Supplemental Material

Martinková P, Freeman J, Drabinová A, et al.: Physiotherapeutic interventions in multiple sclerosis across Europe: regions and other factors that matter

In this Supplemental Material, some additional tables and figures are presented and sample R code is provided. R code was prepared and tested using free statistical software R version 3.4.3 (R Core Team, 2017).

Contents

Supplemental Table 1: Vocabulary of PT interventions provided to survey respondents.

Intervention short name	Interventions as offered to respondents	Description offered to respondents†
Aerobic	Aerobic training, conditioning exercises	Physical exercise of relatively low intensity that depends primarily on the aerobic energy-generating process and enhances or maintains physical fitness and overall health and wellness.
Breathing	Breathing exercise, e.g. expiratory muscle training, respiratory muscle training	Respiratory muscle training (resistive training, pressure threshold loading, and normocapnic hyperpnea).
Strengthening	Strengthening, resistance training	Exercise (very often with resistance) to induce muscular contraction, which builds the strength, anaerobic endurance, and size of skeletal muscles.
Stretching	Muscle stretching	Physical exercise in which a specific muscle or tendon (or muscle group) is deliberately flexed or stretched in order to improve the muscle's elasticity and achieve comfortable muscle tone.
Balance	Balance training (static, dynamic), postural awareness	Activities to maintain or improve your balance system (e.g. slackline, rail balance, weightlifting, hand balancing, balance board, BOSU® balls).
Transfer	Training for transfers and ambulatory abilities	No description was offered.
Daily	Training for other activities of daily living	No description was offered.
Dual	Dual tasking	A procedure (or exercise) that requires an individual to perform two tasks simultaneously.
Orthotics	Biomechanical approaches (e.g. hip flexion assistance device, ankle foot orthosis)	The approach uses the relationship between musculoskeletal function and how the body is designed for and used.
Biofeedback	Modality intervention, e.g. biofeedback, functional electrical stimulation, pulse magnetic field therapy, TENS	No description was offered.
Cryotherapy	Cryotherapy (local or general)	Local or general use of low temperatures.
Heat	Heat therapy	Also called thermotherapy, is the application of heat to the body for pain relief and health. It can take the form of a hot cloth, hot water, heating pad, hydrocollator packs, whirlpool baths, heat therapy wrap, and many others.
Self-care	Professionally guided self-care, lifestyle changes, coping skills, education of patients or carers	An application of environmental, behavioral, medical and motivational principles to the management of lifestyle-related health problems in a clinical setting.
Fatigue	Fatigue management program, energy conservation on fatigue	Advice and information about issues such as the value of rest, budgeting and banking energy, incorporating rest periods throughout the day, learning to communicate personal needs to others,

		using good body mechanics and posture, etc.
Pain	Pain control	Learning to deal with pain, release muscle tension throughout the body and remove attention from the pain.
Cognitive	Cognitive, visual and sensory perceptual training	Cognitive training involves completing a variety of exercises specifically designed to improve cognitive functioning in areas such as sustained attention, thinking before acting, visual and auditory processing, listening and reading. Vision therapy, also known as vision training, is used to improve vision skills such as eye movement control, eye focusing and coordination, and the teamwork of the two eyes. Perceptual learning is the process of learning improved skills of perception. These improvements range from simple sensory discriminations (e.g. knowing where you are being touched) to complex categorizations of spatial and temporal patterns relevant to real-world expertise (e.g. moving).
Stimulation	Sensory stimulation	Activities that challenge or make use of the senses (touch, taste, smell, listening, and visual) in one's learning.
Vojta	Vojta reflex locomotion	Applying external stimuli at specific zones to activate reflex creeping or reflex turning patterns, in order to provoke a defined movement response that is ideal and already genetically encoded.
Brunnstrom	Brunnstrom approach	Using reflexes to develop movement behavior through sensory stimulation, in order to inhibit spasticity, and promote movement retraining to enhance recovery.
Bobath	Bobath concept	Concept also known as 'neuro-developmental treatment' has main goal to promote motor learning for efficient motor control in various environments, thereby improving participation and function. This is done through specific patient handling skills to guide patients through initiation and completion of intended tasks.
PNF	Proprioceptive neuromuscular facilitation	A method developed by neurophysiologist Herman Kabat that uses natural movement patterns to maximize muscle flexibility (involves a series of contractions and relaxations with enforced stretching during the relaxation phase).
Perfetti	Perfetti approach	A sensory motor technique based on tactile recognition from passive exploration to active manipulation (relative preservation of cognition is needed).
Motor learning	Motor learning program	Using principles of motor learning resulting from practice or a novel experience, in the capability for responding. It often involves improving the smoothness and accuracy of movements and is necessary for complicated movements, as parameters of the body and environment change over time.
Brügger	Brügger concept	Alter postural and motion patterns, which are understood as a protection of the organism. These patterns need to be changed into physiological motion patterns, particularly based on the

		reduction of the so-called intruding factors, which were identified and evaluated during the process of diagnosis, together with the specification of their stratification.
Frenkel	Frenkel's exercise	A system of slow repetitious exercises of increasing difficulty developed to treat ataxia.
Feldenkrais	Feldenkrais method	Aims to reduce pain or limitations in movement, to improve physical function, and to promote general wellbeing by increasing individual's awareness of themselves and by expanding movement repertoire.
Conductive	Conductive education programme	So called Petö concept is based on the premise that a person who has a motor disorder may not only have a medical condition requiring treatment, but may often have a major problem in learning that requires special education.
Constraint	Constraint-induced movement therapy	Is a form of rehabilitation therapy that improves upper extremity function by forcing the use of their affected upper limb by constraining the stronger arm.
Rood	Rood's approach	Has these goals and basic principles: normalize muscle tone; treatment begins at the developmental level of functioning; movements is directed toward functional goals and repetition is necessary for the re-education of muscular response.
Pelvic	Pelvic floor exercise	Consists of repeatedly contracting and relaxing the muscles that form part of the pelvic floor, now sometimes colloquially referred to as the 'Kegel muscles'.
Hippotherapy	Hippotherapy	Uses the characteristic movements of a horse to provide carefully graded motor and sensory input.
Aquatherapy	Aquatherapy	Also referred to as aquatic therapy or pool therapy - physical therapy that is performed in the water.
Nordic	Nordic walking	The activity performed with specially designed walking poles similar to ski poles.
Music	Music therapy, dance therapy	Uses physical, emotional, mental, social, aesthetic, and spiritual strength of music and dancing to help clients to improve or maintain their health.
Manual	Manual therapy	Treatment primarily used on the neuromusculoskeletal system, includes kneading and manipulation of muscles, joint mobilization and joint manipulation. Mobilisation indicates passive movements facilitated by the therapist or self-assisted movements by the patient, used to modify abnormal tone and/or to improve alignment. These movements are not active but passive or self-assisted.
Proprioneuro	Proprioneuro-physiolgical methods	The post-isometric relaxation technique begins by placing the muscle in a stretched position. Then an isometric contraction is exerted against minimal resistance. Relaxation and then gentle stretch follow as the muscle releases. Soft tissue technique is a manual therapy technique directed towards muscles and fascia throughout the body.

Mechanotherapy	Mechanotherapy	No description was offered.
Relaxation	Relaxation techniques	Is any method, process, procedure, or activity that helps a person to relax; to attain a state of increased calmness; or otherwise reduce levels of anxiety, stress or anger.
Oriental	Oriental methods	No description was offered.
Robotic	Robotic-assisted rehabilitation therapy (e.g. Lokomat®, Armeo®)	Lokomat® is a driven gait robot that automates locomotion therapy on a treadmill and improves the efficiency of treadmill training. The Armeo® is an ergonomically designed arm robot. Its key features are arm weight support, augmented feedback, and assessment tools.
Gaming technology	Sensor assisted rehabilitation (e.g. Wii, Kinect)	The Wii Balance Board is a balance board accessory for the Wii video game console. Kinect is a motion sensing input device for video games console.
Treadmill	Devices for walking (e.g. Treadmill, Body weight support system)	A treadmill is a device for walking or running while staying in the same place. Body weight support system provides stability during locomotion and helps progress weight bearing according to a patient's needs.
Balance platform	Devices for proprioceptive posture therapy (e.g. 3D Spacecurl, POSTUROMED®, vibration platform)	The POSTUROMED® device which uses movable and adjustable unstable therapy plates to improve balance.
Simple	Simple devices (e.g. kinesio-tape, overball, mirror, thera-band, splints, standing frame)	No description was offered.
Pharmacotherapy	Pharmacotherapy combined with therapy	No description was offered.

† Information available to respondents when completing the questionnaire. List of PT interventions was developed by a core group of professionals, all of whom were members of a European wide Special Interest Group in Multiple Sclerosis Mobility (see http://www.eurims.org/SIG-Mobility/sig-mobility-about-us.html).

Supplemental Table 2: Classification of PT interventions provided to survey respondents.

Intervention short name	PT interventions classification		
	Initial categories*	Cluster categories+	Final categories°
Aerobic	1	PTI-E	1
Breathing	1	PTI-D	3
Strengthening	1	PTI-E	1
Stretching	1	PTI-B	3
Balance	3	PTI-D	3
Transfer	3	PTI-D	3
Daily	3	PTI-G	3
Dual	3	PTI-G	3
Orthotics	1	PTI-E	4
Biofeedback	4	PTI-E	4
Cryotherapy	4	PTI-B	2
Heat	4	PTI-B	2
Self-care	3	PTI-G	0
Fatigue	3	PTI-G	3
Pain	3	PTI-G	3
Cognitive	3	PTI-G	3
Stimulation	2	PTI-B	2
Vojta	2	PTI-A	2
Brunnstrom	2	PTI-B	2
Bobath	2	PTI-B	2
PNF	2	PTI-B	2
Perfetti	3	PTI-F	2
Motor learning	3	PTI-G	3
Brügger	3	PTI-B	2
Frenkel	3	PTI-B	3
Feldenkrais	3	PTI-A	3
Conductive	3	PTI-F	3
Constraint	3	PTI-F	3
Rood	2	PTI-F	2
Pelvic	1	PTI-G	3
Hippotherapy	4	PTI-C	1
Aquatherapy	4	PTI-C	1
Nordic	3	PTI-C	1
Music	3	PTI-C	1
Manual	1	PTI-A	2
Proprioneuro	2	PTI-A	2
Mechanotherapy	1	PTI-B	2
Relaxation	3	PTI-A	2
Oriental	2	PTI-C	1
Robotic	4	PTI-E	4
Gaming technology	4	PTI-E	4
Treadmill	4	PTI-E	4
Balance platform	4	PTI-B	4
Simple	4	PTI-B	0
Pharmacotherapy	4	PTI-E	0

* Based on expert consensus: 1 = Muscle re-education; 2 = Neuroproprioceptive facilitation; 3 = Task oriented approach; 4 = Use of special technology or environment.
+ Based on statistical analysis of usage by centers, see Figure 3 and 4.
° Informed by cluster analysis: 0 = Excluded from categorization, not a PT; 1 = Physical activity (fitness/endurance/resistance) training; 2 = Neuroproprioceptive 'facilitation/inhibition' techniques; 3 = Motor/skill acquisition (individualized therapy led intervention); 4 = Technology based interventions.

Supplemental Table 3: Regression model of number of PT interventions in centers.

Variables	Exp(Estimate)	Estimate	SE	Z-value	p-value
Intercept	16.45	2.80	0.12	23.47	**<0.01***
Number of respondents	1.05	0.05	0.01	3.89	**<0.01***
Female proportion	0.94	-0.06	0.06	-1.04	0.30
Size (baseline = Small)					
Intermediate	0.95	-0.05	0.05	-1.12	0.26
Large	0.93	-0.07	0.08	-0.92	0.36
MS ratio (baseline = General)					
Intermediate	1.00	0.00	0.08	0.03	0.97
Specialized	1.01	0.01	0.06	0.23	0.82
MS inpatient ratio (baseline = Outpatient)					
Balanced	1.07	0.06	0.05	1.26	0.21
Inpatient	1.04	0.04	0.06	0.64	0.52
Max years of practice (baseline = 0-2 years)					
3-10	1.07	0.07	0.09	0.79	0.43
>10	1.19	0.17	0.08	2.15	**0.03***
Max worktime with MS patients (baseline = 0-24%)					
25-49%	1.20	0.18	0.06	2.83	**<0.01***
50-74%	1.21	0.19	0.06	3.27	**<0.01***
75-100%	1.28	0.25	0.06	4.03	**<0.01***
Min education (baseline = PhD)					
Masters	1.22	0.20	0.09	2.13	**0.03***
Bachelor	1.17	0.16	0.10	1.63	0.10
Diploma specialist	1.17	0.16	0.09	1.69	**0.09**
Other education	1.31	0.27	0.11	2.40	**0.02***
Region (baseline = East)					
North	0.80	-0.23	0.07	-3.30	**<0.01***
South	0.89	-0.12	0.07	-1.73	**0.08**
West	0.90	-0.10	0.09	-1.20	0.23

P-values smaller than 0.1 (borderline significance) are bold. Significant factors (p-value < 0.05) are marked with an asterisk.

Supplemental Table 4: Use of PT interventions in center clusters+. PT interventions are ordered by number of centers which use it.

Interventions	Total (115 centers)	Cluster				p-value
		A (17 centers)	B (26 centers)	C (35 centers)	D (37 centers)	
Balance	113 (98.3%)	16 (94.1%)	26 (100.0%)	35 (100.0%)	36 (97.3%)	0.60
Transfer	112 (97.4%)	16 (94.1%)	25 (96.2%)	35 (100.0%)	36 (97.3%)	0.79
Stretching	109 (94.8%)	17 (100.0%)	26 (100.0%)	33 (94.3%)	33 (89.2%)	0.23
Aerobic	103 (89.6%)	16 (94.1%)	24 (92.3%)	31 (88.6%)	32 (86.5%)	0.86
Strengthening	101 (87.8%)	14 (82.4%)	22 (84.6%)	33 (94.3%)	32 (86.5%)	0.66
Self-care	99 (86.1%)	17 (100.0%)	20 (76.9%)	27 (77.1%)	35 (94.6%)	**0.04***
Fatigue	99 (86.1%)	15 (88.2%)	18 (69.2%)	30 (85.7%)	36 (97.3%)	**0.03***
Breathing	97 (84.3%)	16 (94.1%)	24 (92.3%)	28 (80.0%)	29 (78.4%)	0.33
Simple	97 (84.3%)	15 (88.2%)	25 (96.2%)	27 (77.1%)	30 (81.1%)	0.26
Pain	95 (82.6%)	17 (100.0%)	20 (76.9%)	28 (80.0%)	30 (81.1%)	0.30
Orthotics	93 (80.9%)	16 (94.1%)	18 (69.2%)	33 (94.3%)	26 (70.3%)	**0.03***
Relaxation	90 (78.3%)	17 (100.0%)	24 (92.3%)	21 (60.0%)	28 (75.7%)	**0.01***
Dual	87 (75.7%)	13 (76.5%)	16 (61.5%)	30 (85.7%)	28 (75.7%)	0.26
Cognitive	84 (73.0%)	12 (70.6%)	18 (69.2%)	30 (85.7%)	24 (64.9%)	0.30
Bobath	82 (71.3%)	16 (94.1%)	21 (80.8%)	29 (82.9%)	16 (43.2%)	**<0.01***
Daily	80 (69.6%)	14 (82.4%)	19 (73.1%)	21 (60.0%)	26 (70.3%)	0.48
PNF	79 (68.7%)	16 (94.1%)	25 (96.2%)	20 (57.1%)	18 (48.6%)	**<0.01***
Pelvic	77 (67.0%)	16 (94.1%)	23 (88.5%)	13 (37.1%)	25 (67.6%)	**<0.01***
Stimulation	76 (66.1%)	11 (64.7%)	23 (88.5%)	25 (71.4%)	17 (45.9%)	**0.01***
Proprioneuro	75 (65.2%)	14 (82.4%)	25 (96.2%)	18 (51.4%)	18 (48.6%)	**<0.01***
Motor learning	74 (64.3%)	15 (88.2%)	13 (50.0%)	23 (65.7%)	23 (62.2%)	0.13
Aquatherapy	66 (57.4%)	6 (35.3%)	17 (65.4%)	14 (40.0%)	29 (78.4%)	**<0.01***
Treadmill	64 (55.7%)	8 (47.1%)	14 (53.8%)	22 (62.9%)	20 (54.1%)	0.78
Manual	62 (53.9%)	13 (76.5%)	22 (84.6%)	12 (34.3%)	15 (40.5%)	**<0.01***
Biofeedback	60 (52.2%)	14 (82.4%)	16 (61.5%)	14 (40.0%)	16 (43.2%)	**0.03***
Pharmacotherapy	51 (44.3%)	9 (52.9%)	7 (26.9%)	20 (57.1%)	15 (40.5%)	0.15
Nordic	45 (39.1%)	7 (41.2%)	15 (57.7%)	1 (2.9%)	22 (59.5%)	**<0.01***
Oriental	44 (38.3%)	2 (11.8%)	13 (50.0%)	6 (17.1%)	23 (62.2%)	**<0.01***
Cryotherapy	38 (33.0%)	16 (94.1%)	10 (38.5%)	4 (11.4%)	8 (21.6%)	**<0.01***
Mechanotherapy	37 (32.2%)	12 (70.6%)	16 (61.5%)	5 (14.3%)	4 (10.8%)	**<0.01***
Frenkel	36 (31.3%)	17 (100.0%)	12 (46.2%)	4 (11.4%)	3 (8.1%)	**<0.01***
Gaming technology	34 (29.6%)	6 (35.3%)	5 (19.2%)	11 (31.4%)	12 (32.4%)	0.66
Balance platform	30 (26.1%)	5 (29.4%)	11 (42.3%)	4 (11.4%)	10 (27.0%)	**0.09**
Heat	29 (25.2%)	7 (41.2%)	15 (57.7%)	2 (5.7%)	5 (13.5%)	**<0.01***
Constraint	29 (25.2%)	9 (52.9%)	4 (15.4%)	6 (17.1%)	10 (27.0%)	**0.04***
Music	29 (25.2%)	4 (23.5%)	8 (30.8%)	3 (8.6%)	14 (37.8%)	**0.05**
Conductive	26 (22.6%)	11 (64.7%)	4 (15.4%)	2 (5.7%)	9 (24.3%)	**<0.01***
Robotic	21 (18.3%)	2 (11.8%)	10 (38.5%)	4 (11.4%)	5 (13.5%)	**0.04***
Perfetti	20 (17.4%)	4 (23.5%)	1 (3.8%)	5 (14.3%)	10 (27.0%)	0.13
Feldenkrais	20 (17.4%)	5 (29.4%)	4 (15.4%)	5 (14.3%)	6 (16.2%)	0.66
Vojta	19 (16.5%)	4 (23.5%)	9 (34.6%)	1 (2.9%)	5 (13.5%)	**0.02***
Hippotherapy	15 (13.0%)	0 (0.0%)	3 (11.5%)	0 (0.0%)	12 (32.4%)	**<0.01***
Brunnstrom	13 (11.3%)	6 (35.3%)	2 (7.7%)	2 (5.7%)	3 (8.1%)	**0.02***
Rood	11 (9.6%)	5 (29.4%)	2 (7.7%)	2 (5.7%)	2 (5.4%)	**0.05***
Brügger	10 (8.7%)	3 (17.6%)	7 (26.9%)	0 (0.0%)	0 (0.0%)	**<0.01***

P-values smaller than 0.1 (borderline significance) are bold. Significant factors (p-value < 0.05) are marked with an asterisk.

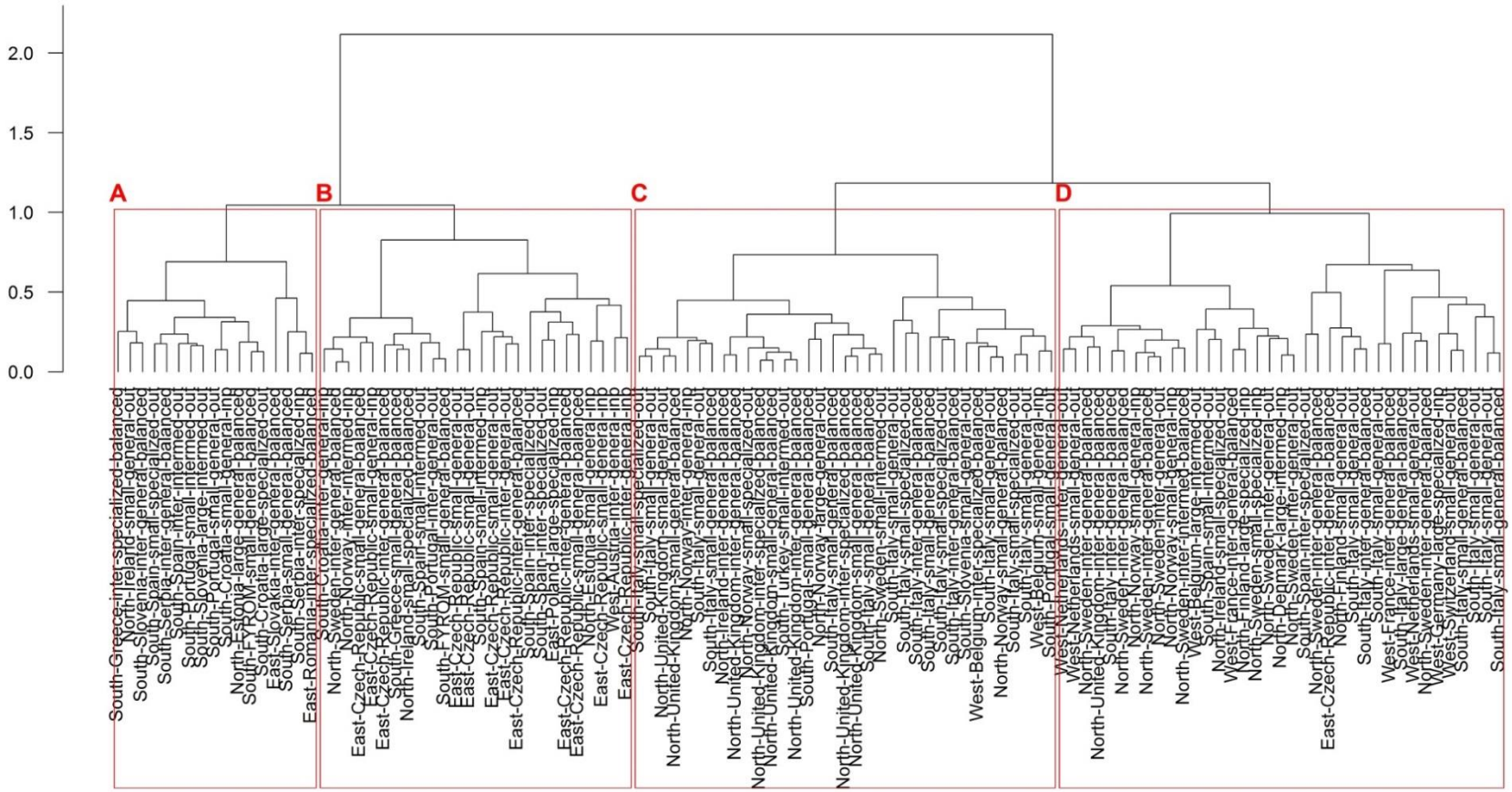
+ Center clusters correspond to Supplemental Figure 1.

Supplemental Table 5: Description of center clusters+.

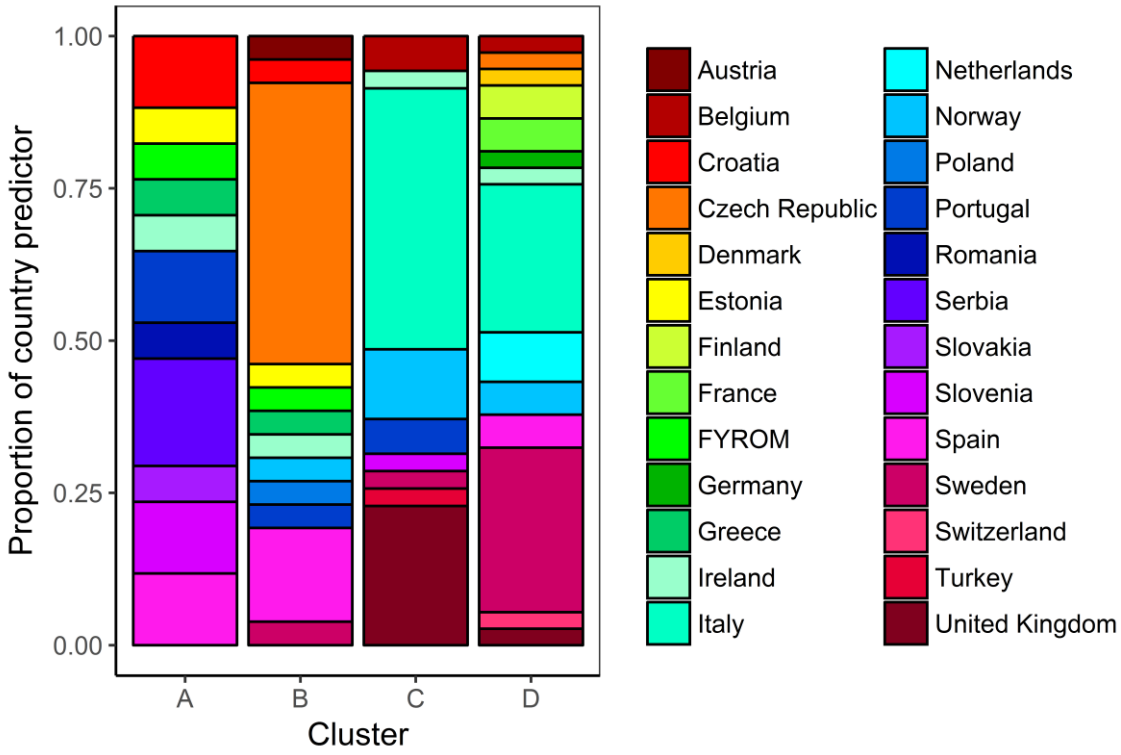
Variables	Total (115 centers)	Cluster				p-value
		A (17 centers)	B (26 centers)	C (35 centers)	D (37 centers)	
Number of respondents	1.84 (±1.71)	2.6 (±2.1)	2.3 (±2.0)	1.2 (±0.5)	1.8 (±1.9)	**<0.01***
Female gender proportion	0.75 (±0.39)	0.7 (±0.3)	0.7 (±0.4)	0.7 (±0.5)	0.9 (±0.3)	**<0.01***
Region						
East	16 (13.91%)	2 (11.8%)	13 (50.0%)	0 (0.0%)	1 (2.7%)	
North	37 (32.17%)	2 (11.8%)	4 (15.4%)	14 (40.0%)	17 (45.9%)	
South	51 (44.35%)	13 (76.5%)	8 (30.8%)	19 (54.3%)	11 (29.7%)	
West	11 (9.57%)	0 (0.0%)	1 (3.8%)	2 (5.7%)	8 (21.6%)	**<0.01***
Size						
Small (<100 patients/year)	60 (52.17%)	7 (41.2%)	13 (50.0%)	25 (71.4%)	15 (40.5%)	
Intermediate (100-500 p/y)	45 (39.13%)	7 (41.2%)	12 (46.2%)	9 (25.7%)	17 (45.9%)	
Large (>500 patients/year)	10 (8.70%)	3 (17.6%)	1 (3.8%)	1 (2.9%)	5 (13.5%)	**0.09**
MS ratio						
General (up to 20% MS)	81 (70.43%)	9 (52.9%)	19 (73.1%)	25 (71.4%)	28 (75.7%)	
Intermediate (20-80% MS)	12 (10.43%)	3 (17.6%)	3 (11.5%)	2 (5.7%)	4 (10.8%)	
Specialized (> 80% MS)	22 (19.13%)	5 (29.4%)	4 (15.4%)	8 (22.9%)	5 (13.5%)	0.62
MS Inpatient ratio						
Outpatient (>80% out)	47 (40.87%)	7 (41.2%)	8 (30.8%)	16 (45.7%)	16 (43.2%)	
Balanced (20-80% out)	49 (42.61%)	8 (47.1%)	9 (34.6%)	17 (48.6%)	15 (40.5%)	
Inpatient (<20% out)	19 (16.52%)	2 (11.8%)	9 (34.6%)	2 (5.7%)	6 (16.2%)	0.15
Max years of practice						
0-2	11 (9.57%)	1 (5.9%)	7 (26.9%)	3 (8.6%)	0 (0.0%)	
3-10	32 (27.83%)	1 (5.9%)	4 (15.4%)	15 (42.9%)	12 (32.4%)	
>10	72 (62.61%)	15 (88.2%)	15 (57.7%)	17 (48.6%)	25 (67.6%)	**<0.01***
Max worktime with MS patients						
0-24%	49 (42.61%)	6 (35.3%)	12 (46.2%)	16 (45.7%)	15 (40.5%)	
25-49%	18 (15.65%)	4 (23.5%)	1 (3.8%)	7 (20.0%)	6 (16.2%)	
50-74%	20 (17.39%)	4 (23.5%)	5 (19.2%)	6 (17.1%)	5 (13.5%)	
75-100%	28 (24.35%)	3 (17.6%)	8 (30.8%)	6 (17.1%)	11 (29.7%)	0.70
Min education						
PhD	9 (7.83%)	0 (0.0%)	1 (3.8%)	6 (17.1%)	2 (5.4%)	
Masters	35 (30.43%)	5 (29.4%)	11 (42.3%)	11 (31.4%)	8 (21.6%)	
Bachelor	43 (37.39%)	5 (29.4%)	9 (34.6%)	13 (37.1%)	16 (43.2%)	
Diploma specialist	19 (16.52%)	3 (17.6%)	3 (11.5%)	4 (11.4%)	9 (24.3%)	
Other education	9 (7.83%)	4 (23.5%)	2 (7.7%)	1 (2.9%)	2 (5.4%)	0.11

P-values smaller than 0.1 (borderline significance) are bold. Significant factors (p-value < 0.05) are marked with an asterisk.

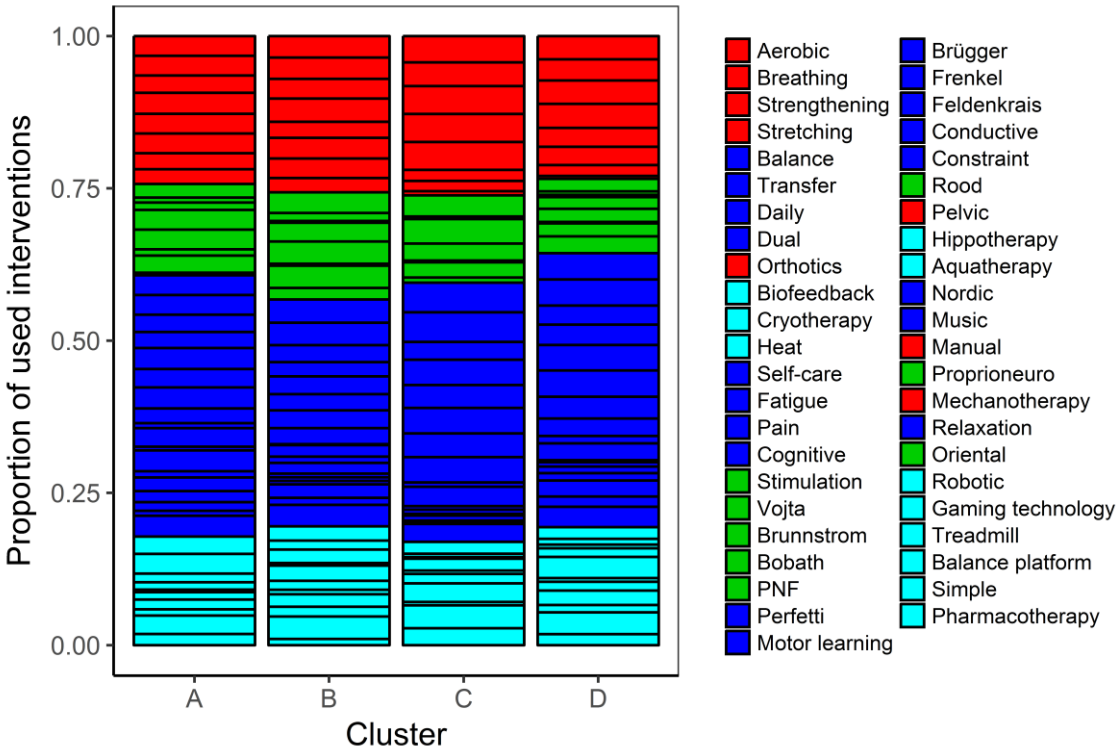
+ Center clusters correspond to Supplemental Figure 1.



Supplemental Figure 1: Dendogram of cluster analysis using Ward's linkage displaying four optimal clusters of PT interventions. Centers with similar patterns of the use of the PT interventions are plotted nearby each other. Distance measure is based on polychoric correlations.



Supplemental Figure 2: Proportional representation of countries in the four center clusters. Clusters correspond to Supplemental Figure 1.



Supplemental Figure 3: Types of PT interventions used by center clusters. Clusters correspond to Supplemental Figure 1. Colors depict initial categorization of PT interventions: Red – muscle re-education, Green – neuroproprioceptive facilitation, Dark blue – task oriented approach, Light blue – use of special tools/device. The difference in types of interventions in center clusters is not significant, Pearson's Chi-squared test, Chi-squared value = 16.299, p-value = 0.061.

Sample R code

```
# PACKAGES ############################################################

# install.packages("corrplot")
library("corrplot")
# install.packages("cowplot")
library("cowplot")
# install.packages("data.table")
library("data.table")
# install.packages("ggplot2")
library("ggplot2")
# install.packages("Gmisc")
library("Gmisc")
# install.packages("psych")
library("psych")

# DATA SET ############################################################

# loading data
load("DATA.RData")
head(DATA)
summary(DATA)

# PT interventions
methods <- DATA[, 1:45]
names(methods)

# PT interventions initial category
methodCategoryInit <- c(1, 1, 1, 1, 3, 3, 3, 3, 1, 4, 4, 4, 3, 3, 3, 3, 2, 2, 2, 2,
                        2, 3, 3, 3, 3, 3, 3, 3, 2, 1, 4, 4, 3, 3, 1, 2, 1, 3, 2, 4,
                        4, 4, 4, 4, 4)

set.seed(123)

#######################################################################
# Table 2: Number of centers by region and country

table(DATA$Region)
table(DATA$Country)

#######################################################################
# Table 3: Description of centers by region.

# Descriptives for Number of respondents (total and by regions)
mean(DATA$NumberofResp); sd(DATA$NumberofResp)
aggregate(DATA$NumberofResp ~ DATA$Region, FUN = function(x) c(mean(x), sd(x)))
# analogous code would apply for other continuous characteristics:
# FemaleProp
```

```
#  Descriptives for Size (total and by regions)
table(DATA$Size); prop.table(table(DATA$Size))
table(DATA$Size, DATA$Region)
prop.table(table(DATA$Size, DATA$Region), margin = 2)
# analogous code would apply for other categorical characteristics:
# MSratio, MSinpRatio, MaxYearPractice, MaxWorktimeMS, LowestEdu

# testing differences between regions in center characteristics
# for Size
chisq.test(DATA$Size, DATA$Region, simulate.p.value = T, B = 500000)

#########################################################################

# methods used by more than 75% of centers
which(apply(methods, 2, mean) > 0.75)
# methods used by less than 25% of centers
which(apply(methods, 2, mean) < 0.25)

#########################################################################
# Table 4: Description of centers by region. Use of PT interventions
#         in centers by regions. PT interventions are ordered by the
#         number of centers that use it.

# use of PT interventions in regions
# for Balance, analogous code applies for other PT interventions
table(methods$Balance, DATA$Region)
prop.table(table(methods$Balance, DATA$Region), margin = 2)

# difference in use between regions
# for Balance, analogous code applies for other PT interventions
chisq.test(methods$Balance, DATA$Region, simulate.p.value = T, B = 500000)

# for all PT interventions, using BH multiple comparison correction
pval <- sapply(1:45, function(x) chisq.test(methods[, x], DATA$Region, simulate.p.value = T, B =
500000)$p.value)
pval <- p.adjust(pval, method = "BH")

#########################################################################
# Supplemental Table 2: Classification of PT interventions.

# polychoric matrix
methodCor <- polychoric(methods)
# distance matrix
methodDistMatrix <- as.dist((1 - methodCor$rho)/2)
# clustering
methodClust <- hclust(methodDistMatrix, method = "ward.D")
plot(methodClust)
# categories based on clusters
methodCategoryClust <- as.factor(cutree(methodClust, k = 7))
levels(methodCategoryClust) <- paste("PTI-", c("E", "D", "B", "G", "A", "F", "C"))
```

```
# categories from cluster analysis
methodCategoryClust
# final categories informed by cluster analysis
methodCategoryNew <- c(1, 3, 1, 3, 3, 3, 3, 3, 4, 4, 2, 2, 0, 3, 3, 3, 2, 2, 2, 2, 2, 2, 3,

                       2, 3, 3, 3, 3, 2, 3, 1, 1, 1, 1, 2, 2, 2, 2, 1, 4, 4, 4, 4, 0, 0)
data.frame(methodCategoryInit, methodCategoryClust, methodCategoryNew)

######################################################################
# Supplemental Table 3: Regression model.

# number of PT interventions used in centers
PKT <- apply(methods, 1, sum)

# Poisson model for number of PT interventions used in centers
fit <- glm(PKT ~ NumberofResp + FemaleProp + Size + MSratio + MSinpRatio +
             MaxYearPractice + MaxWorktimeMS + LowestEdu + Region,
           data = DATA, family = "poisson")
summary(fit)


######################################################################
# Supplemental Table 4: Use of interventions in centers by clusters.

# polychoric matrix
centerCor <- polychoric(t(methods))
# distance matrix
centerDistMatrix <- as.dist((1 - centerCor$rho)/2)

# center clusters
centerClust <- hclust(centerDistMatrix, method = "ward.D")
plot(centerClust)

# cut into 4 clusters (renumbered to correspond with the dendrogram)
centerCutClust  <- cutree(centerClust, 4)
centerCutClust <- factor(centerCutClust)
levels(centerCutClust) <-  c("4", "3", "1", "2")
centerCutClust <- as.numeric(paste(centerCutClust))
centerCutClust

# number of centers within clusters
table(centerCutClust)

# usage of PT interventions in clusters
# for Balance, analogous applies to other PT interventions
table(methods$Balance, centerCutClust)
prop.table(table(methods$Balance, centerCutClust))

# differences in usage between clusters
# for Balance, analogous applies to other PT interventions
chisq.test(methods$Balance, centerCutClust, simulate.p.value = T, B = 500000)
```

```
# for all PT interventions, using BH multiple comparison correction
pval <- sapply(1:45, function(x) chisq.test(methods[, x], centerCutClust, simulate.p.value = T, B =
500000)$p.value)
pval <- p.adjust(pval, method = "BH")


#########################################################################
# Supplemental Table 5: Description of centers by clusters

# for Number of respondents (total and by clusters)
mean(DATA$NumberofResp); sd(DATA$NumberofResp)
aggregate(DATA$NumberofResp ~ centerCutClust, FUN = function(x) c(mean(x), sd(x)))
# analogous code applies for other continuous characteristics:
# FemaleProp

# for Size (total and by clusters)
table(DATA$Size); prop.table(table(DATA$Size))
table(DATA$Size, centerCutClust)
prop.table(table(DATA$Size, centerCutClust), margin = 2)

# testing differences between regions in characteristics
# for Size
chisq.test(DATA$Size, centerCutClust, simulate.p.value = T, B = 500000)

#########################################################################
#########################################################################
# default theme for figures
mytheme <- theme_bw() +
  theme(text = element_text(size = 12),
        plot.title = element_text(size = 12, face = "bold", hjust = 0.5),
        axis.line  = element_line(colour = "black"),
        panel.grid.major = element_blank(),
        panel.grid.minor = element_blank(),
        plot.background = element_rect(fill = "transparent", colour = NA))

#########################################################################
# Figure 1: Proportion of interventions used in regions.
# A. Vojta intervention
# B. Fatigue intervention

# data preparation
df.fig1 <- melt(DATA[, c(1:46)])
df.fig1$value <- as.factor(df.fig1$value)

df.fig1.Vojta <- df.fig1[df.fig1$variable == "Vojta", ]
df.fig1.Fatigue <- df.fig1[df.fig1$variable == "Fatigue", ]

# Vojta intervention
fig.usage.region.Vojta <- ggplot(df.fig1.Vojta, aes(x = Region, fill = value)) +
  geom_bar(position = "fill", color = "black") +
  xlab("Region") +
```

```
  ylab("Proportion") +
  scale_fill_manual(name = "",
                    values = c("#bbcdda", "#1d4063"),
                    labels = c("Center uses the intervention",
                               "Center does not use the intervention"),
                    breaks = c("1", "0")) +
  mytheme +
  theme(axis.text.x = element_text(vjust = 1),
        legend.position = "top") +
  ggtitle(paste("Use of Vojta intervention in centers by region"))
fig.usage.region.Vojta

# Fatigue intervention
fig.usage.region.Fatigue <- ggplot(df.fig1.Fatigue, aes(x = Region, fill = value)) +
  geom_bar(position = "fill", color = "black") +
  xlab("Region") +
  ylab("Proportion") +
  scale_fill_manual(name = "",
                    values = c("#bbcdda", "#1d4063"),
                    labels = c("Center uses the intervention",
                               "Center does not use the intervention"),
                    breaks = c("1", "0")) +
  mytheme +
  theme(axis.text.x = element_text(vjust = 1),
        legend.position = "top") +
  ggtitle(paste("Use of Fatigue intervention in centers by region"))
fig.usage.region.Fatigue

######################################################################
# Figure 2: Proportion of used interventions and their categories
#           in regions

# colours by initial method categorization
colr <- methodCategoryInit + 1
# preparing data
df.fig2 <- df.fig1[df.fig1$value == 1, ]
df.fig2 <- data.frame(df.fig2,
                      colr = rep(colr, as.vector(table(df.fig2$variable))))
df.fig2 <- df.fig2[order(df.fig2$colr), ]
df.fig2$variable <- factor(df.fig2$variable, levels = unique(df.fig2$variable))
# Figure 2
fig.usage.region.category <- ggplot(df.fig2, aes(x = Region, fill = variable)) +
  geom_bar(position = "fill", color = "black") +
  xlab("Region") +
  ylab("Proportion of used interventions") +
  scale_fill_manual(breaks = df.fig2$variable,
                    values = colr[order(colr)]) +
  guides(fill = guide_legend(ncol = 2)) +
  mytheme +
  theme(legend.title = element_blank(),
```

```
      legend.text = element_text(size = 8),
      legend.key.size = unit(0.7, "line"))
fig.usage.region.category

# difference in categorization between regions
chisq.test(df.fig2$colr, df.fig2$Region,
        simulate.p.value = T, B = 500000)


######################################################################
# Figure 3: Polychoric correlation heatmap of use of PT
#         interventions by centers.

# labels with old and new categories
label.method <- paste(colnames(methods), "-", methodCategoryInit, "/",
                methodCategoryNew, sep = "")

rownames(methodCor$rho) <- label.method
colnames(methodCor$rho) <- label.method

# corrplot for 7 clusters
corrplot(methodCor$rho,
       order = "hclust",
       hclust.method = "ward.D",
       addrect = 7,
       tl.cex = 0.7, cl.cex = 0.7, tl.col = "black")

######################################################################
# Figure 4: Dendrogram of cluster analysis using Ward's linkage
#         displaying seven optimal clusters of PT interventions.

# dendrogram
plot(methodClust, main = "",
    xlab = "", ylab = "", sub = "", hang = -1, cex = .7, col = "black",
    labels = label.method, cex.axis = .7)
rect.hclust(methodClust, k = 7, border = "red")

methodRH <- rect.hclust(methodClust, k = 7, border = "red")
x_clus <- cumsum(c(1, lengths(methodRH)))[-8] + 1
y_clus <- 0.67
text(x = x_clus, y = y_clus, col = "red",
    labels = paste("PTI-", LETTERS[1:7], sep = ""),
    font = 2)

######################################################################
# Supplemental Figure 1: Dendrogram of cluster analysis using
#                 Ward's linkage displaying four optimal
#                 clusters of centers.
```

```
# clusters description
description <- paste(DATA$Region,
                     DATA$Country,
                     DATA$Size,
                     DATA$MSratio,
                     DATA$MSinpRatio, sep = "-")


# dendrogram with description
plot(centerClust, main = "",
    xlab = "", ylab = "", sub = "", hang = -1, cex = .75, cex.axis = 0.75,
    labels = description, col = "black")
rect.hclust(centerClust, k = 4, border = "red")
centerRH <- rect.hclust(centerClust, k = 4, border = "red")
x_clus <- head(cumsum(c(1, lengths(centerRH))), -1)
y_clus <- 1.125
text(x = x_clus, y = y_clus, col = "red", labels = LETTERS[1:4], font = 2)


######################################################################
# Supplemental Figure 2: Proportional representation of countries
#                        in the four clusters.

# data preparation
df.sfig2 <- melt(data.frame(country = DATA$Country, clust = centerCutClust))
df.sfig2$value <- as.factor(df.sfig2$value)

col <- c("#800000", "#b30000", "#FF0000FF", "#FF7600FF", "#ffcc00", "#ffff00", "#ccff33", "#66ff33",
"#00ff00",
       "#00b300", "#00cc66", "#99ffcc", "#00FFC4FF", "#00ffff", "#00C4FFFF", "#007ae6", "#003dcc",
"#000fb3",
       "#6200FFFF", "#a71aff", "#D800FFFF", "#ff1aec", "#cc0066", "#ff3377", "#e60036", "#80001e")
# Supplemental figure 2
fig.clust.country <- ggplot(df.sfig2, aes(x = value, fill = country)) +
  geom_bar(position = "fill", color = "black") +
  xlab("Cluster") +
  ylab("Proportion of country predictor") +
  scale_fill_manual(values = col) +
  scale_x_discrete(breaks = 1:4, labels = LETTERS[1:4]) +
  mytheme +
  theme(legend.title = element_blank())
fig.clust.country

######################################################################
# Supplemental Figure 3: Types of PT interventions used by center clusters.

# data preparation
df.sfig3 <- melt(data.frame(methods, centerCutClust),
              id.vars = c("centerCutClust"))
df.sfig3 <- df.sfig3[df.sfig3$value == "1", ]
```

```
# colours by initial categorization
colr <-  methodCategoryInit + 1

df.sfig3 <- data.frame(df.sfig3,
                       colr = rep(colr, as.vector(table(df.sfig3$variable))))
df.sfig3 <- df.sfig3[order(df.sfig3$colr), ]
df.sfig3$variable <- factor(df.sfig3$variable, levels = unique(df.sfig3$variable))
# Supplemental figure 3
fig.clust.usage.category <- ggplot(df.sfig3, aes(x = as.factor(centerCutClust), fill = variable)) +
  geom_bar(position = "fill", color = "black") +
  xlab("Cluster") +
  ylab("Proportion of used interventions") +
  scale_fill_manual(breaks = df.sfig3$variable,
                    values = colr[order(colr)]) +
  scale_x_discrete(breaks = 1:4, labels = LETTERS[1:4]) +
  guides(fill = guide_legend(ncol = 2)) +
  mytheme +
  theme(legend.title = element_blank(),
        legend.text = element_text(size = 8),
        legend.key.size = unit(0.7, "line"))
fig.clust.usage.category

# difference in categorization between clusters
chisq.test(df.sfig3$colr, df.sfig3$centerCutClust,
           simulate.p.value = T, B = 500000)


#########################################################################
```