‘Pilates’ based core stability training as rehabilitation for people with MS

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Multiple Sclerosis (MS)

- MS is one of the most prevalent causes of neurological disability affecting young adults in the UK.

- MS is an auto-immune disease affecting the central nervous system, causing widespread demyelination and axonal injury.
Balance and mobility impairments

- Gait and balance impaired early (EDSS <2.5) (Martin 2006)
- 65%–85% report difficulty walking (Salter 2010)
- Mobility is consistently ranked the most important issue (Heesen 2008)
- Decreased balance associated with falls (Sosnoff et al 2011)
- Trunk stability is reduced (Lanzetta et al 2004)

Consequences of balance and mobility impairments

- Falls risk increases with declining mobility (Sosnoff et al. 2011; Matsuda et al. 2012)
- Avoidance of activities of daily living (Yildiz, 2012)
- Economic burden to people with MS (Pake et al. 2012)
- Functional limitations have been correlated with reduced ‘Quality of Life’ in people with MS (Stuifbergen et al. 2006)

Management of these problems is a clinical priority
“Interventions to improve mobility could have significant benefits for MS patients and society as a whole”


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**Pilates**

- Invented by ‘Joseph Pilates’ in WW1
- Based loosely on tai chi, yoga, gymnastics
- Pilates gained popularity in New York dance studios
- Modified/ clinical Pilates now used commonly in clinical practice

Joseph Pilates
Source: www.everything-about-pilates.com
Principles of Pilates

- Concentration
- Control of movement
- Fluidity of movement
- Combining movement and breathing
- Intuition

Pilates was not intended as a clinical intervention
Pilates was not intended as a clinical intervention

The ligamentous spine is inherently unstable and dependent on neural control of muscles to apply forces in order to stabilise the spinal column.

(Panjabi, 1992)

Concept of core stability
The deep abdominal muscles

Internal Oblique (IO)

Transversus Abdominus
(TrAb or Trans Abs)

Trunk stability in neuro-physiotherapy

The creation of trunk, or “core” stability, and the resulting ability to isolate the activity in the limbs from that in the trunk, has been a central tenet of the Bobath Concept throughout its evolution

*(Bobath 1969)*
Therapeutic exercise to improve core stability

It is proposed that:

To improve the stability of the spine, abdominal muscle exercises can be employed......

Drawing the navel to the spine (clinical Pilates method)
1) increases Transversus Abdominis muscle activity
2) increases intra- abdominal pressure
3) increases activity of Internal Oblique

(Urquhart et al. 2005)

Retraining transversus leads to functional improvements
Ultrasound imaging: abdominal wall

Pilates and core stability training for improving balance and mobility

Core muscles make up the main musculature of the trunk.

Due to the influence of the trunk on balance Pilates core stability training may influence balance and consequent mobility?
## Evaluation of the evidence

<table>
<thead>
<tr>
<th>Author</th>
<th>Type of review and population</th>
<th>Authors Conclusions</th>
</tr>
</thead>
</table>
| Cruz-Ferreira et al. (2011) | Systematic review of healthy population. | Strong evidence that Pilates increases flexibility, dynamic balance and lumbar stabilisation.  
No evidence for postural alignment, strength and static balance. |
| Granacher et al. (2013)  | Systematic review assessing the effects of Pilates and core stability training upon the trunk muscle strength, balance and falls of seniors. | Pilates and/or core stability training can be used as an adjunct or even an alternative to traditional balance and/or resistance programmes for older adults. |

## Pilates for people with MS

<table>
<thead>
<tr>
<th>Author</th>
<th>Type of study</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeman et al. (2010)</td>
<td>Multicentre series of case studies (pilot work for main study). (MS)</td>
<td>The study provides preliminary evidence for the effectiveness of 8 weeks of core stability training for improving balance and mobility in ambulant people with MS.</td>
</tr>
<tr>
<td>Guclu-Gunduz et al. (2013)</td>
<td>RCT (MS)</td>
<td>An 8 week Pilates programme was effective at improving balance, mobility and strength in people with MS.</td>
</tr>
<tr>
<td>van der Linden et al. (2013)</td>
<td>Feasibility study (MS)</td>
<td>Pilates appears to be efficacious in improving sitting stability and posture and decreasing pain and is well tolerated.</td>
</tr>
<tr>
<td>Marandi et al. (2013)</td>
<td>Three arm trial (MS)</td>
<td>Both types of exercise had positive effect on dynamic balance but there were no significant differences between the two types of exercises.</td>
</tr>
<tr>
<td>Shea &amp; Moriello (2013)</td>
<td>Feasibility study (stroke)</td>
<td>It is feasible to complete a programme of Pilates in conjunction with traditional rehabilitation and that is was possible to modify classical Pilates.</td>
</tr>
</tbody>
</table>
Pilot work

- Freeman et al (2010) with the UK ‘Therapists in MS’ group
- A series of 8 single case studies
- Preliminary evidence of effectiveness

The effects of ‘Pilates’ based core stability training in ambulant people with Multiple Sclerosis: A multi-centre, randomised, assessor-blinded, placebo controlled trial.
Objectives

• Compare the effectiveness of Pilates against placebo control

• Compare the effectiveness of a standardised physiotherapy exercise programme against placebo control

Secondary objective

• Compare Pilates with standardised physiotherapy exercise

• Explore the underlying mechanisms of change by performing ultrasonography of the deep abdominal muscles

Methodology

• Multi-centre (n= 100, seven UK centres)

• Block randomised to:
  Pilates
  Standardised exercise
  Placebo control (relaxation)

• Blinded assessment
## Inclusion/Exclusion Criteria

**Inclusion**
- Definite diagnosis of MS
- 18 years +
- EDSS 4-6.5

**Exclusion**
- In relapse or relapse in previous 3 months
- Medical conditions contra-indication core stability exercises
- Score of less than 6 on abbreviated mental test
- Involvement in any other interventional study
- Participation in Pilates or core stability exercises
Outcome Measures

Primary clinical outcome measure
• 10 metre timed walk

Secondary outcome measures
• Walking velocity
• MS walking scale (MSWS-12)
• Functional reach (forwards and lateral)
• Activities-specific balance confidence (ABC) Scale
• 10 point visual analogue scale “difficulty in carrying a drink when walking”

Exploratory Ultrasound

• Ultrasound imaging of the abdominal muscles will be performed before and after intervention to assess changes in abdominal musculature at one of centers.
Reliability of measuring core stability

- Reliability of measuring core stability is poor
  (Weir et al., 2010)

- Only moderate reliability for palpation and pressure biofeedback
  (Oliveira and Costa, 2006)

Recommendation for research: US imaging

Validity and reliability of US: measuring abdominal activity

Validity
EMG and MRI activity of TrAb and IO activity correlated in:
- healthy (Hides et al. 2006)
- stroke (Hough et al. 2009)

Reliability
High inter and intra rater
(Costa et al. 2009, Ferreira et al., 2011)
I've reduced to one slide all validity and reliability slides.

JF15

j1freeman, 9/20/2012
Ultrasound images (video clips)

• Active straight leg raise

clip
make relevant to MS - oft used ex
j1freeman, 9/20/2012
Comparison with matched controls

• Age, weight and height healthy subjects recruited to act as matched controls for ultrasound scans (first occasion).

Interventions

• Pilates based core stability training based on pilot work by Freeman et al (2010)

• Standardised physiotherapy exercises (Barrett et al 2009)

• Placebo control (relaxation)

• All received 30 minute, face to face training sessions over a 12 week period; together with a 15 minute daily home programme

Analysis

- Last observation carried forward was used to impute data from people lost to follow up (relapses excluded)
- Independent t-tests to compare groups using SPSS

Sample Characteristics (n=100)

<table>
<thead>
<tr>
<th>Demographic information</th>
<th>Description</th>
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<tbody>
<tr>
<td>Mean age</td>
<td>54.1 years (sd 10.1, range 31-77)</td>
</tr>
<tr>
<td>Gender %</td>
<td>74% female, 26% male</td>
</tr>
<tr>
<td>MS type</td>
<td>Relapse remitting 38%</td>
</tr>
<tr>
<td></td>
<td>Primary progressive 30%</td>
</tr>
<tr>
<td></td>
<td>Secondary Progressive 31%</td>
</tr>
<tr>
<td></td>
<td>Benign 1%</td>
</tr>
<tr>
<td>Mean years since diagnosis</td>
<td>13.1 years (sd 10.5, range 0-42)</td>
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### Results:
**Pilates vs. Relaxation control**

<table>
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<tr>
<th>Outcome measure</th>
<th>Percentage change of Pilates group</th>
<th>Significance</th>
<th>95% Confidence intervals</th>
<th>Effect Size</th>
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<tr>
<td>10mtw</td>
<td>9.35%</td>
<td>p=0.32</td>
<td>-0.67 to 2.75</td>
<td>0.22</td>
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<tr>
<td>Walking velocity</td>
<td>15.90%</td>
<td>p=0.04</td>
<td>-0.01 to 0.16</td>
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<td>MSWS-12</td>
<td>10.26%</td>
<td>p=0.12</td>
<td>-1.72 to 13.27</td>
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<td>Functional reach forward</td>
<td>19.99%</td>
<td>p=0.04</td>
<td>0.11 to 6.11</td>
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<tr>
<td>Functional reach lateral</td>
<td>19.11%</td>
<td>p=0.04</td>
<td>0.02 to 5.77</td>
<td>0.36</td>
</tr>
<tr>
<td>ABC scale</td>
<td>10.26%</td>
<td>p=0.06</td>
<td>-0.03 to 1.2</td>
<td>0.43</td>
</tr>
<tr>
<td>Difficulty carrying a drink</td>
<td>1.71%</td>
<td>p=0.29</td>
<td>-0.51 to 1.67</td>
<td>0.31</td>
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The changes did not remain at 16 week follow up for the Pilates group.

### Results:
**Pilates core stability training vs. Relaxation control**

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### Results:
**Standardised exercise vs. Relaxation control**

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<th>Outcome measure</th>
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<th>95% Confidence intervals</th>
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</tr>
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<tr>
<td>10mtw</td>
<td>15.46%</td>
<td>p=0.05</td>
<td>-0.05 to 2.9</td>
<td>0.42</td>
</tr>
<tr>
<td>Walking velocity</td>
<td>21.66%</td>
<td>p&lt; 0.01</td>
<td>0.08 to 0.23</td>
<td>0.63</td>
</tr>
<tr>
<td>MSWS-12</td>
<td>26.71%</td>
<td>p&lt; 0.01</td>
<td>2.99 to 15.92</td>
<td></td>
</tr>
<tr>
<td>Functional reach forward</td>
<td>21.51%</td>
<td>p=0.02</td>
<td>0.76 to 8.15</td>
<td>0.50</td>
</tr>
<tr>
<td>Functional reach lateral</td>
<td>31.15%</td>
<td>p&lt;0.01</td>
<td>1.57 to 7.23</td>
<td>0.67</td>
</tr>
<tr>
<td>ABC scale</td>
<td>26.71%</td>
<td>p&lt; 0.01</td>
<td>0.34 to 1.58</td>
<td>0.51</td>
</tr>
<tr>
<td>Difficulty carrying drink</td>
<td>-7.66%</td>
<td>p=0.46</td>
<td>-0.01 to 1.33</td>
<td>0.17</td>
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</table>

Changes remained at 16 weeks with the exception of forward functional reach.
Comparison with drug data

• 21.7% increase in walking speed after 12 weeks standardised exercise

• 25.2% increase in walking speed with 14 weeks of oral fampridine (Goodman et al, 2009)

• 20% increase in walking speed considered to be clinically significant (Kragt et al, 2006)

Results: Pilates vs. Standardised exercise

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<td>p=0.32</td>
<td>-11.07 to 3.70</td>
</tr>
<tr>
<td>Functional reach forward</td>
<td>p=0.37</td>
<td>-4.29 to 1.61</td>
</tr>
<tr>
<td>Functional reach lateral</td>
<td>p=0.28</td>
<td>-4.04 to 1.19</td>
</tr>
<tr>
<td>ABC scale</td>
<td>p=0.25</td>
<td>-1.02 to 0.27</td>
</tr>
<tr>
<td>Difficulty carrying a drink</td>
<td>p=0.69</td>
<td>-0.86 to 1.29</td>
</tr>
</tbody>
</table>

Note: the study was not adequately powered to detect change between groups
### Results of ultrasound imaging

<table>
<thead>
<tr>
<th>Matched Controls</th>
<th>USI over time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting thickness of TrAb was thinner in people with MS than matched controls (p&lt;0.05).</td>
<td>TrAb or IO at rest or activation were not affected by either a 16 weeks of Pilates, a standardised exercises or control.</td>
</tr>
<tr>
<td></td>
<td>Type 2 error is possible due to the small sample size (n=15, 5 in each group).</td>
</tr>
</tbody>
</table>

### Adherence to exercise

**Attendance at therapy sessions:**
- 66% Pilates
- 84% Standard Exercise
- 92% for Relaxation

**Adherence to home exercises:**
- 80% Pilates
- 78% Standard Exercises
- 91% Relaxation
# Adherence to exercise

<table>
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<th>Attendance at therapy sessions:</th>
<th>Adherence to home exercises:</th>
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<td>• 92% for Relaxation</td>
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## Discussion and clinical message

- Task specific training in the standard exercise group could have accounted for improvements made.

- Pilates develops proximal muscles, people with MS may have foot drop due to distal demyelination.

- In clinical practice therapists use combined interventions (FES, orthotics, balance training, strength training and core stability exercise).

- Enjoyment of Pilates expressed by people with MS (van der Linden, 2013).
Discussion and clinical message

- **Pilates** exercises improved clinician rated measures of balance and walking velocity; these changes were small and not retained at 4 weeks follow up.

- **Standardised physiotherapy exercises** improved both clinician rated and patient reported balance and mobility measures. These changes were evident for 4 weeks after the therapist contact time had ceased.

- Patients improved with both exercise interventions, but the standardised exercises produced a larger magnitude of change and affected a broader range of measures.

Acknowledgements

- With many thanks to the MS Trust for funding the trial
- People who gave up time to participate in the trial.
- Special thanks to Physiotherapists working at the recruiting centres:
  - Paula Cowan (Kenilworth Medical Centre, Cumbernauld, Glasgow,
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  - Melissa King, The Merlin Centre, Cornwall,
  - Ruth Neville, Plymouth University
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