 15]. Available from: <https://www.parkinsons.org.uk/information-and-support/what-parkinsons>
 7. Keus SHJ, Munneke M, Graziano M. European Physiotherapy Guidelines for Parkinson's disease. Holland: Royal Dutch Society for Physical Therapy (KNGF) and ParkinsonNet; 2015. Available from: <http://parkinsonnet.info/news/penultimate-version-european-guideline-online>.
 8. Van der Marck MA, Klok MPC, Okun MS, et al. Consensus-based clinical practice recommendations for the examination and management of falls in patients with Parkinson's disease. *Parkinsonism & Related Disorders*. 2014;20(4):360-369. doi: 10.1016/j.parkreldis.2013.10.030. PubMed PMID: 24484618.
 9. Shen X, Wong-Yu ISK, Mak MKY. Effects of Exercise on Falls, Balance, and Gait Ability in Parkinson's Disease: A Meta-analysis. *Neurorehabilitation And Neural Repair*. 2016;30(6):512-527. doi: 10.1177/1545968315613447. PubMed PMID: 26493731.
 10. Hulbert, Sophia May; Rochester, Lynn; Nieuwboer, Alice; Goodwin, Victoria A; Fitton, Carolyn; Chivers-Seymour, Kim; Ashburn, Ann on behalf of PDSAFE grant holders. 'Staying Safe'- a narrative review of falls prevention in people with Parkinson's - 'PDSAFE'. *Disability & Rehabilitation* DOI: 10.108-/09638288.2018.1471167
 11. Chivers Seymour K, Pickering R, Rochester L, Roberts H, Ballinger C, Hulberts S, Kunkel D, Marian I, Fitton C, McIntosh E, Goodwin V, Nieuwboer A, Lamb S, Ashburn A. Multicentre, randomised controlled trial of PDSAFE, a physiotherapist-delivered

- fall prevention programme for people with Parkinson's. *J Neurol Neurosurg Psychiatry* 2019; 90: 774-782
12. Folstein MF, Folstein SE, McHugh PR et al. A practical method for grading the cognitive state of patients for the clinician. *J Psych Res* 1975; 12: 189-98.
 13. Stack E, Ashburn A. Fall-events described by people with Parkinson's disease: Implications for clinical interviewing and research agenda. *Physiotherapy Research International* 1999; 4(3) 190-200
 14. King L, Horak F. On the Mini-BESTest: Scoring and the Reporting of Total Scores. *Physical Therapy* 2013, 93:571-575.
 15. Yardley L, Beyer N, Hauer K, Kempen GIJM, Piot-Ziegler C, Todd C. Development and initial validation of the Falls Efficacy Scale-International (FES-I). *Age and Ageing* 2005; 34: 614-619.
 16. Gazibara T, Tepavcevic D, Svetel M, Tomic A, Stankovic I, Kostic V, Pekmezovic Near-falls in people with Parkinson's disease: Circumstances, contributing factors and association with falling. *Clinical Neurology and Neurosurgery* 2017; 161:51-5517. Ritchie J, Spencer L . Qualitative data analysis for applied policy research. In *Analysing qualitative data*, Bryman A, Burgess R (eds) pp 173-194: London Routledge; 1994.
 18. Mancini M, Smulders K, Cohen RG, Horak FB, Giladi N, Nutt JG. The clinical significance of freezing while turning in Parkinson's disease. *Neuroscience* 20117 343: 222-228; 11.045 Epub 2016 Dec 9

Figure 1 Outline of the PDSAFE content

Strategies	Exercise	Category	Functional task eg.
1. Avoiding tripping 2. Freezing Cues 3. Turning 4. Moving in tight spaces 5. Stepping backwards 6. Picking up and object 7. Dual tasking 8. Reaching	Standing balance	Standing balance (with and without foam surface or metronome)	1. Opening the door 2. Making a cup of tea 3. Hanging the washing out 4. Walking in the garden 5. Tidying the house Specific 'patient centred' activity
	Tandem Stand		
	Reaching	Dynamic balance	
	Compensatory step and lunge		
	Heel/toe walking		
	Toe/heel walking backwards		
	Tandem walking		
	'Figure of 8' walking		
	Picking up and object		
	Stepping over an object		
	Sit to stand	Strengthening (with and without weights)	
	Standing toe and heel raises		
Forward stepping up and down			
Side stepping up and down			

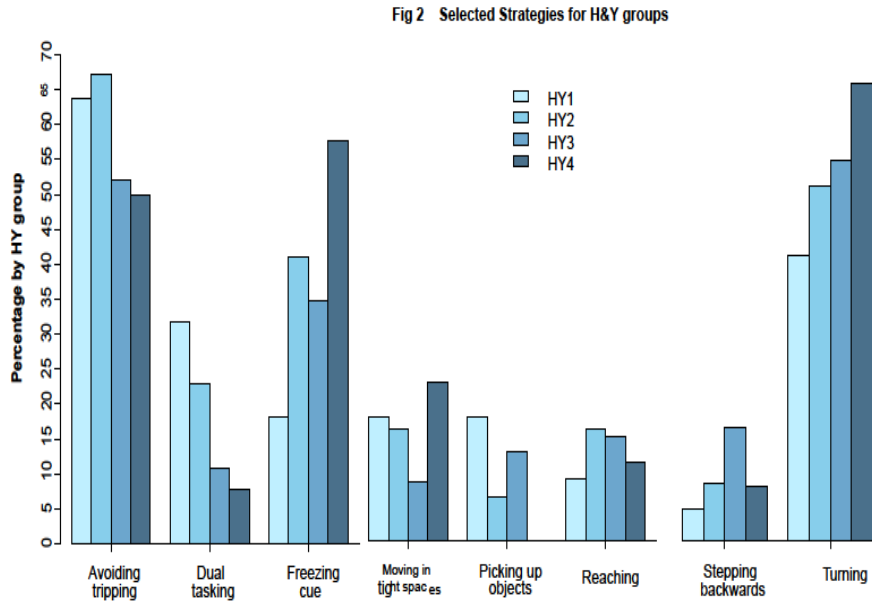


Fig 2 Selected Strategies for H&Y groups

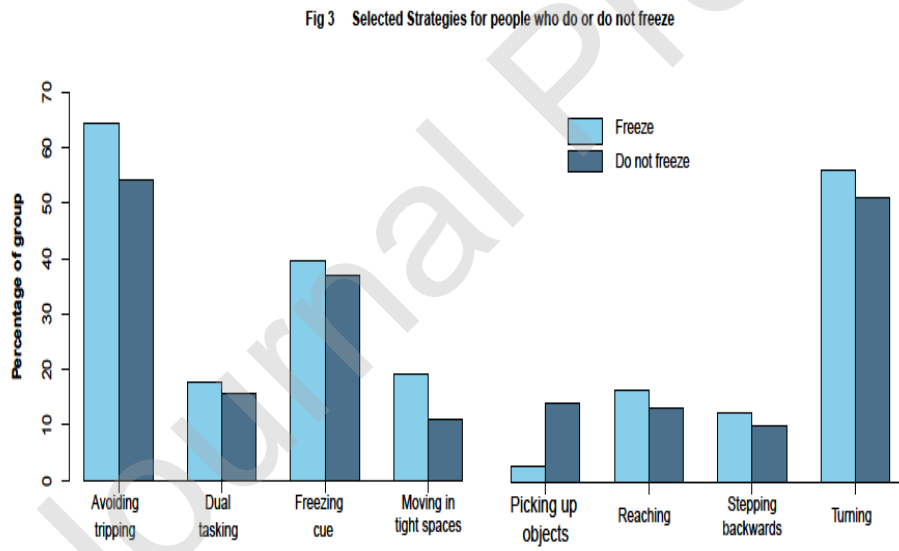


Fig 3 Selected Strategies for people who do or do not freeze

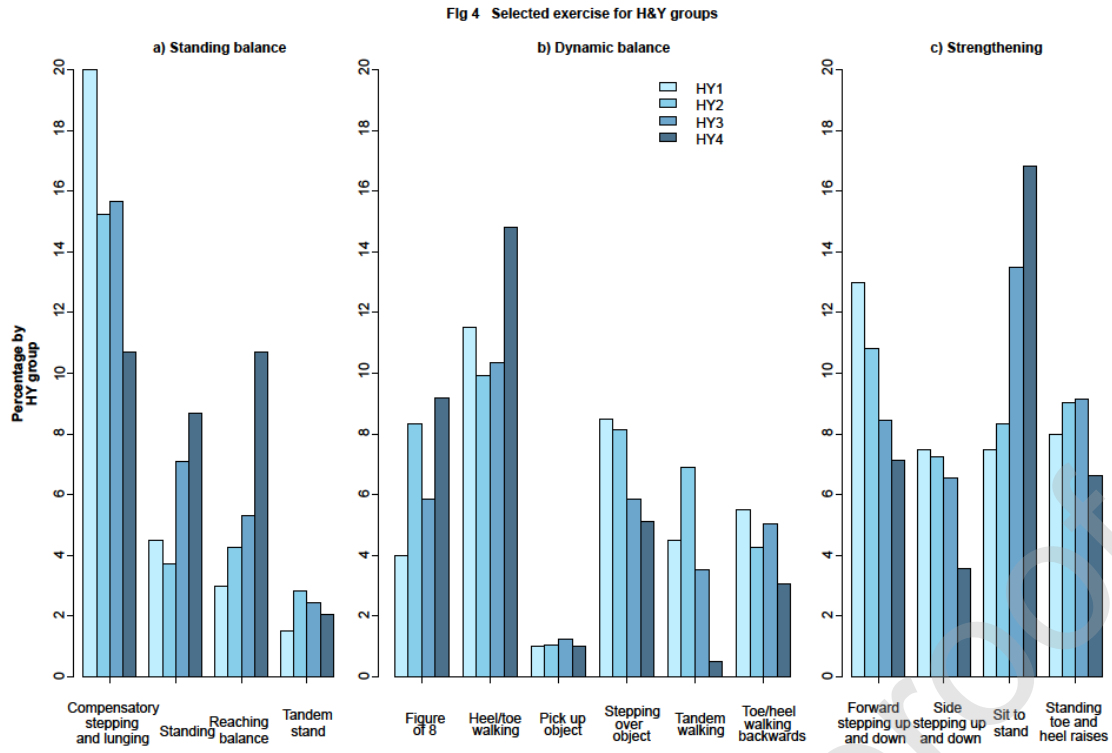


Fig 4 Selected exercise for H&Y groups

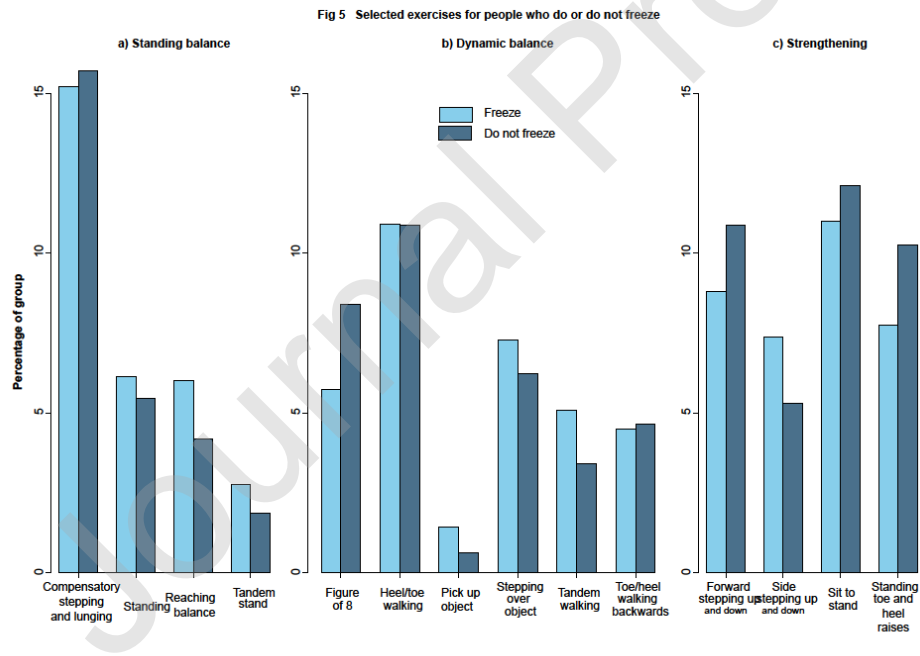


Fig 5 Selected exercises for people who do or do not freeze