

# Supporting physical activity and exercise in people with Neurological conditions

REBECCA RAYNER, STROKE CLINICAL LEAD  
NORFOLK AND NORWICH UNIVERSITY HOSPITAL



# Aims of the Presentation

- ▶ Overview of Exercise and Physical Activity
- ▶ Make you think about what you do now and what you may want to do in the future?
- ▶ Update on current evidence for a few Neuro conditions – Stroke, MS, PD, Neuromuscular disorders
- ▶ Barriers (patient and Physio)

*“How do you promote Physical Activity and Exercise in people with Neuro Conditions?”*



*Why do we promote physical  
activity/ exercise?*

# Physical Activity vs Exercise

- ▶ How would you describe physical activity to your patients?
- ▶ How would you describe exercise?
- ▶ Do you think of them differently or the same thing?
- ▶ How would you describe the difference to your patients?



**What are the 4 main categories of exercise?**

**What tends to be your priority when working with people with neurological conditions - why?**

# Types of Exercise

```
graph TD; A[Types of Exercise] --> B[Strength]; A --> C[Aerobic]; A --> D[Flexibility]; A --> E[Balance];
```

Strength

Aerobic

Flexibility

Balance

These are often all important in management and recovery from neurological conditions.

**"If exercise were a pill, it would be one of the most cost-effective drugs ever invented"**

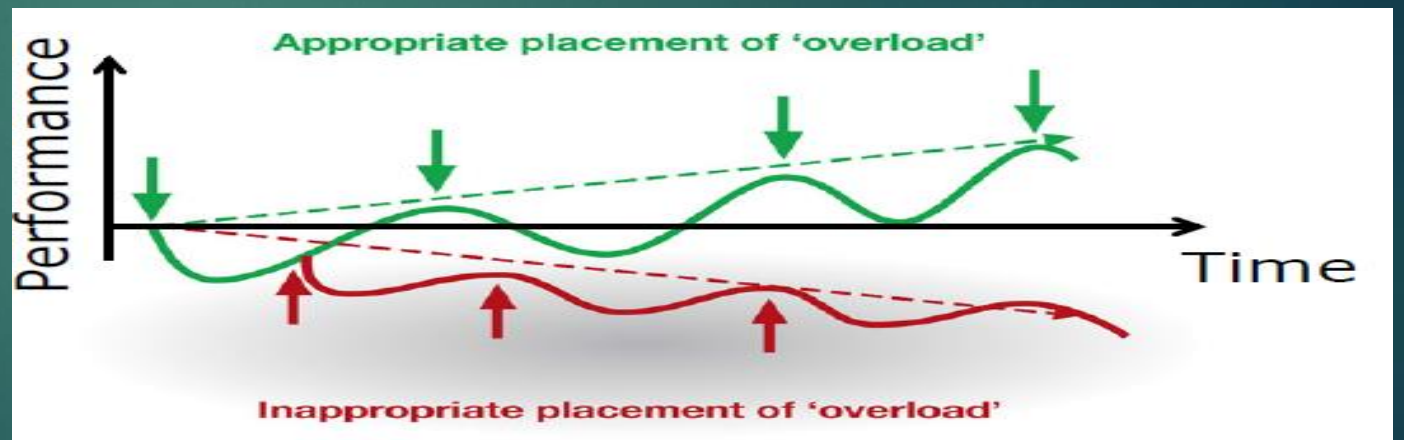
**Dr Nick Cavill, Health Promotion Consultant**





# Four Principles of Exercise

1. Individual differences
2. Specificity
3. Progressive Overload & Recovery
4. Reversibility





# ACSM EXERCISE GUIDELINES UPDATED in 2018

To stay healthy, adults should try to be active daily and should do:

▶ at least 150 minutes of moderate aerobic activity every week

**AND**

▶ strength exercises on two or more days a week that work all the major muscles

**These guidelines based on evidence from studies in which people with disability are often excluded.**

## Global Recommendations on Physical Activity for Health

### 18–64 years old

These guidelines are relevant to all healthy adults aged 18–64 years, unless specific medical conditions indicate to the contrary, irrespective of gender, race, ethnicity or income level. They also apply to individuals in this age range with chronic noncommunicable conditions not related to mobility such as hypertension or diabetes. These recommendations can be applied to adults with disabilities. However they may need to be adjusted for each individual based on their exercise capacity and specific health needs. Pregnant, postpartum women and persons with cardiac events may need to take extra precautions and seek medical advice before striving to achieve the recommended levels of physical activity for this age group.

Strong evidence demonstrates that compared to less active adult men and women, individuals who are more active:

- have lower rates of all-cause mortality, coronary heart disease, high blood pressure, stroke, type 2 diabetes, metabolic syndrome, colon and breast cancer, and depression;
- are likely to have less risk of a hip or vertebral fracture;
- exhibit a higher level of cardiorespiratory and muscular fitness; and
- are more likely to achieve weight maintenance, have a healthier body mass and composition.

#### Recommendations:

In adults aged 18–64, physical activity includes leisure time physical activity, transportation (e.g. walking or cycling), occupational (i.e. work), household chores, play, games, sports or planned exercise, in the context of daily, family, and community activities.

The recommendations in order to improve cardiorespiratory and muscular fitness, bone health, reduce the risk of NCDs and depression are:

1. Adults aged 18–64 should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week **or** do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week **or** an equivalent combination of moderate - and vigorous-intensity activity.
2. Aerobic activity should be performed in bouts of at least 10 minutes duration.
3. For additional health benefits, adults should increase their moderate-intensity aerobic physical activity to 300 minutes per week, **or** engage in 150 minutes of vigorous-intensity aerobic physical activity per week, **or** an equivalent combination of moderate - and vigorous-intensity activity.
4. Muscle-strengthening activities should be done involving major muscle groups on 2 or more days a week.

Inactive people should start with small amounts of physical activity and gradually increase duration, frequency and intensity over time. Inactive adults and those with disease limitations will have added health benefits when they become more active.

For further information see: <http://www.who.int/dietphysicalactivity/ga/en/index.html> or contact WHO on [dietandhealth@who.int](mailto:dietandhealth@who.int)



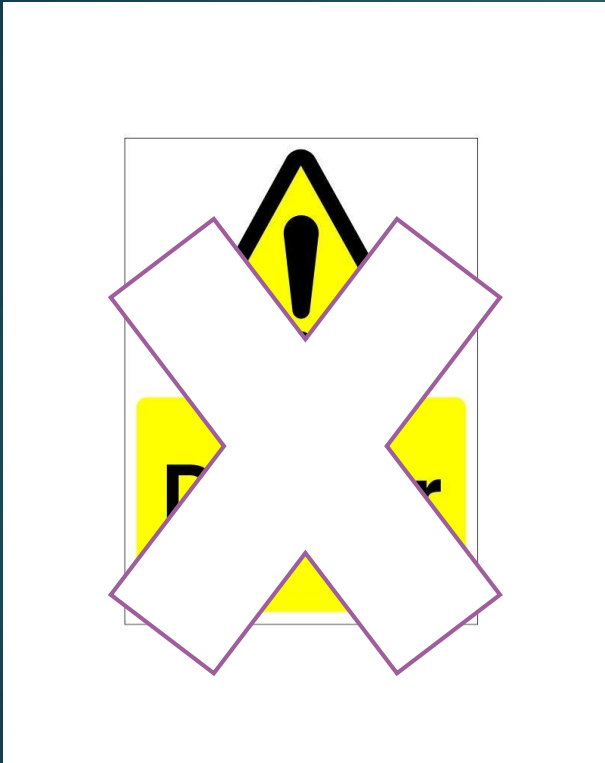
© World Health Organization 2011





# Neurological Condition specific advice...



# Multiple Sclerosis



## Effects of Exercise therapy

	MS patients vs. healthy controls		
Muscle strength	↓		↑↑
Muscle mass	↓		↑↑
Muscle activation	↓		↑↑
Aerobic capacity (VO2-max)	↓	↑↑	
CVD risk	↑	↓	↓
Depression	↑	↓	↓
Fatigue	↑	↓	↓
Daily activity level	↓	↑	↑
Functional capacity	↓	↑	↑
Balance	↓	↑	↑
QoL	↓	↑	↑

Red arrow = Impaired in MS patients

Green arrow = Improved after exercise in MS patients

Motl & Pillutti, *Nat Rev Neurol*; Sep;8(9):487-97.2012

Dalgas et al. *Mult. Scler*. 14(35);35-53:2008

# Can exercise be harmful for people with MS?

Review article

The safety of exercise training in multiple sclerosis: A systematic review

Lara A. Pilutti<sup>a,\*</sup>, Matthew E. Platta<sup>a</sup>, Robert W. Motl<sup>a</sup>, Amy E. Latimer-Cheung<sup>b</sup>

<sup>a</sup> Department of Kinesiology and Community Health, University of Illinois at Urbana-Champaign, Urbana, USA

<sup>b</sup> School of Kinesiology and Health Studies, Queen's University, Kingston, Canada

- ▶ Exercise training not associated with increased risk of relapse
- ▶ Indeed, exercise training was associated with a slightly reduced risk of relapse
- ▶ Rate of adverse events for people with MS was no higher than that associated with exercise training in healthy populations



# What about the increase in symptoms with exercise?

ORIGINAL ARTICLE

## Symptom Change With Exercise Is a Temporary Phenomenon for People With Multiple Sclerosis

*Robyn M. Smith, MHSc, Marion Adeney-Steel, GradDip, Gary Fulcher, PhD, Wendy A. Longley, MA*

BLUR



- ▶ Many people experience an increase in symptoms with exercise
- ▶ Most common are sensory, fatigue and visual disturbances
- ▶ Vast majority return to baseline within 30 minutes
- ▶ Very occasionally can be up to 24 hours

# STROKE / TIA

- ▶ S.S lead more sedentary lifestyles / de-conditioning
- ▶ Physical activity and exercise (aerobic and strength training) shown to be beneficial at all stages of recovery and helps management of risk factors.
- ▶ Brief statements recommending “Physical activity” included in NICE and RCP guidelines.
- ▶ Individualised prescriptions.

## AHA/ASA Scientific Statement

### Physical Activity and Exercise Recommendations for Stroke Survivors

A Statement for Healthcare Professionals From the American Heart Association/American Stroke Association

*The American Academy of Neurology affirms the value of this statement as an educational tool for neurologists.*

Sandra A. Billinger, PT, PhD, FAHA, Chair; Ross Arena, PT, PhD, FAHA, Co-Chair;  
Julie Bernhardt, PT, PhD; Janice J. Eng, BSc, PT/OT, PhD; Barry A. Franklin, PhD, FAHA;  
Cheryl Meston-Johnson, GTR; Marilyn MacKay-Lyons, BSc, MScPT, PhD;

Call the Stroke Helpline: 0303 3033 100  
or email: [info@stroke.org.uk](mailto:info@stroke.org.uk)

**Stroke**  
association

### Exercise and stroke

Even if your mobility is restricted after a stroke, it is likely you will be able to carry out some form of exercise to improve your overall wellbeing. This guide explains how exercise can improve your health, and suggests types of exercise and resources to help you to be more active.

**Table. Summary of Exercise/Physical Activity Recommendations for Stroke Survivors**

Setting/Mode of Exercise	Goals/Objectives	Prescriptive Guidelines: Frequency/Intensity/Time
Hospitalization and early convalescence (acute phase) <ul style="list-style-type: none"> <li>• Low-level walking, self-care activities</li> <li>• Intermittent sitting or standing</li> <li>• Seated activities</li> <li>• Range of motion activities, motor challenges</li> </ul>	<ul style="list-style-type: none"> <li>• Prevent deconditioning, hypostatic pneumonia, orthostatic intolerance, and depression</li> <li>• Evaluate cognitive and motor deficits</li> <li>• Stimulate balance and coordination</li> </ul>	<ul style="list-style-type: none"> <li>• ~10- to 20-bpm increases in resting HR; RPE <math>\leq 11</math> (6–20 scale); frequency and duration as tolerated, using an interval or work-rest approach</li> </ul>
Inpatient and outpatient exercise therapy or "rehabilitation" <p><b>Aerobic</b></p> <ul style="list-style-type: none"> <li>• Large-muscle activities (eg, walking, graded walking, stationary cycle ergometry, arm ergometry, arm-leg ergometry, functional activities seated exercises, if appropriate)</li> </ul> <p><b>Muscular strength/endurance</b></p> <ul style="list-style-type: none"> <li>• Resistance training of U/L extremities, trunk using free weights, weight-bearing or partial weight-bearing activities, elastic bands, spring coils, pulleys</li> <li>• Circuit training</li> <li>• Functional mobility</li> </ul> <p><b>Flexibility</b></p> <ul style="list-style-type: none"> <li>• Stretching (trunk, upper and lower extremities)</li> </ul> <p><b>Neuromuscular</b></p> <ul style="list-style-type: none"> <li>• Balance and coordination activities</li> <li>• Tai chi</li> <li>• Yoga</li> <li>• Recreational activities using paddles/sport balls to challenge hand-eye coordination</li> <li>• Active-play video gaming and interactive computer games</li> </ul>	<ul style="list-style-type: none"> <li>• Increase walking speed and efficiency</li> <li>• Improve exercise tolerance (functional capacity)</li> <li>• Increase independence in ADLs</li> <li>• Reduce motor impairment and improve cognition</li> <li>• Improve vascular health and induce other cardioprotective benefits (eg, vasomotor reactivity, decrease risk factor)</li> <li>• Increase muscle strength and endurance</li> <li>• Increase ability to perform leisure-time and occupational activities and ADLs</li> <li>• Reduce cardiac demands (ie, RPP) during lifting or carrying objects by increasing muscular strength, thereby decreasing the % MVC that a given load now represents</li> <li>• Increase ROM of involved segments</li> <li>• Prevent contractures</li> <li>• Decrease risk of injury</li> <li>• Increase ADLs</li> <li>• Improve balance, skill reacquisition, quality of life, and mobility</li> <li>• Decrease fear of falling</li> <li>• Improve level of safety during ADLs</li> </ul>	<ul style="list-style-type: none"> <li>• 40%–70% <math>\dot{V}O_2</math> reserve or HR reserve; 55%–80% HR max; RPE 11–14 (6–20 scale)</li> <li>• 3–5 d/wk</li> <li>• 20–60 min/session (or multiple 10-min sessions)</li> <li>• 5–10 min of warm-up and cool-down activities</li> <li>• Complement with pedometers to increase lifestyle physical activity</li> <li>• 1–3 sets of 10–15 repetitions of 8–10 exercises involving the major muscle groups at 50%–80% of 1RM</li> <li>• 2–3 d/wk</li> <li>• Resistance gradually increased over time as tolerance permits</li> <li>• Static stretches: hold for 10–30 s</li> <li>• 2–3 d/wk (before or after aerobic or strength training)</li> <li>• Use as a complement to aerobic, muscular strength/endurance training, and stretching activities</li> <li>• 2–3 d/wk</li> </ul>

1RM indicates 1 repetition maximum; ADLs, activities of daily living; HR, heart rate; MVC, maximal voluntary contraction; ROM, range of motion; RPE, rating of perceived exertion (6–20 category scale); RPP, rate-pressure product; U/L, upper/lower; and  $\dot{V}O_2$ , oxygen uptake.

Modified with permission from Gordon et al.<sup>124</sup> Copyright © 2004, American Heart Association, Inc.



# Recent Research: UKSF 2018 posters

- ▶ In Sheffield –2 workshops of 15-20 people exploring barriers: Deficient access to information, lack of accessibility support, lack of infrastructure (transport, technology, finances).
- ▶ ESD team - 57% ESD population returned questionnaire, 62% of these were achieving National exercise Guidelines. Those that weren't identified specific individual barriers (Pain 13%, tiredness 7%, motivation 7%).
- ▶ Non-ambulatory stroke survivors (14 interviewed in Scotland) expressed need for supervised, bespoke PA programme. Low confidence/self-esteem an agreed barrier in this sample.

# Parkinson's Disease (PD)

*Neurodegenerative disease, estimated at 2800 per 100,000.*

*Cardinal symptoms – tremor, bradykinesia, rigidity, postural instability.*

- 106 papers examining PA in pwPD from 1981-2015, 868 outcome measures.
- Most effective in improving “Physical Capacity (strength, mobility, balance, motor control, flexibility)”, “physical and cognitive functional capacities (ADLs, level of activity)”.
- Least effective (<50%) and greater variability in improving “Clinical Symptoms of PD (UDPRS)” and “psychosocial aspects of life”.
- Not enough quality research exploring cognitive functions and depression.

- Self-reported activity scores and examined associations with clinical characteristics in 383 PD subjects and 175 healthy controls in PPMI cohort.
- Activity scores 8% lower for PD subjects than healthy controls – males and younger people tended to have higher activity scores.
- Feasible to achieve AHA activity guidelines in early PD.
- Only 47% PD subjects achieved recommended PA levels.

Physical Activity assessment component of American Academy of Neurology (2015) and NICE (2017) Guidelines for Management of PD.

- *Patient's should be “counselled on importance of exercise” and “engage in any activity they are willing to perform”.*

## Parkinson's exercise framework

### Key messages for professionals to give the people they support

	Investing in exercise from diagnosis onwards	Staying active	Managing complex (physical) challenges
Focus	<p>Emerging evidence suggests that increasing exercise to 2.5 hours a week can slow the progression of Parkinson's symptoms, so:</p> <ul style="list-style-type: none"> <li>• seek referral to an informed professional to discuss exercise and its benefits, the individual's physical state and motivation</li> <li>• exposure to an exercise-focused lifestyle (that is sociable and fun), using family, friends or Parkinson's networks, supports regular exercise behaviour</li> <li>• if symptoms are mild, this is the optimal time to improve physical condition to remain well, prevent inactivity and the complications of sedentary behaviour (weight gain, heart disease and metabolic disorders such as diabetes and osteoporosis)</li> </ul>	<p>Keeping moving is important for people with Parkinson's, so:</p> <ul style="list-style-type: none"> <li>• stay as (or more) active than at diagnosis and increase exercise targeting Parkinson's-specific issues such as balance and doing two things at once (dual tasking)</li> <li>• continue to keep the progression of symptoms to a minimum by exercising both the body and the mind (especially for memory, attention, and learning)</li> <li>• use the positive effects of exercise to better manage non-motor symptoms such as mood and sleep</li> </ul>	<p>Movement, ability and motivation change over time, so:</p> <ul style="list-style-type: none"> <li>• pay attention to specific physical functions that focus on daily activities such as getting up out of a chair, turning or walking safely</li> <li>• continue to maintain general fitness for physical wellbeing, finding ways to make sure this is kept up</li> <li>• prevent discomfort related to postural changes</li> </ul>
Exercise style (bearing in mind fitness and any barriers to exercise such as travel or fatigue)	<p>Target postural control, balance, large movement (including twisting) and coordination through:</p> <ul style="list-style-type: none"> <li>• moderate and vigorous intensity exercise to get the best performance from the body. Best done 5 x week in 30 minute bouts (can be built over time)</li> <li>• progressive resistance exercise to build muscle strength and power. Best results if done 2 x week</li> <li>• Parkinson's-specific exercise prescribed by health professionals such as dual-tasking and stretching for flexibility. Best results if done 2 x week</li> </ul> <p>(Evidence from animal models that vigorous intensity exercise may have neuroprotective effects is in its infancy with humans, so more research is needed.)</p>	<p>Target flexibility (dynamic stretching), plus slower exercise to control postural muscles for balance through:</p> <ul style="list-style-type: none"> <li>• maintaining effortful exercise that pushes people according to their fitness levels</li> <li>• continuing resistance exercises</li> <li>• increasing balance exercises</li> <li>• increasing postural exercises</li> <li>• Parkinson's-specific review by health professionals</li> </ul>	<p>Target better movement through:</p> <ul style="list-style-type: none"> <li>• functional exercise (chair-based with the use of resistance bands)</li> <li>• supervised classes with a professional reviewing safety to perform exercise</li> <li>• home programmes to stay moving, avoid sedentary behaviour, reduce flexed position and the secondary effects of being less mobile</li> </ul>

## Parkinson's exercise framework

### Examples of exercise styles to focus on

	Investing in exercise from diagnosis onwards	Staying active	Managing complex (physical) challenges
Examples	<ul style="list-style-type: none"> <li>• Sport: racket sport, cycling, jogging, running and swimming</li> <li>• Leisure centre and other classes: aerobics, vigorous intensity training (such as boot camps with high level balance work), Nordic walking</li> <li>• Home DVDs or high intensity exergaming</li> <li>• Parkinson's-specific exercise such as PD Warrior, boxing training classes, the Parkinson's Wellness Recovery (PWR!) programme, some exercise classes run by the Parkinson's UK network</li> </ul>	<ul style="list-style-type: none"> <li>• Golf, bowling, (paired) dance, health walks, swimming</li> <li>• Flexibility with strength: tai chi, Pilates and yoga</li> <li>• Specific classes for people with Parkinson's such as LSVT BIG and balance and walking classes (run by the Parkinson's UK network)</li> </ul>	<ul style="list-style-type: none"> <li>• Specific classes for people with mobility and balance challenges, especially dance</li> <li>• Pedal exerciser</li> <li>• Resistance band workouts</li> <li>• Supervised balance and mobility challenge tasks</li> <li>• Seated exercise groups (some run by the Parkinson's UK network)</li> </ul>



People with Parkinson's can find more information on exercise and managing their symptoms at [parkinsons.org.uk/exercise](https://www.parkinsons.org.uk/exercise)

**PARKINSON'S<sup>UK</sup>**  
CHANGE ATTITUDES.  
FIND A CURE.  
JOIN US.

[https://www.parkinsons.org.uk/sites/default/files/2017-11/Parkinson%27s%20Exercise%20Framework%2010\\_2017.pdf](https://www.parkinsons.org.uk/sites/default/files/2017-11/Parkinson%27s%20Exercise%20Framework%2010_2017.pdf)



# Neuroprotective effects?

- ▶ Exercising did not affect the amount of dopamine in the brain, but showed the brain cells were using dopamine more efficiently in exercise group.
- ▶ Exercise improves efficiency by modifying the substantia nigra and basal ganglia.
- ▶ Exercise induces and increases the beneficial neurotrophic factors, particularly GDNF (glial-derived neurotrophic factor), which reduces the vulnerability of dopamine neurons to damage.
- ▶ Prolongs dopamine within synapses so signal lasts longer and increased places for dopamine to bind (D2 receptors)

How do we get in early and encourage the importance?

# Neuromuscular Disorders

*What are the main neuromuscular disorders you typically treat?*

- ▶ Main Presenting problems?

Primary Muscle weakness, atrophy, Secondary muscle weakness and/or sensory disturbance, neuropathic pain.

~70% of people with CMT, myotonic dystrophy and FSHD report severe fatigue (Kalkman et al 2005)

- ▶ People with NMDs traditionally told not to exercise: Concerns about worsening the condition and more recently about eccentric exercise

**Exercise for people with peripheral neuropathy (Review)**

White CM, Pritchard J, Turner-Stokes L

**Therapeutic exercise for people with amyotrophic lateral sclerosis or motor neuron disease (Review)**

Dal Bello-Haas V, Florence JM, Krivickas LS

**Strength training and aerobic exercise training for muscle disease (Review)**

Voet NBM, van der Kooi EL, Riphagen II, Lindeman E,  
van Engelen BGM, Geurts ACH





- Exercise in NMDs is safe
- **May** be beneficial: early positive results
- **May** be a difference in response between conditions
- Carry over into function of more traditional training?
- **May** be less able to strengthen weaker muscles

May/may not improve strength function  
health and well being effects must be  
considered to reduce other risk factors  
Not enough evidence yet to ascertain if high  
intensity eccentric contractions are safe  
Little guidance on optimal dosage  
More research required!

# Balance & Flexibility?

Do we/our patients typically think of this as exercise /physical activity?

How do we make sure all aspects are covered without at least 4 pages of exercises?

? Tai-chi / Multi-sensory balance training / Yoga / Community walking groups

Hopefully many things we prescribe / suggest cover more than one area of exercise.

Any thoughts?

# Things to consider...

- ▶ Evidence shows that often p.w. NC work much harder (energy expenditure) during walking and other tasks due to impairments.

Do we consider this when prescribing exercise/physical activity dose?

What is our role?

Education, goal setting, prescription, sign-posting to local services

- ▶ Key differences in long term N.C vs single event recovery





**What tends to be the biggest difficulties engaging p.w. NC in physical activity / exercise?**

# Barriers (Patient)

- ▶ Safety – big concern
- ▶ Fear of injury /worsening condition / not doing it right
- ▶ Access
- ▶ Lack of information and advice
- ▶ Lack of support
- ▶ Lack of on-going, maintenance PT
  
- ▶ Symptoms – Pain, fatigue, weakness





# Barriers (Physio)



CITY UNIVERSITY  
LONDON

## Engaging people with neurological conditions in Physical Activity (PA): An exploration of physiotherapists' perspectives and current practice

Rhiannon Stokes<sup>1</sup>, Kathleen Mulligan<sup>2</sup>, Shashi Hirani<sup>3</sup>

<sup>1</sup>Specialist Physiotherapist, The National Hospital for Neurology and Neurosurgery, rhiannon.stokes@cnh.nhs.uk; <sup>2</sup>Senior Research Fellow, School of Health Sciences, City University, London; <sup>3</sup>Senior Lecturer, School of Health Sciences, City University, London

Limited evidence exploring what physiotherapists do and if they regularly engage people with neurological conditions in physical activity.

**Study aim: to explore physiotherapists' perspectives and current practise in engaging people with neurological conditions in PA.**

- **Convenience sampling:** Members of the Association of Chartered Physiotherapists interested in Neurology (ACPIN) and professional contacts
- Theoretical Domains Framework (TDF) used to guide both methods. The TDF is constructed of domains identified to explain behaviour and has been used to help understand factors that influence delivery of healthcare

### Semi-structured interviews (n=14)

- Recruited via email sent by ACPIN to members or to professional contacts
- Topic guide developed from previous study using TDF<sup>7</sup>
- Followed TDF during content-analysis and construct belief statements

### Online survey (n=92)

- Recruited via email sent by ACPIN to members only
- Primary outcome measure developed to determine the behaviour
- Used Determinant of Implementation Behaviours Questionnaire (DIBQ) developed in 2014 using TDF<sup>8</sup>
- Correlations and multiple regression analysis

### TDF 14 Domains

Knowledge  
Skills  
Social/professional role and identity  
Beliefs about capabilities  
Optimism  
Beliefs about consequences  
Reinforcement  
Intentions  
Goals  
Memory  
Attention and Decision making processes  
Environmental Context and Resources  
Social Influences  
Emotions  
Behavioural Regulation<sup>6</sup>

# Rhiannon's MRes Main Findings

- PT agree that engaging p.w.NC in PA = key part of PT role.
- Main PT goal: facilitate self-directed PA and improve patients' self-management of their condition.
- 80% participated in discussions about PA, less set goals, addressed barriers and monitored progress.
- Main barriers - time restrictions, organisational issues within the NHS and their workplace, reduced funding and staffing, the patients' lack of motivation and their own barriers.
- Facilitators - teamwork, local non-NHS resources, patients who are motivated and have a good support network and access to facilities.



*How do you promote Physical Activity and Exercise in people with Neuro Conditions?*

# Other key references:

Jurkiewicz et al (2015) Adherence to a home-based exercise program for individuals after stroke. *Topics in Stroke Rehabilitation* 8(2011): 277-284

Tiedemann et al (2012) Predictors of adherence to a structured exercise program and physical activity participation in community dwellers after stroke. *Stroke Research and Treatment* Article ID 136525

McAuley et al, (2007) Enhancing physical activity adherence and well-being in multiple sclerosis: a randomised controlled trial *Multiple Sclerosis Journal* 13(5):652-659

Heath, G.W., Parra, D.C., Sarmiento, O.L., Andersen, L.B., Owen, N., Goenka, S., Montes, F., Brownson, R.C. (2012) 'Evidence-based intervention in physical activity: lessons from around the world', *The Lancet*, 380, pp. 272-281.

Lauze, M, Daneault, JF, and Duval, C. (2016) *The effects of Physical Activity in Parkinson's Disease: A review, Journal of Parkinson's Disease*, 6(4): 685-698

Morris, J.H., Oliver, T., Kroll, T., Joice, S., Williams, B. (2014) 'From physical and functional to continuity with pre-stroke self and participation in valued activities: A qualitative exploration of stroke survivors', carers' and physiotherapists' perceptions of physical activity after stroke' *Disability Rehabilitation*, Early Online, pp. 1-14.

Mulligan, H., Fjellman-Wiklund, A., Hale, L., Thomas, D., Hääger-Ross, C. (2011) 'Promoting physical activity for people with neurological disability: Perspectives and experiences of physiotherapists', *Physiotherapy Theory & Practice*, 27, pp. 399-410.

Doyle, L., Mackay-Lyons, M., (2013) 'Utilization of aerobic exercise in adult neurological rehabilitation by physical therapists in Canada', *Journal of Neurological Physical Therapy*, 37, pp. 20-26.

<https://parkinson.org/Understanding-Parkinsons/Treatment/Exercise/Neuroprotective-Benefits-of-Exercise>