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REHABILITATION APPROACHES

Balance Right in Multiple Sclerosis (BRiMS): A guided self-management programme to reduce falls and improve quality of life, balance and mobility in people with secondary progressive multiple sclerosis: a protocol for a feasibility randomised controlled trial

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Background: Impaired mobility is a cardinal feature of multiple sclerosis (MS). By the secondary progressive phase, balance, mobility and physical activity levels are significantly compromised; an estimated 70% of people with secondary progressive MS fall regularly. Our ongoing research has systematically developed 'Balance Right in MS' (BRiMS), an innovative, manualised 13-week safe mobility and falls selfmanagement programme tailored to the needs of people with MS. Our eventual aim is to assess the clinical and cost effectiveness of BRiMS via a fully powered, multicentre, assessor-blinded randomised controlled trial (RCT). This feasibility study will assess the acceptability of the intervention and achievability of running such a trial.

Methods/ Design: This is a pragmatic multi-centre feasibility RCT with blinded outcome assessment. Sixty ambulant people

with secondary progressive MS who self-report two or more falls in the previous six months will be randomly allocated 1:1 to either the BRiMS programme plus usual care or to usual care alone. All participants will be assessed at baseline and followed up at 15 weeks and 27 weeks post randomisation.

Outcomes:

- Feasibility outcomes, including recruitment, retention and completion
- Assessment of the proposed outcome measures for the anticipated definitive trial (including measures of walking, quality of life, falls, balance and activity level)
- Measures of adherence to the BRiMS programme
- Data to inform the economic evaluation in a future trial
- Process evaluation (assessment of treatment fidelity and qualitative evaluation of participant and treating therapist experience).

Conclusion: The BRiMS intervention addresses an issue which is a key concern for MS service users and providers. This feasibility trial will provide important insights into the acceptability of the BRiMS intervention and the practicality of running a full-scale trial, and will enable a protocol to be finalised for use in the definitive trial.

Trial Registration: ISRCTN13587999

Training effectiveness of Wii gaming system: comparison between patients with Multiple Sclerosis and Parkinson disease. A pilot study

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Background: Many functional skills in people with Multiple Sclerosis (MS) and Parkinson disease (PD) deteriorated in a period of time. Although many existing studies confirm that Wii gaming system has a good rehabilitation results in people with MS and PD, there are no many evidences about that in which patients is this simple tool more effective.

Objective: The aim of this study was to compare motoric improvements in patients with MS and PD after training with Wii gaming system.

Methods: In this small pilot clinical trial 12 patients were divided in 2 groups. First group was represented by 6 patients with MS (3 male, 3 female, mean age 38.3, mean EDSS of 3.6). Second group was represented by 6 patients with PD (5 male, 1 female, mean age 66.5, Hoehn and Yahr scale of 3.6). Participants in both groups were assessed before and after 10 training sessions with short version of Berg Balance Scale (BBS), Timed Up and Go Test (TUG) and Four Square Step Test (FSST). During 5 weeks period each patient finished 10 training sessions 30 minutes long, with possibility to make 2 short (1 minute long) breaks during the session. Training protocol included several

games (selected from the Wii Fit Plus package, Nintendo; <http://www.wiifit.com/training/balance-games.html>).

Results: Improvement in test results was statistically significant in two of three tests in both groups. Berg balance scale scores showed an overall statistically significant difference in group of people with MS and people with PB ($p = 0,045$). Four square test scores also showed an overall statistically important difference in both of the groups ($p = 0,040$). Timed up and go test scores didn't show any statistically significant difference as same as comparison of the results between the groups.

Conclusion: Training with the Wii gaming system showed significant improvement in results in two of three tests. These findings could suggest that Wii gaming system can improve balance (Berg balance scale, Four square test) and may have impact on coordination (Four square test), meanwhile effect on the walking speed is not clear. Findings of the existing studies are supporting these thesis and could be strong recommendation for implementing Wii gaming system in rehabilitation programs for people with MS an PB. Submission ID: 8; Submission Group: Rehabilitation Approaches.

Randomized controlled trial of a home-based palliative approach for people with severe multiple sclerosis

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Background: Evidence on the efficacy of palliative care in persons with severe multiple sclerosis (MS) is scarce. We assessed the efficacy of a home-based palliative approach (HPA) in adults with severe MS and their carers.

Methods: Adults with severe MS-carer dyads were assigned to either HPA or usual care (UC) in a 2:1 ratio (web-based

randomization). At each center, a multi-professional team delivered the six-month intervention. A blind examiner assessed dyads at baseline, after three and six months; dyads also received monthly telephone interviews. Primary outcome measures were Palliative care Outcome Scale-Symptoms-MS (POS-S-MS), and Schedule for the Evaluation of Individual Quality of Life-Direct Weighting (SEIQoL-DW, not assessed in severely cognitively compromised patients). Secondary outcomes were patient's needs (POS scale), Hospital Anxiety and Depression scale (HADS), Functional Independence Measure (FIM), unplanned hospital admissions, and deaths; carer's Zarit Burden Interview (ZBI), quality of life (SF-36), and HADS. The trial was registered with Current Controlled Trials (ISRCTN73082124).

Results: Between January- November 2015, we randomly assigned 78 dyads (52 HPA, 26 UC). One dyad withdrew consent and one patient died before first HPA visit; 76 dyads (50 HPA, 26 UC) were analyzed. Three HPA patients died (deaths unrelated to intervention). Discontinuation rate was 2% in HPA group and 8% in UC group. In intention-to-treat analysis, symptom burden (POS-S-MS) significantly reduced in HPA group compared to UC ($p=0.047$). Effect size was 0.20 at three, 0.32 at six months, and statistical significance borderline in per-protocol analysis ($p=0.062$). Changes in SEIQoL-DW index did not differ in the two groups, as changes in secondary patient (POS, HADS, FIM), and carer outcomes (ZBI, SF-36, and HADS).

Conclusions: HPA reduced symptoms burden, and we found no evidence of HPA efficacy on patient QOL, and on secondary patient and carer outcomes. Economic evaluation and nested qualitative study analysis are ongoing.

Adherence and health outcomes after a multimodal lifestyle educational intervention in people with multiple sclerosis: three year follow-up

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Modifiable risk factors such as smoking and sedentary lifestyle adversely affect multiple sclerosis (MS) progression. This study assessed adherence and health outcomes after a lifestyle risk-factor modification intervention. 95 people with MS completed baseline surveys before participating in the 5-day intervention workshops. 76 and 78 participants completed the 1-year and 3-year follow-up surveys respectively. Mean age at 3-year follow-up was 47 years, 72% was female, diagnosed 4 years ago (median), and 73% had relapsing remitting (RR) MS. Results from generalized estimated equations and whole case analysis are reported. Compared to baseline, diet score increased at 1-year (Mean Difference (MD), 95% confidence interval: 4.47, 2.98—5.96) and 3-year (MD 2.88, 1.33—4.43); meditation frequency (>1 hour/week) increased at 1-year (Odds ratio (OR), 95%CI: 4.5, 2.149—9.26) and 3-year (OR 2.0, 95%CI: 1.07—3.73); vitamin D supplementation (>5000 IU daily) increased at 1-year (OR 4.0, 2.15—7.40) and 3-year (OR 3.6, 1.94—6.69); flaxseed oil supplementation increased at 1-year (OR 7.45, 3.79—14.65) and 3-year (OR 5.39, 3.10—9.35); and moderate/high exercise increased at 1-year (OR 1.43, 0.82—2.48) and at 3-year (OR 1.95, 0.95—3.97) follow-ups. Medication Use increased at 1-year follow-up (OR 1.76, 1.09—2.89) and at 3-year follow-up (OR 1.78, 1.04—3.03). Compared To baseline, participants reported

clinically significant increases in physical (MD7.96, 5.34–10.59) and mental (MD9.19, 5.23–13.15) quality of life (QOL) at 1-year, and physical (MD8.69, 4.96–12.42) and mental (MD7.95, 4.37–11.53) QOL at 3-year follow-up. There was a small decrease in disability from baseline to 1-year follow-up (5.7%, 9.5%–1.7%) and to 3-year follow-up (4.2%, 8.2%–1.1%). Of Those with RRMS, compared to baseline, fewer had a relapse during the year before 1-year follow-up (OR0.08, 0.03–0.17) and 3-year follow-up (OR0.15, 0.06–0.33). Regression to the mean may play a role. These results show that lifestyle risk-factor modification is feasible and sustainable over time, and associated with improved health outcomes in a small self-selected sample of people with MS.

Standing up in Multiple Sclerosis (SUMS): Protocol for a multi-centre randomised controlled trial evaluating the clinical and cost effectiveness of a home-based self-management standing frame programme in people with progressive multiple sclerosis.

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Background: Multiple sclerosis (MS) is an incurable, unpredictable but typically progressive neurological condition. Within 15 years of diagnosis, approximately 50% of people are unable to walk unaided, and over time an estimated 25% depend on a wheelchair. Those who are more severely impaired spend much of their day sitting, often with limited ability to change position. In response, secondary complications can occur including: muscle wasting and weakness, pain, reduced skin integrity, spasms, stiffness, constipation, and associated psychosocial problems such as depression. Effective self-management strategies, which can be implemented relatively easily and cheaply are needed to improve mobility and reduce sedentary behaviour. This is challenging, particularly in the latter stages of disease. Regular supported standing is one potential option.

Methods/Design: SUMS is a pragmatic multi-centre randomised controlled trial evaluating use of Oswestry standing frames with blinded outcome assessment and full economic evaluation. Participants are randomly allocated (1:1) to either a home-based, self-management standing programme (with advice and support) along with their usual care or to usual care alone. The intervention group participants are

asked to stand for 30 minutes three times weekly over 20 weeks. Participants are followed-up at 20 and 36 weeks post baseline. The primary clinical outcome is motor function (Amended Motor Club Assessment) and primary economic endpoint is quality-adjusted life years. Secondary outcomes include measures of explanatory physical impairments, key clinical outcomes, and health-related quality of life. An embedded qualitative component explores participant's and carer's experiences of the standing programme.

Discussion: This is the first powered multi-centre trial to assess the clinical and cost effectiveness of a home based standing frame programme for people severely impaired by MS. If demonstrated to be effective this evidence will be used to develop recommendations for a health service delivery model which could be implemented across the UK.

Trial Registration: ISRCTN69614598

Impact of high-intensity interval training on cardiovascular risk factors in persons with Multiple Sclerosis.

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Introduction: The prevalence of cardiovascular risk factors can be reversed by high intensity interval training (HIIT). Because this was never investigated in MS, the present study aims to examine the effect of HIIT on cardiovascular risk factors present in MS.

Methods: Before (PRE) and after (POST) 12 weeks of sedentary control (SED, n=13) or HIIT (100% HR max, 3/w, n=16) exercise capacity (maximal cycle test), muscle strength (isometric/isokinetic dynamometry), body composition (DEXA), resting blood pressure and heart rate, 2h oral glucose tolerance (OGTT, HbA1c, [glucose] blood, [insulin]blood), blood lipids (HDL, LDL, total cholesterol, triglyceride levels) and C-reactive Protein (CRP) were analyzed.

Results: In SED, HDL cholesterol (PRE: 61.8±4.1mg/dl vs. POST: 56.9±3.7mg/dl), workload (PRE: 113.5±11.9W vs. POST: 100.1±11.2W) and isometric muscle strength (PRE: 133.8±11.7Nm vs. POST: 122.5±11.3Nm) decreased during the study course. In contrast, HIIT increased maximal oxygen uptake (+18%) and isometric muscle strength (+14%) and compared to SED, 12 weeks of HIIT significantly improved resting heart rate (68±2.3bpm vs. 64±2.2bpm), 2h [glucose]blood (7.8±0.7mmol vs. 6.8±0.5mmol) and HOMA index (2.1±0.3 vs. 1.6±0.1). Blood pressure, body composition, blood lipids or CRP however were not affected.

Conclusion: Although 12 weeks of HIIT improved exercise capacity, muscle strength, resting heart rate and probably whole body glucose disposal in persons with MS, it did not affect blood CRP levels, blood pressure, body composition and blood lipid profiles. Additional treatment strategies are thus warranted in persons with MS to improve cardiovascular risk factors.

Muscle carnosine in Experimental Autoimmune Encephalomyelitis and Multiple Sclerosis: effects of exercise

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Introduction: Part of the neuromuscular dysfunction in Multiple Sclerosis (MS) may reside within the muscle (impaired cross-bridging, impaired Ca²⁺ handling, altered exercise-induced lactate response). Muscle carnosine may affect this. The impact of MS on muscle carnosine however was never investigated before.

Methods: First, muscle carnosine levels of m. tibialis anterior were measured in control rats (CON, n=40) and in an animal MS model (EAE, Experimental Autoimmune Encephalomyelitis, n=40) before and after exercise therapy (EAEEX, CONEX, 10d, 1h/d, 24m/min treadmill running) and sedentary conditions (EAESD, CONSED, n=20). Furthermore, m. vastus lateralis carnosine levels of healthy controls (HC) and MS patients were measured (HC, n=22; MS: n=24). Hereafter and in a subgroup of MS patients only, the effect of high intense exercise therapy (MSEX, n=11, 12w, 5sessions/2w, 80-100% HRmax) versus sedentary conditions (MSED, n=6) on muscle carnosine levels were evaluated.

Results: EAE decreased (p<0.05) muscle carnosine levels by -40% to -64% in EAESD 10d to 17d following EAE induction. This was not restored/prevented by exercise therapy (-37% to -64%). MS decreases (p<0.05) muscle carnosine levels by ~25% compared to HC. Exercise did not appear to remediate this.

Conclusion: EAE and MS decrease muscle carnosine levels substantially. Exercise therapy does not appear to restore this.

Intensive and multimodal upper limb rehabilitation can be effective in multiple sclerosis complicated by progressive multifocal leukoencephalopathy: a functional MRI study

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A 48-year-old woman with multiple sclerosis (MS), treated with natalizumab for more than one year without clinical and MRI signs of disease activity, had a diagnosis of definite progressive multifocal leukoencephalopathy (PML) presenting with subacute motor deficit of the right upper limb, followed by involvement of the homolateral leg and urinary urgency. The patient was treated with steroids and plasma exchange. On follow-up MRI scans, PML lesion remained stable and no MS rebounds were observed, but the patient complained a progressive worsening of the right upper limb motor impairment, becoming dependent in most activities

of daily living. A three-week cycle of intensive rehabilitation was then started, including daily sessions of upper limb robot therapy. Functional MRI (fMRI) was acquired before and at the end of the rehabilitation cycle using a motor task which consisted of 2 runs: in one run (control task), the patient was asked to observe and in the remaining run (experimental task) to execute hand grasping movements. At the end of the rehabilitation period, the number of sub-movements, the time and the assistive force required by her arm to reach the target of the exercise were significantly reduced. After training, compared with baseline, fMRI showed increased functional activation within the sensory-motor network in the experimental task (p<0.05; FWE corrected), while no significant differences were found in the control task.

Intensive rehabilitation including robot-assisted upper limb training seems to be clinically effective and to have a significant impact on brain functional reorganization on a short-term, even when MS is complicated by superimposed tissue damage provoked by PML comorbidity.

Objective Physical Activity Levels in People with Multiple Sclerosis: A Meta-Analysis.

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Background: Physical activity (PA) levels among people with Multiple Sclerosis (pwMS) were previously reported in a meta-analysis in 2005. That review relied heavily on self-report measurement and concluded that pwMS were less physically active than a non-diseased population who themselves were largely sedentary. Given the growing body of PA literature published since 2005 and advances in objective PA methodology, an updated review is timely.

Objective(s): 1) To quantify PA levels in pwMS using objective measurement only and 2) to establish using a meta-analytical approach if pwMS are less physically active than a general population sample.

Methods: A systematic search of 8 databases was conducted using keywords associated with MS and PA. Cohort and intervention studies which included an objective measure of PA were included. A general population sample from the National Health and Nutritional Examination Survey (NHANES) in the United States of America was used as a comparative group. Objective PA outputs of steps per day, activity counts per day and minutes of moderate-vigorous activity (MVPA) per day were extracted from the MS studies and the published NHANES dataset. Meta-analysis was conducted.

Results: The systematic search resulted in 32 papers. There was a total of 3,762 pwMS included, the sample was largely female (n=3118, 82.8%) and ambulatory with/without use of an aid. Meta-analysis indicated statistically significant differences between the MS and NHANES samples with respect to 1) steps per day [mean difference: -3845 (-4120.17,-3569.83), p<0.0001], 2) activity counts per day [mean difference: -91377.69 (-103827.8,-78927.54), p<0.0001] and 3) minutes of MVPA per day [mean difference: 8.95 (-12.52, -5.38), p<0.0001], indicating pwMS are less physically active than the NHANES sample.

Conclusion: Results of this review suggest that pwMS are less physically active than a general population, who themselves are not meeting recommended PA guidelines. There is a need to increase PA levels among pwMS.

Train Your Brain: Neurofeedback for Cognitive Rehabilitation in Multiple Sclerosis

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Neurofeedback is a kind of biofeedback in which subjects can learn to voluntarily modulate their own brain activity while getting real-time feedback about specific brain activation patterns. Neurofeedback might be an alternative training method to target cognitive functioning directly where it emerges in the brain. Prior evidence in healthy individuals as well as in neurologic patients such as stroke patients showed that successful brain control using neurofeedback leads to behavioural and cognitive improvements. Similar evidence in patients with multiple sclerosis (MS) is lacking so far. Furthermore, portable and easy-to-use neurofeedback systems enable telerehabilitation bridging the gap between institutionalized and home-based cognitive training. Aim of the present investigation was to provide first data on potential effects of EEG-based neurofeedback on cognitive functions in patients with MS. Therefore, ten patients with relapsing-remitting or secondary progressive MS, suffering from cognitive deficits, performed ten neurofeedback training sessions on their own at home using a telerehabilitation system. During the training, audio-visual feedback should have served to help them to increase their sensorimotor rhythm (SMR, 12–15 Hz) in the EEG. Cognitive functions were assessed before and after NF training (pre-post design). Six patients successfully increased their SMR activity during training. These NF responders also significantly improved cognitively, especially in memory and executive functions. Four patients were not able to voluntarily modulate their own brain activity in the desired direction during training. No changes in cognitive functions were noted in these non-responders. Cognitive improvements also correlated significantly with the neurofeedback training performance. The results of this first proof-of-principle study show that successful neurofeedback training improves cognitive functions in MS. Furthermore, the telerehabilitation system employed turned out to be feasible, easy-to-use, and highly accepted by MS patients. Together, our data provide evidence for the potential of such a neurofeedback-based remote training for future cognitive rehabilitation.

NeuronUp as a tool for Cognitive Rehabilitation in MS

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Objectives: To evaluate the feasibility of the cognitive rehabilitation program NeuronUp as a tool for cognitive stimulation of multiple sclerosis patients, when it is used in a clinical setting versus a home-based application. And, to assess the general efficiency of said program.

Methods: 46 patients divided into 2 groups, one with an on-site and one with a home-based edition of the program NeuronUp, performed a weekly training for 3 months which consisted of 12 sessions of 30 minutes each. The web-based platform NeuronUp allows personalizing interventions for the treatment of cognitive impairment through exercises for cognitive functions and ADLs. The neuropsychologist sets the program individually for each patient, and gets a record of the performance on each of the exercises. Questionnaire assessing patient and professional satisfaction were administered a posteriori.

Results : There are no significant differences, either in terms of registration of NeuronUp activity or patient-data. There were only those in the time dedicated by the neuropsychologist to the revision of sessions of the on-site group and those in the patient satisfaction questionnaires, which value general satisfaction with the presented exercises as “very good” and that the level of difficulty adjusts to their cognitive impairments.

Conclusions: NeuronUp allows assistance to a bigger number of patients. It is considered as effective. Both groups found the use of NeuronUp comfortable and consider it useful for coordination, attention, motivation, stimulation and memory training.

Web-based self-care support for MS patients

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Background: MS is a chronic and often disabling disease. Many of the patients with MS (PwMS) are in need of personalized care and support. Self-care is an important aspect of comprehensive treatment and rehabilitation in MS. Internet-based interventions have been confirmed effective in guiding health behavior.

The purpose of the study was to investigate the needs of PwMS and their significant others for web-based self-care support. The study was a part of the I Care –project of the Finnish MS Nurses Organization. The main objective was to create a web program (MS-Station).

Material and methods: The study was conducted according to the action research method during 2016. Participants (n=145, of whom PwMS 120, significant others 25) were contacted by a questionnaire via email. The data was analyzed with SPSS statistical program. Open questions were interpreted using content analysis. The expert group of rehabilitation professionals was formed and their discussions on the results were recorded and considered in the planning of the web program.

Results: 43% of PwMS and 41% of their significant others felt they had not received adequate information during the disease. In the opinion of 43 % of them, professional self-care support had been inadequate. 90 % of the respondents were interested to use online support program.

The main needs of PwMS and their significant others for web program were: 1) evidence-based information on MS and its self-care, 2) interactivity, 3) national guidelines and 4) psychosocial support in form of peers and professionals. A nationwide and

easy-to-use program was hoped for. The expert group emphasized the program should mainly contain evidence based information and should be user-friendly also for severely disabled.

Conclusions: Finnish PwMS and their significant others are in need for information and support from both peers and professionals online. MS-Station will provide an innovative, empowering and independent way to meet these needs.

Frequency and Consequences of Falls in MS

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Background: Gait and balance are commonly affected in MS which can result in the occurrence of falls. Falls prevalence in this population is high (Nilsagard 2009) and prospective falls recording is the gold standard and is recommended for a minimum period of 3 months.

Objectives: To determine the frequency and consequences of falls from three months of prospective falls diaries in an MS cohort.

Methods: Consecutive patients with MS attending the Neurology service in a tertiary hospital were recruited. Data collected included the Expanded Disability Status Scale score (EDSS), time since diagnosis, type of MS and walking aid(s) used. Participants completed a questionnaire of falls risk factors as part of the baseline assessment and then completed a falls diary for 3 months recording their falls, and providing information about the circumstances, causes, and consequences of their falls.

Results: Falls status was available for 100 participants. Mean age was 52.6(10.7) and 66% were female. Mean EDSS was 5.3(1.1) and mean time since diagnosis was 14.3(9) years. 72.3% of the sample had progressive MS with 73% using a mobility aid. There were 791 falls reported over the three month period from a total of 55 participants. 60% of fallers reported injurious falls (94 falls in total) and 11% needed medical attention (5% accessed an emergency department). 35% of fallers needed help to get up after a fall and 9% of fallers lay on the floor for at least 10 minutes but none experienced a long lie (more than 60 minutes).

Conclusion: Falls frequency is very high in people with MS and almost two thirds of fallers report injurious falls. While a very low number of injuries require medical attention, there are other worrying factors such as inability to get up independently. Further analysis will examine circumstances and causes of falls in this cohort.

Effects Of A 12-Week Hypotherapy Program In Spanish People With Multiple Sclerosis.

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Background: Hypotherapy is a therapeutic activity that takes advantage of the movement of the horse to provide sensory feedback and it is used to treat some symptoms that people with multiple sclerosis (PwMS) have. Despite this, there are no scientific studies in the Spanish population that demonstrate their effectiveness.

The purpose of this prospective randomized clinical trial was to evaluate the effects of a 12-week hippotherapy program on the frequency of muscle spasms, balance, gait and transfer capacity, respiratory function, and upper extremity coordination in PwMS.

Patients and Methods: Seventeen PwMS with a mean age of 48.41 years and an EDSS of less than 6, were selected and randomly assigned to the Treatment (TG) or Control (CG) group. The TG, composed of 9 participants, was added to its usual rehabilitation treatment a weekly session of individualized hippotherapy controlled by a specialized physiotherapist for 12 weeks. The CG, composed of 8 participants, did not change their usual rehabilitation treatment.

Participants were assessed before and after the 12-week period by means of: Spasm Frequency Scale, Smeltzer Pulmonary Index, Tinetti Index, FIM motor, Rivermead Index, Berg Balance Scale and finger-nose Test.

Results: The TG showed a statistically significant decrease in the frequency of muscle spasms ($P = 0.027$), an improvement in gait capacity ($P = 0.027$), balance ($P = 0.08$) and upper extremity coordination ($P = 0.08$).

There were no significant changes in respiratory function ($P = 0.963$) or transfer capacity (FIM motor $P = 0.236$, RIVERMEAD $P = 0.743$).

Conclusions: The results suggest that hippotherapy is a therapeutic strategy that allows to reduce the frequency of muscle spasms and to improve balance, gait capacity and upper extremity coordination in PwMS.

Fatigue and Dietary Intake – a relationship?

Uwe Martin Pommerich, John Brincks, Marie Ernst Christensen

Background: A common symptom of MS is fatigue, which occurs in up to 90% of the patients at some point. Two out three patients perceive fatigue as their most unsettling symptom. So far, remedies have shown little and contradicting results for the treatment of fatigue. Conversely, in theory there seems to exist a relationship between dietary intake and fatigue. However, evidence examining the results of dietary interventions are limited.

Aim: This review systematically explored relations and potential interactions between dietary intake and the subjective perception of fatigue in adult people with MS (pwMS).

Method: Major databases were systematically searched in order to locate relevant literature, including Cochrane Database of Systematic Reviews, Embase, Medline, Web of Science, and CINAHL complete, SPORTDiscus, PsycInfo, and Rehabilitation and Sports Medicine. In order to be included, studies had to evaluate interactions or relations between dietary intake and subjective fatigue in adult pwMS. A modified Downs & Black, and U.S. National Institute of Health checklist was used to assess the methodological quality of included studies.

Results: A total amount of 330 studies was screened for eligibility after removing duplicates. Seventeen full text references were reviewed. Finally, five studies met the inclusion criteria, one assessor-blinded randomised controlled trial, one double-blinded randomised trial, one single arm intervention trial and two cross-sectional studies. Interventions included a low fat diet, a low fat

starchy plant-food diet, and a modified paleo diet. The cross-sectional studies evaluated potential relationships between dietary intake and fatigue.

Conclusion: A relationship between dietary intake and fatigue is beginning to establish itself; it is however still inconclusive and not well described, yet. There might exist an interrelation between magnesium and folate intake and fatigue according to our preliminary results.

Effect of a 10-week MS exercise programme on muscle strength and aerobic capacity in inactive people with MS

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Background: Recent MS exercise guidelines recommend resistance and aerobic exercise twice per week. To optimise adherence, the Step it Up programme delivered this programme in combination with theory based education and compared it to attention control education.

Objective: The aim of this analysis was to examine the effects of a 10-week MS exercise guideline programme on muscle strength and aerobic capacity in inactive people with MS (pwMS).

Methods: Multi-centre, double blind, randomised, controlled trial. Intervention group attended a weekly resistance class and group, structured education based on principles of social cognitive theory and completed a home programme consistent with the guideline. The control group received the same group exercise programme with an attention control education component. Outcomes for this analysis were Five times sit to stand (5xSTS) and Modified Canadian Aerobic Fitness test (MCAFT).

Results: Participants were inactive (n=65), mean age 42 (SD=9.8), mean EDSS 3.29 (SD=0.68), 85% female, 83% relapsing remitting MS. Using linear mixed effects model, no statistical differences between groups were found after 10 weeks of intervention and at 3 and 6 month follow up. Post-hoc analysis found significant improvement following 10-week intervention for 5xSTS (mean change intervention group -1.51 (95%CI -2.41, -0.60), p<0.01; control group -1.55 (95%CI -2.30, -0.79), p<0.01) and at 6 month follow up (intervention -2.29 (95%CI -3.20, -1.39), p<0.01; control -1.19 (95%CI -1.97, -0.40), p<0.01). Though not statistically significant, at 6-month follow up, fitness levels for intervention group remained above baseline, control group tended to deteriorate.

Conclusions: The 10-week exercise programme brought inactive people to the exercise guideline and resulted in significant improvements in 5xSTS in both groups. The lack of improvement in MCAFT is at odds with the results for the primary outcome 6MWT, which improved by over 80m in the intervention group. Exploration of other fitness measures is warranted.

Barriers and facilitators of long-term adherence to physical activity in MS – an international interview and survey study

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Background/research question: Systematic reviews support the beneficial effects of physical activity (PA) and exercise on various outcomes among people with MS (pwMS). However, most PA interventions have been short-term and long-term adherence has not been assessed. As pwMS are known to be less physically active than the general population, we aim to assess the barriers and facilitators of long-term adherence to PA in pwMS.

Methods: We focused on the findings of three behavior change models associated with PA behavior change (HAPA by Schwarzer et al., Physical Activity Maintenance Model by Nigg et al. and MOVO Model by Fuchs et al.) and a review of the MS-specific literature. These informed 12 interviews we conducted with MS exercise experts from various disciplines and five European countries to identify constructs possibly relevant for long-term PA in MS. We used the Theoretical Domains Framework to structure the variety of constructs, identify valid scales and to develop a comprehensive survey questionnaire.

Results: The interviewees frequently mentioned disease specific factors (e.g. fatigue, impairment, walking limitations), confirmed most of the HAPA constructs and additionally four major themes emerged: 1. Exercise History, 2. Experienced consequences when being physically active after MS diagnosis, 3. Motivation and 4. Environmental factors from the social and physical environment. Drawing on these results we developed a comprehensive survey questionnaire, which covers disease specific and personal factors as well as factors of the social and physical environment.

Outlook: Currently the web-based questionnaire is being applied in Germany. First results will be available by end of April 2017. Analyses will be done with path analysis comparing barriers and facilitators among pwMS in different stages of change. In an additional European and US survey we aim to assess variations among MS populations possibly related to cultural differences or the country-specific health care system.

Transdisciplinary in a Integral Cognitive Program in Young Ms Patients

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Introduction: Neuropsychology, Speech Therapy and Occupational Therapy Services have initiated a transdisciplinary integrating treatment with young MS patients with mild-moderate cognitive impairment using a neurorehabilitation transdisciplinary program, to treat these deficits in a motivating way to improve their Life Quality.

Objectives:

1. Optimize the available resources to perform an optimal cognitive rehabilitation.
2. Improve cognitive sphere of MS patients to increase their life quality.
3. Using current technology platform of cognitive rehabilitation to increase the motivation of young people and the effectiveness of treatment

Methods: Selected the sample of 18 people who are patients between 30 and 45 years old with mild-moderate cognitive impairment; to objective the results has been initial and final neuropsychological evaluation: BRB-N, SDMT, PASAT, WLG, FDT, TMT-A-B, HADS, LAWTON, HOLDEN, MSIS-29.

Transdisciplinary program lasts for 36 sessions at a rate of three sessions per week:

- 2 grupal, training situations by role playing, problem solving, cognitive and social grupal games.
- 1 individual cognitive computerise stimulation by Neuronup Platform, using same specifics exercises of attention, working memory, language, executive function and Activities Daily Living practice.

Results: Cognitive profile of patients . 12 improved, 2 had similar results; 2 worsened their situation and 2 didn't finish treatment. Emotional state and quality of life. The intensive program in young patients with cognitive impairment, enlarges the life quality and increases the positive neurological rehabilitation results.

Conclusions:

1. The systematic organization and homogenisation therapeutic tools resulted in transdisciplinary treatment, decreasing workload of each specialist and optimizing objectives therapeutics.
2. The results pre and post evaluation show the improvement, especially in life quality, which is the main objective of treatment neurorehabilitation.

High Intensity Endurance Exercise Increases Cognitive Functions and Reduces Peripheral Matrix Metalloproteinase-2 Levels in Persons with MS - A Randomized Controlled Trial

Jens Bansi

Background: A frequent symptom in persons with MS (pwMS) is the decline of cognitive capacity. Regular aerobic exercise is known to induce beneficial structural and functional adaptations of the central nervous system.

The primary aim of this study was to investigate the influence of a three week high intensity aerobic exercise program (HIT) on cognitive functions in pwMS.

Methods: 62 pwMS (Expanded Disability Status Scale, 1.0-6.5) were randomly assigned to a HIT or a standard moderate intensity training group (CT). The HIT group exercised three times/week for 20 minutes, including five three-minute exercise intervals at 80% of their VO₂ peak with 90 second recreational breaks, whereas the CT group worked-out five times/week constantly for 30 minutes/session at 65% of their VO₂peak. Cognitive functions were assessed using the Brief International Cognitive Assessment for Multiple Sclerosis, the Trail Making Test as well as a Go/NoGo task at entry (t0) and discharge (t1). Moreover, resting serotonin, brain-derived neurotrophic factor (BDNF) as well as matrix metalloproteinase (MMP) -2 and MMP-9 levels were measured at t0 and t1.

Findings: The HIT group revealed significant improvements in executive functions (attention (p=0.029 95% CI [0.725; 12.704]), response inhibition (p=0.002 95% CI[0.428; 1.714]), and tended to improve verbal memory (p=0.084 95% CI [-5.956; 0.385]) compared to the CT. Endurance capacity increased in both groups but increase was significantly higher in the HIT group (p=.026 95%CI[.20; 2.97]). MMP-2 serum levels significantly decreased (p=0.037 95% CI [1.088; 32.770]) and BDNF (p=0.065 95% CI[-10.841; 0.343]) levels indicate a tendency to increase in the HIT group (p=.026 95% CI [.20; 2.97]).

Interpretation: These results suggest that HIT represents a promising time-efficient strategy to improve cognitive functions and physical fitness in pwMS. Furthermore, alterations in MMP-2 and BDNF serum levels suggest that exercise impacts physiological parameters which are involved the pathogenesis of MS.

Pilot Study of Effect Regular Yoga Exercise on Subjective Wellbeing and Physical Performance in Group of Multiple Sclerosis Patients

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Background: There is limited and conflict evidence about the effect of yoga on subjective wellbeing and objective performance in multiple sclerosis (MS) patients. Some studies suggest that regular yoga practice can help to reduce MS symptoms.

Methods: We performed data search in Pubmed using keywords yoga+multiple sclerosis. Based on selected articles we have prepared pilot study of effect regular yoga exercise on subjective wellbeing and physical performance in group of multiple sclerosis patients. Participants of study completed 8 weeks of regular yoga exercise (every week 1 supervised group yoga exercise organised in MS centre in General University Hospital in Prague and 2 individual home yoga exercise). The following evaluations were performed at baseline and after 8 weeks of exercise: Beck Depression Inventory, Fatigue Severity Scale, Multiple Sclerosis Walking Scale-12 (MSWS12), Timed 25 Foot Walk Test (T25FT), The 6 Minute Walk Test.

Results: A total of 8 people with MS (7 women, 1 men) with mean age 36,6 years (SD 4,6 years) and mild or moderate disability level (median EDSS 2,75, range 1,5-4,5) participated in our pilot study. There was improvement in subjective perceived walking limitation (MSWS12) from 25 to 21,5, in objectively measured walking performance in T25FT from 4,42 sec to 4,29 sec, and in the 6 minute walk test from 573 meters to 602 meters.

Conclusion: Regular yoga exercise with using of standing and balance positions is likely to improve gait performance in MS patients with mild to moderate disability. Other clinical trials with greater sample and control group is needed to confirm this finding.

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Effect of Music Therapy on Common Symptoms of Multiple Sclerosis

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Background: Music therapy is kind of psychotherapeutic interventions with aim to address physical, emotional, cognitive and social needs of individuals. There is only limited evidence how effective can be musical therapy in reducing symptoms of multiple sclerosis (MS).

Methods: To assess impact of music therapy on MS symptoms we organised pilot study: group of MS patients with music therapy and control group of MS patients.

The following evaluations were performed at baseline and after 3 months of musical therapy: Beck Depression Inventory (BDI), Beck Anxiety Inventory (BAI), Health related Quality of Life (SF36), Fatigue Severity Scale (FSS), Abilhand questionnaire, Multiple Sclerosis Impact Scale (MSIS29), Multiple Sclerosis Walking Scale-12 (MSWS12), Timed 25 Foot Walk Test (T25FT), The 2 Minute Walk Test, Quantitative gait parameters were assessed using GAITRite instrument, Nine hole peg test, Timed up and go test (TUG).

Results: A total 12 women with MS were enrolled in our study: 8 women in intervention group (mean age 39,7 years, SD 10,7 years, mean disease duration 9,2 years, SD 8,1 years, mean EDSS 3,4, range 1,5-5,5), 4 women in control group (mean age 39 year, SD 9,4 years, mean disease duration 8,5 years, SD 7,8 years, mean EDSS 3,3, range 1,5-6).

From all assessed outcomes in music therapy group we have found slightly improvement in anxiety and hand function. Participants of music therapy give positive feedback of therapy. They enjoyed first of all special musicotherapy instruments (samsula) and relaxation with music which was at the end of every sessions.
Conclusion: Music therapy can help to some MS patients in reducing symptoms such as anxiety or hand function. This study support for further dissemination of musical therapy as part of complementary care of people with MS.

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Effectiveness and User Experience of Web-based Interventions for Increasing Physical Activity in People with Multiple Sclerosis: A Comprehensive Systematic Review

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Background: Achieving and maintaining recommended levels of physical activity is important but challenging. Recent quantitative

reviews suggest web-based interventions are effective at increasing physical activity. Capturing the user experience is important to optimise the development of these interventions and understand factors impacting on their use. Thus, a review of both qualitative and quantitative studies is indicated.

Aims: To investigate the use of web-based interventions in increasing physical activity in adults with MS, and to explore user experiences. The review also sought to establish whether levels of physical activity achieved are in line with MS-specific guidance.

Methods: Using the Joanna Briggs methodology for comprehensive systematic reviews, 12 databases were searched (dates: 2000- 2016). Inclusion criteria were studies published in English investigating the use of web-based interventions to increase physical activity in adults with MS. Interventions were exercise or lifestyle activity based, with/without an active comparator, usual care or wait-list control and reported measures of physical activity (e.g. accelerometers or physical activity questionnaires). Qualitative studies exploring users' experiences of these interventions in any context were included. Studies describing use of the internet to deliver virtual assessments or gaming interventions (e.g. Wii/Xbox) were excluded.

Results: 881 records were identified through database and hand searching; after removal of duplicates 618 titles and abstracts were screened of which 549 were excluded. 69 full text papers were screened for eligibility with 60 excluded (n=5 not web based, n=13 no physical activity measure, n=15 review papers, n=10 duplicates, n=15 no full text, n=2 other). Two reviewers independently evaluated the quality of the remaining 9 papers and all were selected for inclusion. All used a quantitative methodology.

Conclusions: Data extraction and analysis is ongoing. The results (including effect sizes, 95% confidence intervals and analysis of heterogeneity), together with meta-analysis where appropriate, will be reported in this poster.

Participants' Experience of a Web-based Physiotherapy Programme for people with Multiple Sclerosis (MS): Does it impact physical activity levels?

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Background: Achieving and maintaining recommended levels of physical activity is important but challenging. Web-based interventions are increasingly used to deliver targeted exercise programmes and promote physical activity.

Aims: This research explored the experiences of people participating in a three centre, six month randomised controlled feasibility trial of web-based physiotherapy (WEBPaMS). Specifically, participants were asked about the impact the programme had upon their everyday levels of physical activity, and their ideas for its future development.

Methods: In-depth individual, face-to-face interviews were undertaken with consenting participants allocated to the web-based programme at one study site (Plymouth), within one month of their final WEBPaMS assessment (3 month follow up). Interviews were audio recorded, transcribed verbatim and data were analysed thematically.

Results: 11 out of a possible 12 people were interviewed (age range 28- 68 years; 90% female; Expanded Disability Scale range 4-6.5; Disease course - Relapsing Remitting [n=4], Primary Progressive [n= 1], Secondary Progressive MS [n=6]). Most (n=9) felt their overall physical activity levels had increased, [in part] as a result of using the programme. Three key themes were identified: (1) 'It's all in one place' encompasses the value perceived in having the convenience, flexibility and portability of a programme accessed on an electronic device; (2) 'Keeping an eye' captures thoughts regarding supervision offered by a physiotherapist, through the website ; (3) 'Hopes and expectations' reflects the importance of clinicians understanding participants' hopes and expectations when implementing the programme, particularly for those whose condition is deteriorating or when maintenance of physical activity levels is the primary intention.

Conclusions: Most participants found the web-based programme helpful in increasing and maintaining increased everyday physical activity levels. The level of supervision and type of support provided, particularly for those whose condition is deteriorating are important factors to consider with programmes of this nature.

Effects of 6 weeks GroupCoreDIST compared to standard care on balance and walking in ambulant people with multiple sclerosis: A single blinded Randomised Controlled Trial

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Background: People with multiple sclerosis (MS) often have balance and walking problems due to various impairments in underlying aspects of balance such as dynamic core stability, somatosensory deficits, paresis and coordination problems. A new group-based intervention; GroupCoreDIST (D=dose, dual; I=individualised, intensive; S=somatosensory, selective, specific; T=teaching, training) was developed to optimise dynamic core stability and improve balance and walking in people with MS.

Objectives: The study examined the effect of GroupCoreDIST intervention compared to standard care on balance and walking in people with MS.

Methods: This two-armed randomised controlled trial included 80 participants, Expanded Disability Status Scale score (EDSS) 1-6.5 randomly allocated to GroupCoreDIST intervention (n=40) or standard care control group (n=40). The intervention was conducted in groups of three participants together with a physiotherapist for 6 weeks, one hour, three times per week in a community setting. Assessments were undertaken by a blinded assessor at baseline and the week after the intervention was completed. Primary outcome measures were the Trunk Impairment Scale-Norwegian Version (TIS-NV) and Mini-BESTest. Secondary outcome measures were the 2 Minutes Walk Test (2MWT), 10 Meter Walk Test (10MWT) fast speed, Multiple Sclerosis Impact Scale -29 (MSIS-29), Multiple Sclerosis Walking Scale- 12 (MSWS-12). Independent sample t-test was used to detect statistical differences between groups.

Results: Seventy-nine subjects (EDSS: control group; Mean 2.28, SD 1.28; intervention group: Mean 2.45, SD 1.65) completed the study. Differences in means between groups from baseline to post test showed significant improvement in the intervention group for all outcomes: TIS-NV (p=0.000), Mini-BESTest (p=0.000), 2MWT (p=0.001), 10MWT (p=0.006),

MSIS-29 (p=0.009) and MSWS-12 (p=0.036) and no significant improvement in the control group.

Conclusion: The six week GroupCoreDIST program improved balance in sitting, standing and walking in ambulant people with MS to a greater extent than standard care.

The Impact of FES on gait speed in MS: a systematic review and meta-analysis

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Introduction: Functional Electrical Stimulation (FES) is an assistive technology used for foot drop in MS and other neurological conditions. Previous studies have reported positive effects of FES on gait speed. Community ambulation can be predicted by gait speed as measured by a range of short and long walking speed tests. There has been a growing body of evidence of FES for foot drop in MS, especially over the past 6 years. The aim of this systematic review is to review the efficiency of FES for foot drop in MS on gait speed in short and long walking performance tests.

Method and Materials: Five databases (Cochrane Library, CINAHL, Embase, MEDLINE, Pubmed) and reference lists were searched. Studies of observational and experimental design where gait speed data in people with MS (pwMS) could be extracted were included. Methodological quality was assessed using the Effective Public Health practice Project (EPHPP) tool. Initial and ongoing orthotic and therapeutic effects were assessed with regards to the impact of FES on gait speed in short and long walking tests.

Results: Four hundred and ninety pwMS recruited in 19 studies were identified. Studies were rated as moderate or weak in methodological quality. Meta-analysis revealed a significant initial (t= 2.14, p=0.016) and ongoing (t=2.81, p=0.003) orthotic effect with a mean increase in gait speed of 0.05 meters per second (m/s) and 0.08m/s respectively on combined short walking tests. There were no initial or ongoing orthotic effects on gait speed in combined long walk tests or a therapeutic effect in either walk tests.

Discussion and Conclusion: FES used for foot drop has a positive initial and ongoing effect on gait speed as measured by short, but not longer walking tests. Further fully powered RCTs comparing FES with alternative treatments are required.

Effect of treadmill training with virtual reality in improving gait and dynamic balance in patients with Multiple Sclerosis

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Background: The ability to adapt gait to different environmental situations is important to walk safely during daily life and is often reduced in people with Multiple Sclerosis (pwMS).

A new generation of treadmills, using Virtual Reality (VR), can improve gait adaptability and dy-namic balance providing

specific gait exercises including variable practice, high number of repetitions and performance feedback. However, their effect compared to traditional treadmills has not been proved.

Aims: to assess whether Treadmill training with VR (T-VR) is better than Traditional Treadmill (TT) training in improving dynamic balance in pwMS.

Methods: So far 32 subjects (age mean±standard deviation: 50.9±10.2 years, EDSS (medi-an±Interquartile range: 6±1.6) were assessed using the Timed up & go (TUG), Dynamic Gait Index (DGI) and Berg Balance Scale (BBS) before and after intervention.

The group was split (1:4 ratio) in the T-VR (n=6) and TT (n=26) group. The T-VR group under-went to about 15 30-40 minutes daily treadmill sessions. They were asked to react to visual targets or obstacles projected on the treadmill belt. TT group received a similar treatment without VR. Between group change scores (post-pre) were assessed using Mann-Whitney U test.

Results: No statistically significant between group differences were found at baseline. Median TUG change scores for T-VR and TT were respectively -3.4s(2.5) and -2.2s(3.0), P=0.07). DGI and BBS change scores for T-VR and TT were respectively 3.0(2.2) and 2.0(4.0), P=0.16 and 5.5(6.5) and 2.5(7.5), P=0.23.

Conclusions: These preliminary results suggest the use of T-VR specifically may increase the efficiency of TT in improving balance and gait adaptability in pwMS. Further investigations are needed confirm these results.

The effectiveness of Functional Electrical Stimulation on balance and gait in people with Multiple Sclerosis

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Background: Impaired mobility in people with MS is often manifested as footdrop which causes stumbles, falls, gait instability and decreased gait efficiency. This problem is recently solved with the functional electrical stimulation (FES).

Objective: In this study, we investigated the efficacy of two different applications of FES on balance and gait.

Methods: 46 pwMS aged 30 to 65 (22 females, 24 males, EDSS 2 – 7.5), were divided into 2 groups and underwent 2 different programmes for 2 months. Patients in the first group had borrowed programmed stimulator and used it in normal life. Patients in the second group underwent ambulatory program (one hour, twice a week) of facilitation physiotherapy with the 10 minutes of the FES exercise programme.

Participants were assessed on 4 occasions: 4 weeks before baseline, at baseline, after treatment and 2 months after treatment.

We examined balance (Berg Balance Scale, BBS, Timed Up and Go Test, Dynamic Gait Index, The Activities - specific Balance Confidence Scale), gait (Timed 25 - foot Walk Test, 2 - Minute Walk Test, Multiple Sclerosis Walking Scale 12, MSWS 12) and Multiple Sclerosis Impact Scale 29, MSIS 29.

Results: We found significant improvement in BBS (p<0.0005) and trend to improvement in MSWS 12 (p<0.02) and MSIS 29 (p<0.02) in both groups.

Conclusion: Both programs, facilitation physiotherapy with FES and using FES in normal life, have a positive effect on balance, gait and quality of life in people with MS.

Serious games for upper limb rehabilitation in People with Multiple Sclerosis: a feasibility study

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Introduction: Serious games are a promising solution for arm rehabilitation allowing the implementation of engaging and high-intensity solutions by adding the entertaining component of gaming to focused treatment. Preliminary positive results have been seen with different serious-gaming solutions developed but there are no studies involving People with Multiple Sclerosis (PwMS). Within the European project Rehab@home a serious games platform was developed using the Kinect® technology and applied to arm rehabilitation of PwMS.

Aim: to investigate the feasibility of a serious games approach for upper limb rehabilitation in a sample of PwMS.

Methods: 18 PwMS reporting upper limb deficits, screened for cognitive deficits and depression, were recruited (mean age 56±10 years; mean disease duration 18±10 years; mean EDSS 6.5±1.0; 12 female). Every participant received 12 to 15 sessions (3-5x week) of serious games aimed at improving the most affected upper limb in addition to usual care. Evaluation were conducted pre and post treatment: upper limbs fine (Nine Hole Peg Test) and gross (Box and Blocks Test) function, quality of life (SF-12) and quality of health (EQ-5D-5L).

Wilcoxon matched pair test was used to assess changes from baseline to post treatment in both treated and non-treated arm. T-test was applied to verify differences between treated and non-treated change scores.

Results: Statistically significant improvement was found only in the treated arm in Nine Hole Peg Test (p=0.007) and in Box and Blocks Test (p=0.03) while no differences were found in changes scores between treated and non-treated arm. A statistical improvement was found in the mental composite score of the SF-12 (p=0.03) but not in physical score of SF-12 and in the EQ-5D-5L.

Conclusion: An intervention with a serious-games approach positively influenced arm recovery in PwMS, improving treated arm, and probably played some role in improving self-perception of mental health.

A modified version of a UK group-based fatigue management programme for people with MS (FACETS) for an inpatient setting in Norway

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Background: FACETS (Fatigue: Applying Cognitive behavioural and Energy effectiveness Techniques to lifestyle) is a 6-week group-based fatigue management outpatient programme developed in the UK for people with MS (pwMS) that has demonstrated effectiveness in a multi-centre randomised controlled trial.

Aims: i. to translate FACETS into Norwegian; ii. modify the 6-week outpatient group programme into an inpatient programme; iii. assess preliminary feasibility and acceptability.

Methods: The facilitator manual was translated by a UK translation company. The participant workbook and PowerPoint materials were translated by two occupational therapists and a physiotherapist at MS-Senteret Hakadal (MSSH). Subsequent cultural and institutional transadaptation of all programme materials was undertaken at MSSH. The modified group programme was tried out in the rehabilitation setting over a 6-month period. A final modified version was feasibility tested in a small pre-post pilot study (n=11) involving delivering two FACETS groups. Content, duration and usefulness was assessed by an evaluation questionnaire incorporating open questions. The Chalder Fatigue Questionnaire (CFQ) and Fatigue Self-Efficacy Scale (FSE) were administered pre- and post-programme.

Results: The modified version includes four sessions with "homework" between sessions. Participants were content with the group format and facilitation and liked the homework. Participation did not adversely affect other desired rehabilitation activities. Reported benefits included normalisation of fatigue, greater awareness of energy use and of ways to rest. Participants highly valued the peer support element and the opportunity to learn new fatigue management strategies. Mean differences (MD) for the CFQ (baseline M=22.36; SD=6.25; MD=10.09 [95% CI: 5.13, 15.05], $p = .001$) and the FSE (baseline M=40; SD=12; MD=-20 [95% CI: -27, -12], $p < .001$) indicated improvements.

Conclusion: The modified version of FACETS appears feasible and acceptable. While only a small uncontrolled study, preliminary findings suggest FACETS offers promise in an inpatient rehabilitation setting with further research warranted.

Functional motor disorders: diagnostic and treatment options for patients with Multiple Sclerosis

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Background: Multiple Sclerosis (MS) is characterized by weakness, tremor, dystonia, paralysis, and motor symptoms caused by pathological processes in the central nervous system (Noseworthy et al., 2000). The same symptoms can be caused by functional problems called functional motor disorder (FMD) (Nielsen et al., 2010).

Objectives: In our study we try to describe FMD in MS and secondly measure the benefit of an individualized, outpatient physiotherapy program focused on FMD.

Methods: A total of 44 patients with MS (32 female, 12 male; EDSS less than 6.5; no previous physiotherapy in 6 month; ability to stand independently at least 30s) were randomly picked for study and divided in two groups; each group receives a different kind of therapy (Manual physiotherapeutic correction or Dynamic Neuromuscular Stabilization) during the three months. The effect of therapy was verified by special developed computer software evaluating function of 82 muscles (MFK System) and outcome measures evaluating balance (Berg Balance Scale, BBS; Dynamic Gait Index, DGI). All tests were repeated four times; one month before therapy, immediately before and after therapy and two months after the therapy.

Results: People with MS suffer from FMD that can worsen their motor functions. The individualized physiotherapy program/ both physiotherapeutic methods had a significantly positive effect on the muscle functions ($p < 0,005$) and BBS ($p < 0,005$).

Conclusions: Future research should explore whether the achieved changes of muscle functions persist and for how long, and whether the intervention can influence clinical symptoms of MS, and consequently their quality of life.

The effect of yoga in people with Multiple Sclerosis

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Multiple sclerosis (MS) affect patients' physical, cognitive and emotional domains. Current empirical research has provided evidences about the positive effect of yoga among people with MS (PwMS) (e.g. decreased pain, reduced depression and fatigue, improved muscle strength flexibility and relaxation, lower levels of stress, improved QoL). Most of studies evaluated the effects after a long period of treatment (from 12 to 24 weeks; 2/3 sessions a week). Thus, up to now the effects of yoga on a shorter treatment duration are unknown. In this study we evaluated the effects of a short-period treatment of yoga (at least 15 sessions in 6 weeks, 5 sessions each 2 weeks) on these domains. We enrolled 20 Italian PwMS according to inclusion criteria (EDSS<5; no comorbidities; age 18-65 years). The experimental group (EXP, 10 subjects) performed yoga exercises whereas control group (CTRL, 10 subjects) performed no exercise (or other rehabilitative treatments) during the same period of 6 weeks. Groups did not differ for age (EXP, 44.80±15.10y; CTRL, 48.00±14.03y), disease duration (EXP, 10.00±9.33y; CTRL, 12.50±7.21y), EDSS (EXP, 2.85±1.68y; CTRL, 2.95±1.48y) and disease course (both groups of 8 relapsing-remitting and 2 secondary progressive). RM-ANOVA showed that all the outcome measures were not significantly different at the baseline between groups, whereas they were found significantly different ($p<0.05$) immediately after the last session of yoga. In fact, EXP group improved 2MWT, MFIS, MSIS-29, SDMT, HADS and Life Satisfaction Index.

By confirming previous findings, results showed yoga improves physical, cognitive and emotional status of PwMS; interestingly, the effect is present already after a short-period of treatment. However, to draw more useful conclusions about the potential use and benefits of yoga in managing the symptoms of MS, future research should include more rigorously designed trials.

Is there a center for cognitive reserve in multiple sclerosis? The role of the right BA40 in cognitive performance

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Cognitive impairment is common in people with multiple sclerosis (PwMS), but often it does not directly relate with brain pathology extent. The model of cognitive reserve suggests that the brain

actively attempts to cope with brain damage by using pre-existing cognitive processes or enlisting compensatory strategies.

Our aim was to investigate the effects of cognitive rehabilitation based on adaptive working memory training on cognitive performance and brain functional reorganization in PwMS.

Eighteen PwMS underwent a 8-week home-based cognitive rehabilitation treatment, with a recently developed application software for portable devices able to administer personalized treatments based on working memory exercises. Before and after the training, they underwent an fMRI session during a cognitive task (Paced Visual Serial Addition Test-PVSAT) and were evaluated with the auditory analogue test (PASAT) to assess cognitive performance. Eighteen matched healthy controls were included for comparison.

The training was effective in improving the patients' cognitive status. Moreover, after the training PVSAT elicited in PwMS a brain activation map which was more similar to that found in healthy participants than at baseline. In fact, after cognitive rehabilitation PwMS showed reduced neural activity, with activation clusters mainly located in the right cerebellum and in the left hemisphere. The only right hemisphere activation cluster observed in patients after the treatment was located in the inferior parietal lobule (BA 40); the BOLD signal extracted in this area significantly correlated with cognitive performance at both sessions.

An adaptive working memory training can improve cognitive performance in PwMS and also impact brain functional reorganization, increasing brain efficiency by reducing the additional networks involved by cognitively impaired individuals and restricting the neural recruitment to the circuits that are responsible for the maintenance of function (e.g., right BA 40). We suggest that the right BA 40 may represent a "core" of cognitive reserve in PwMS.

Conflict of interest and funding

This work was supported by the FISM project n. 2011/R/8. The authors declare no conflict of interest related to this study.

Adherence in multiple sclerosis: A qualitative study comparing firstline and secondline immunotherapies

Untiedt, B., Pust, G.E. (presenter), Liethmann, K., Rholoff, T., Köpke, S., Rahn, A., & Heesen, C.

Low treatment adherence is a substantial problem in Multiple Sclerosis (MS) treatment. Recent data collected in a sample of German patients with MS showed that only 30-40% of the individuals were adherent to disease modifying drugs. The purpose of this qualitative study was to identify patient-related factors associated with a discontinuation or modification of firstline treatments in comparison to patients on secondline treatments were surveyed.

A sample of patients with MS on oral firstline treatment and secondline treatment was surveyed using semi-structured clinical interviews. Medication history and the patients' experiences with prior medication, the decision-making process, adherence behavior and reasons for adherence and non-adherence were assessed. Qualitative content analysis was used to evaluate the interviews.

Two independent raters inductively generated a disjunctive category system (40 categories). The interrater reliability was satisfying (firstline sample: Cohen's Kappa = .76, secondline sample: Cohen's Kappa = .64). The main reason for non-adherence reported

by patients on firstline therapy was "burdensome side effects". The main reason for staying adherent was the "belief in medication effectiveness". In secondline patients, a "lack of perceived medication effectiveness" was the main reason related to changes or a discontinuation of the treatment. Reasons for adherence were "positive illness beliefs/perceptions" and "the belief in a highly active disease". In comparison of the two sub-samples, patients on secondline treatment were less intentionally non-adherent.

This study demonstrates the necessity but also the potential to systematically study factors influencing adherence and non-adherence in patients with MS. Reasons identified in this study can serve as a basis for the development of a standardized tool that could help to advance research in this field and secure treatment adherence in clinical practice by identifying and addressing potential risk-factors. These may apply also to non-drug treatment approaches as behavioral interventions.

Cross-sectional study of pain and symptom clusters in MS

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Background: Pain is often reported as a part of a symptom cluster in MS, described as "three or more symptoms related to each other, connected etiologically, presented at the same time and influencing each other". Multiple Sclerosis-Senteret Hakadal is a specialized center for rehabilitation of people with MS in Norway. **Aim:** Describe prevalence and characteristics of pain, fatigue, depression, sleep quality and Quality of life (QoL) during four weeks prior to attending a rehabilitation stay.

Material and Method: 52 patients (11 PPMS, 5 SPMS, 36 RRMS), age 48±12, 42 women and 10 men, EDSS median 2,5 (range 0-7), were randomly recruited before arrival. Questionnaires for assessment of pain (pain drawing, NRS, PainDetect (PD)), fatigue (Fatigue Scale for Motor and Cognitive Functions (FSMC)), sleep quality (NRS) and QoL (MSIS-29v2) were used.

Results: 94% reported pain, NRS 4,1±2,15 most intense in neck/upper back and most frequent in lower extremities. 33% had probable neuropathic pain. 94% reported fatigue (at any level), 17% reported possible or probable depression and only 2 patients described their sleep as "good". No correlation between pain intensity and fatigue, depression or sleep quality was found. There was good correlation between pain intensity and QoL (Pearson's $p=0,528$, $p<0,01$). There was no difference in pain level between smokers and nonsmokers, patients in relations and those living alone, different education levels, alcohol consumption, employment status, EDSS or sex. No significant differences were found in pain intensity for different levels of fatigue or depression, but there was significant difference in reported pain for those with good vs affected sleep quality ($p=0,033$) and not depressed vs possibly depressed ($p=0,026$).

Conclusion: In this study sample prevalence of pain and fatigue is higher than reported in other studies. There is a high level of coexistence of symptoms, confirming the symptom cluster theory need/benefit of multidisciplinary approach.

Funding

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Medications and falls in Multiple Sclerosis

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Background: Polypharmacy and certain types of medications are well-established risk factors for falls in older adults. To date, little is known about medication usage and fall status in people with Multiple Sclerosis (pwMS).

Objective: To explore medication use and prospectively measured falls in pwMS

Methods: Consecutive patients attending the MS clinic in a tertiary hospital were recruited. MS characteristics and current medications were documented at baseline and verified by treating Neurologists. Participants completed three months of prospective falls diaries. Medications were classified based on the Anatomical Therapeutic Chemical (ATC) classification system.

Results: Data was collected from 101 participants. The mean age was 52.55 (SD=10.73) and 67% of participants were female (n=67). Mean EDSS was 5.25 (SD=1.15) with a mean time since diagnosis of 14.29 (SD=8.99) years. Seventy-four (72.2%) were classed as having a progressive form of MS. Participants took a total of 364 medications and fifty-six participants recorded 791 falls. Mean number of medications for fallers was 3.59 (SD=2.60) and for non-fallers was 3.70 (SD=3.08), which was not significantly different between groups. No correlation was found between number of medications and number of falls in the total sample ($r=0.082$, $p=0.415$) or in the fallers alone ($r=0.199$, $p=0.141$). No significant differences were found between the groups for the number of medications in each ATC class or the number of people taking each class except that more fallers took Genitourinary and Sex Hormone class medications ($\chi^2=6.007$, $p=0.017$).

Conclusions: This study found no correlation between number of medications and number of falls; furthermore fallers did not take more medications than non-fallers in this sample who had mainly progressive MS. The findings of this study may prove beneficial for the development of multi-factorial falls prevention interventions.

Maintenance of the default mode network functional connectivity through an integrative group-based cognitive rehabilitation in multiple sclerosis

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Introduction: The REHACOP, an integrative group-based cognitive rehabilitation programme, has recently been demonstrated to enhance cognitive performance in MS (Rilo, 2016). The study of brain functional (FC) and structural connectivity (SC) might help to clarify the neuroplastic mechanisms that underlie this cognitive improvement. Therefore, this study aimed to investigate brain changes in the FC within the default mode network (DMN) as well as in the brain SC following the implementation of the REHACOP in MS patients.

Methods: Forty MS participants were randomly allocated to the experimental (n=20) or wait list control (n=20) condition. The experimental group attended cognitive rehabilitation for three months (three one-hour sessions/week) focused on attention, learning and memory, executive functioning, language and social cognition. Resting-state and diffusion weighted images were acquired on a Philips Achieva 3-Tesla scanner at baseline and follow-up. Resting-state data was analysed using Conn Functional Connectivity Toolbox. Diffusion weighted images [fractional anisotropy (FA) as well as mean (MD), axial (AD) and radial (RD) diffusivity maps] were analysed utilizing Tract-Based Spatial Statistics as implemented in FSL. Both FC and SC changes following the intervention were explored through 2x2 repeated measures MANOVA GroupxTime interaction.

Results: Resting-state GroupxTime interaction revealed a significant and bilateral FC change between the medial prefrontal cortex (MPC) and the left lateral parietal lobe (LPL) ($F=6.44$; $pFDR-corrected=0.04$, $d=0.66$) following the intervention. Specifically, the FC between the MPC and the left LPL remained stable in the experimental group after the intervention, while the control group exhibited a decline in this connectivity. No significant GroupxTime interactions were detected in brain SC (FA, MD, AD or RD) after the intervention.

Conclusion: These findings suggest that integrative group-based cognitive interventions could maintain the FC within the DMN in MS patients. Therefore, continuous cognitive stimulation could be essential to preserve an adequate FC within this network in MS.

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Web-based physiotherapy for people moderately affected by Multiple Sclerosis: a feasibility multicenter study

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Background: The internet may provide an effective medium to support people with Multiple Sclerosis (MS) to exercise. The aim

of this study was to assess the feasibility of a randomised controlled trial comparing a 6 month web-based physiotherapy programme to a standard home-based exercise programme in people moderately affected by MS.

Methods: A single-blind, randomised controlled feasibility trial was conducted. People with MS (EDSS 4.0-6.5) were recruited from 3 sites; NHS Ayrshire and Arran, NHS Lothian and Plymouth Hospitals NHS Trust. Participants were randomised to receive a six month individualised physiotherapy exercise programme delivered via www.webbasedphysio.com (intervention) or printed exercise sheet with exercise diaries returned to the therapist (comparator). Participants in both groups were asked to complete their programme twice/week. Primary outcomes were compliance to the exercise programme and 2 minute walk. Secondary outcomes included MS Impact Scale-29 (MSIS-29), Berg Balance Scale and 25ft walk.

Results: Ninety people (77% female; 56.7(9.6) years; EDSS 4.0-5.5 (n=24), EDSS 6.0-6.5 (n=66)) were randomized to the intervention (n=46), and comparator groups (n=44). Participants withdrew from both groups due to health reasons (n=3), lack of interest (n=1), transport (n=1), and family reasons (n=1). Preliminary analysis demonstrates that compliance rates, taken as the number of exercise diary entries/week, in both groups were high (>68% compliance). There was no difference between groups in the 2-minute walk test after 6 months (-2.26m, 95%CI(-10.73, 6.22) p=0.69); and no differences at 6 months between groups in the MSIS-29, Berg Balance Scale and 25ft walk.

Conclusion: Although analysis is ongoing, the results appear to show that there was no change in outcomes over time. Given the progressive nature of the condition and the cohort both interventions may be feasible and effective self-management programmes to maintain exercise compliance and physical function in people moderately affected by MS.

Funder

MS Society UK

Effects of an intensive, multidisciplinary inpatient rehabilitation program in subjects with multiple sclerosis with different levels of disability: preliminary data

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Background: Multiple sclerosis (MS) is a chronic disease leading to progressive disability among young adults. Motor rehabilitation strategies proposed for MS patients are heterogeneous; moreover, the optimal duration and intensity of treatment are not yet standardized.

Objective: To investigate the effects of a tailored, intensive multidisciplinary rehabilitation (MR) on disability and health-related

quality of life (HRQoL) in MS patients with different levels of disability.

Methods: 30 MS patients [14 males, 16 females, aged 18-65 years; expanded disability status scale (EDSS) ≤ 8.5] were hospitalized in our Department of Brain Injury and Parkinson's Disease Rehabilitation for an inpatient MR. Rehabilitation protocol (3 hours/day, 6 days/week) included front-to-front physiotherapy, mechanical rehabilitative devices, robotic devices (Lokomat, Hocoma) and occupational therapy; it was individually designed for each patient according to the clinical features and severity of disability. Before and after the intervention, participants were evaluated with: EDSS, functional motor tests [Functional Independence Measure (FIM) and Trunk Control Test (TCT) for all patients; Dynamic Gait Index (DGI), Berg Balance Scale (BBS) only for ambulating patients], self-assessed measurement of disability (12-items MS walking scale, 12MSWS), fatigue (Modified Fatigue Impact Scale, MFIS) and HRQoL (Multiple Sclerosis Quality of Life, MSQoL-54).

Results: all participants completed the rehabilitation protocol. Mean MR duration was 54.8±33.7 days. At the end of rehabilitation period, an improvement of both the self-assessed and functional motor scales was recorded (p<0.05 for EDSS, FIM, TCT, DGI, 12MSWS respect to baseline). A positive effect was also observed in self-perception of global health status and fatigue after treatment (p<0.05 for MSQoL-54 and MFIS).

Conclusions: we suggest that an intensive multidisciplinary rehabilitation protocol is feasible in MS patients with variable levels of disability and effective in improving their motor abilities and quality of life. Further studies are needed to evaluate the long-term treatment effect over time.

Muscle fatigability in persons with multiple sclerosis – preliminary data.

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Background: Most studies show that muscle fatigability is more pronounced in persons with multiple sclerosis (pwMS) than in healthy controls (HC). Numerous fatigability protocols have been applied but no studies have compared muscle fatigability with protocols based on isometric or isokinetic contractions in the functionally important muscle groups of the lower extremities.

Furthermore, the underlying mechanisms are poorly understood.

Objective: The purpose of this study is to 1) compare fatigability of m. quadriceps induced by either isokinetic or isometric muscle contractions in pwMS and in healthy controls, and 2) evaluate the potential involvement of central and peripheral mechanisms.

Methods: 20 MS patients and 10 HC subjects had their m. quadriceps maximal strength and voluntary muscular activation determined, along with muscle fatigability during maximal

isometric and isokinetic contraction protocols. Fatigability is expressed as the relative decline in torque, whereas peripheral and central fatigability was determined by the twitch-interpolation technique.

Results: Our preliminary data showed that muscle fatigability was greater in pwMS than HC after the isokinetic protocol (31 vs. 20 %, $p < 0.05$), and tended to be greater after the isometric protocol (63 vs. 54 %, $p = 0.07$). Additionally, muscle fatigability was greater after the isometric protocol than the isokinetic protocol ($p < 0.05$ in both groups). Central fatigability tended to be higher in pwMS than in HC (isokinetic: 13 vs. 1 %, $p = 0.13$ and isometric: 38 vs. 22 %, $p = 0.08$). No significant differences in peripheral fatigability was observed.

Conclusion: This is the first study to investigate muscle fatigability in pwMS in lower extremities during both isometric and isokinetic contractions. Muscle fatigability is more pronounced in pwMS when compared to HC, plausible explained by a higher level of central fatigability in pwMS. The study is still ongoing, and a larger dataset will be presented at the RIMS conference in case the abstract is accepted.

Psychotherapeutic Intervention in the Initial Coping Phase in Newly Diagnosed Patients of Multiple Sclerosis

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Background: Many studies in clinical samples of patients with multiple sclerosis (PwMS), have found that the moment of diagnosis acts as a vital traumatic episode that could generate different psychological symptoms (eg, generalized anxiety, fear of uncertainty, hypothyroid mood, insomnia, low self-esteem). This symptomatology could negatively modify the coping of the diagnosis of MS, for that reason an intervention program focused in this clinical area is essential.

Objectives: This study presents the following specific objectives; 1) to minimize the reactive psychological symptomatology of diagnosis, 2) to increase the use of coping strategies in the face of external stressors, and 3) to increase the sense of well-being and to provide resources to optimize the quality of life.

Method: The treatment group (TG) consisted of 9 PwMS, of whom 84.6% had MS-Relapsing-Remitting with a mean age of 36.69 years. They were evaluated at the beginning and at the end of the follow-up of a period of 14 sessions using the different scales; SCL-90, Short Form-36 Health Survey (SF 36) and Coping Response Inventory (CRI-A).

Results: Statistically significant differences were found between the beginning and the end of the follow-up. There was a decrease in clinical symptomatology, especially in somatization (1.63 vs 0.82), obsession (1.62 vs 0.62), depression (1.80 vs 0.72) and anxiety (1.40 vs 0.42). 2) Increased approximate coping style (37.27 vs 52.15), and 3) increased perceived health sensation, especially in the physical role (51.88 vs 63.68), mental health (46.47 vs 70.80) and vitality (36.98 vs. 45.92).

Conclusions: The results indicate that early psychological intervention in the process of accepting the diagnosis of MS helps to encourage the psychological adjustment of MS and to develop compensatory strategies for external stressors that affect in the course of the disease.

Clinical Outcomes Following Application of a Clinical Practice Guideline for Persons with Multiple Sclerosis in a Multi-Discipline Rehabilitation Facility

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Background: The Multiple Sclerosis (MS) clinical practice guideline (CPG) was created to assist the rehabilitation clinician in performing a thorough evaluation and develop an evidence-based plan of care. The development of a CPG was conducted to fit the unique mission, situation, and needs of Sheltering Arms Rehabilitation Hospital, its employees, and the community. The development and assimilation of this information represents a significant commitment to excellence in serving individuals living with MS across the rehabilitation across a spectrum of care, for a multitude of services. Persons with MS have variant disability levels and can present to rehabilitation services in acute care, home health, inpatient rehab, outpatient rehab and recreational fitness. The CPG was intended to provide the clinician in each setting, guidance on a thorough assessment and evidence-based plan of care, including an appropriate transition through the rehabilitation spectrum, into a long term fitness program.

Objectives: A retrospective analysis of clinical outcomes related to outpatient Physical Therapy (PT), Occupational Therapy (OT) and Speech Language Pathology (SLP), following implementation of a MS CPG.

Methods: Patients were first grouped by gait velocity; Group 1: 0 – 0.39 m/sec, Group 2: 0.4 – 0.79 m/sec, Group 3: 0.8- 1.19 m/sec, and Group 4: >1.2 m/sec. Analysis of outcome measures were then performed within these groups.

Results & Conclusions: Through the application of a CPG, the patients discussed received excellent outcomes. Even with a heterogeneous patient population, consistency of practice and continuum of care is important in overall health and well-being of persons living with MS.

Effectiveness of using a robotic exoskeleton for gait disorders in people with multiple sclerosis (pwMS)

Loretta Bacci, Tecla Zaccari, D'angelantonio Lucia, Raspa Raffaello, Silvano Alessandro, Morgantini Antonello

Background: The recent diffusion of robotic exoskeleton could change the way in which rehabilitation is provided to neurological patients. Robots for rehabilitation are designed as a possible tool for therapist to automate labor intensive training techniques, especially when patients require a high amount of support.

Methods: The main goal of this study is to assess the effectiveness of the use of an exoskeleton robot for ambulation in pwMS with high disability. An exoskeleton robot (EKSO-Bionics) has been identified: it allows an active assisted ambulation in any environment frequented by the patient and it is customizable to the needs and the clinical case history of the patient. The target of this study are just the pwMS with EDSS from 3.5 to 7.5 at risk of losing functional ambulation. During the study patients will not change pharmacological therapies that could influence gait. Inclusion Criteria: patients with definite MS according to McDonald, in a stable phase of the disease; EDSS from 3,5 to 7,5. Exclusion

Criteria: a relapse in the last three months; psychiatric disorders, severe cognitive impairment. Patients with relapses during the study will be excluded. Six pwMS have been evaluated: T0 (start of rehabilitation treatments), T1 (end of rehabilitation treatments) and T2 (three month follow up). Clinical evaluation (T0, T1, and T2) have been performed with the following clinical scales: 6 minutes walking test (6MWT), Berg Balance Scale (BBS), Time up and go Test (TUG), Fatigue Severity Scale (FSS), Fall Efficacy Scale (FAS), Activities-specific Balance Confidence Scale, Activities of Daily Living, Instrumental Activities of Daily Living, Multiple Sclerosis Quality of Life -54 Instrument (MSQOL-54). Patients treated a treatment with EKSO with different settings according to patients' characteristics. The operating mode of EKSO will be personalized for each single patient.

Results: At the end of the treatment an improvement of balance (BBS T0 : 34, T1 :40, T2 :38), walking ability (6MWT: T0 speed:118 sec, T1 speed: 54 sec, T2 speed: 85 sec ; T0 distance: 95 metre, T1 distance 134 metre, T2 distance 97 metre) and quality of life (MSQOL 54 Physical Health T0:57, T1: 70, T2:75 , Mental Health T1: 66, T2:72, T3:92) was observed in almost all the patients.

Conclusions: The improvements were maintained to follow-up. EKSO robot-assisted gait training is feasible and safe and may be an effective additional therapeutic option in MS patients with severe walking disabilities.

Effectiveness of a Pelvic Floor Muscle Training Based on Intravaginal Electrical Stimulation for the Treatment of Urinary Incontinence in Women With Multiple Sclerosis: A Pilot Study.

Eleonora Magni, Anabel Granja Dominguez, Anja Hochsprung

Background: Lower urinary tract dysfunction affects 50-90% of people with Multiple Sclerosis (MS) at some stage throughout the course of the disease. All these dysfunctions generate urinary incontinence, classified as: stress, urge and mixed. It is a serious medical condition with a severe social impact, causing embarrassment and negative self-perception. Urinary incontinence can be treated with: conservative or pharmaceutical intervention, surgery or pelvic floor muscle training (PFMT). PFMT may consist of exercises or intravaginal electrical stimulation.

Objective: Evaluate the effects of PFMT based on intravaginal electrical stimulation in women with MS and urinary incontinence.

Methods: A quasi-experimental trial with a sample of 10 subjects. Females with MS and fulfilling strict inclusion/exclusion criteria were recruited. All the subjects received the treatment, which consisted in intravaginal electrical stimulation with Neurotrac TMETS. Parameters used: frequency: 25 Hz; pulse duration: 450 us; time: 20 min; 20-s on/40-s off cycles. Outcome measures included: urinary leakages (measuring with week-bladder diary), power and endurance of pelvic floor muscle measured with electromyography (Neurotrac TMETS with an intra-vaginal biofeedback electrode). The intervention was carried out once a week under physiotherapy supervision, and daily at home during 9 weeks. Data registered before and after the intervention, with a 3- month follow-up.

Results: Significant difference in pelvic floor's power ($p < 0.003$) and endurance ($p < 0.005$) after the intervention. Mean of urinary leakages before the treatment $\mu = 5$, after the intervention and at the 3-month follow-up $\mu = 1$.

Conclusion: PFMT based on intravaginal electrical stimulation seems to be effective to improve the pelvic floor function, reducing urinary leakages and urinary symptoms in women with Multiple Sclerosis. Further studies will be needed to confirm its efficacy.

Effects of a 6-month yoga program on physical and psychosocial status in persons with multiple sclerosis

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Background: There is evidence about the effects of mostly short-term yoga training programs on psychosocial variables such as fatigue, quality of life, and depression in persons with multiple sclerosis (MS). Therefore, the present study aimed to examine the effects of a long-term (6-month) yoga program on walking and balance, and fatigue, quality of life, depression, pain, and kinesiophobia in persons with MS.

Methods: The persons with MS and their healthy relatives who met the inclusion criteria were evaluated before the study in terms of walking and balance, and fatigue, quality of life, depression, pain, and kinesiophobia. Yoga training was given once a week (at least one hour) for six months. The same assessments were also performed immediately after the end of the training (i.e. after 6 months) by the same assessors. Because the completion rate was very small in the healthy subjects, the comparison before and after the yoga program was not calculated for this group. The changes in outcome measures from baseline at 6 months in the participants with MS were compared with the Wilcoxon signed-rank test.

Results: In total, 44 participants (27 persons with MS and 17 healthy subjects) participated in the study. Twelve persons with MS and three healthy subjects completed the 6-month yoga intervention. The completion rate for the persons with MS was 44.4% and this rate was 17.6% for healthy subjects. In participants with MS, mental component of quality of life, walking speed, fatigue, and depression levels significantly improved after the yoga program ($p < 0.05$). On the other hand, there was no significant change in self-reported walking impact, balance, pain, physical component of quality of life, and kinesiophobia levels ($p > 0.05$).

Conclusion: This study suggests that the 6-month yoga program can improve mental health-related quality of life, walking speed, fatigue, and depression in the persons with MS.

The immediate effects of a patient education meeting on health locus of control of persons with multiple sclerosis and their family members

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Background: Health locus of control (HLOC) is a measure of individuals' beliefs in factors such as their own actions or external agents that are thought to determine their health status. An internal HLOC suggests that positive health results from one's own doing, willpower or sustained efforts. In contrast, an external HLOC is marked by belief in the influence of chance or powerful others upon one's health. Therefore, it is important to improve HLOC to increase patient's skills and motivation to achieve more successful disease management. Here, we report the immediate effects of a patient education meeting on HLOC of persons with multiple sclerosis (pwMS, MS) and their family members.

Methods: The pwMS and their family members participated a four-hour patient education meeting organised by MS Research Association. Healthcare professionals, experts in MS, did presentations about MS characteristics, diagnosis, treatment, and ways of coping. The HLOC was assessed with the Multidimensional HLOC Scale.

Results: In total, 23 pwMS and 18 family members completed the Multidimensional HLOC Scale before and after the meeting. There was no significant difference between pwMS and their family members in terms of age, gender, level of education, marital status, and employment status ($p>0.05$). There was no significant difference in the internal, chance and powerful others scores in pwMS after the meeting ($p>0.05$). The internal score was significantly increased in the family members ($p<0.05$).

Conclusions: This study suggests that the meeting may have a positive effect on the internal HLOC in the family members. This might be interpreted as the family members improved their beliefs that MS is curable and controllable. Thus, their support to their relatives with MS might be increased in the future. However, it seems that there were no significant immediate effects of the meeting on HLOC of pwMS.

Comparison of the Effects of Two Different Balance Systems on the Balance, Functionality and Fatigue of Multiple Sclerosis Patients

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Background: Balance problems are seen very common in multiple sclerosis (MS) patients and its treatment is important to

prevent falls and increase mobility for functionality. Nowadays, virtual reality therapies are frequently used for to reduce different MS symptoms, but to our knowledge, there is not any study that compares the effects of two different virtual reality method in MS. **Purpose:** To investigate and compare the effects of exercise training with 'Nintendo Wii Fit' and 'Balance Trainer' on balance, functionality, and fatigue in patients with MS.

Method: Thirty-four MS patients (30 female, 4 male) were included in the study and randomized to Group I-Nintendo Wii Fit (mean age=47.46±10.53 year, EDSS=4.16±1.37) and Group II-Balance Trainer (mean age=43.08±8.74 year, EDSS=3.83±1.49). Patients were evaluated before and after the treatment with "Berg Balance Scale" and "One Leg Stance Test" for balance, "Timed Up and Go" and "6 minutes walk test" for functionality and "Fatigue Severity Scale" for fatigue. Patients were participated to an exercise program with Nintendo Wii Fit or Balance Trainer under the supervision of a physiotherapist on 2 days a week for 8 weeks.

Results: There were no differences between the groups in the terms of clinical and demographical features before the treatment ($p>0.05$). Outcome measurements before and after the treatment, intragroup changes and differences between groups are shown in Table I. Nintendo Wii Fit is found superior to Balance Trainer only in the Fatigue Severity Scale.

Effects of progressive resistance training on functional capacity in multiple sclerosis – results from the ACTIMS pilot study

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Background: Most exercise studies in persons with multiple sclerosis (MS) does not consider patient medication. Furthermore, the effects of progressive resistance training (PRT) on functional capacity is inconsistent in persons with MS. Thus, the objective of this study was to determine whether PRT improves functional capacity in relapsing-remitting multiple sclerosis patients with stable low EDSS scores on undergoing standard disease modifying therapy (DMT).

Materials and methods: The present study was a multi-centre, randomized, controlled study including a 6 months follow up period. Thirty-five persons with MS were randomized to 6-9 months of either PRT (n=21) or modified physiotherapy (MPT) (SE, n=14). During the intervention period, the PRT intervention consisted of partly supervised standardized whole body resistance training at a fitness facility twice a week as well as one home training session. The SE group performed thrice a week physiotherapist guided home training, including balance training, stretching, low intensity muscular endurance training (> 20 RM) and relaxation exercises. Functional capacity was assessed by the 5 time sit to stand test (5STS) and the 6 minute walk test (6MWT). Muscle strength was assessed by a one repetition maximum test in the PRT group only.

Results: No significant interaction between time and group were apparent for the 5STS ($p = 0.15$) and the 6MWT ($p = 0.15$). A one-way repeated measures ANOVA revealed that the PRT group significantly improved 1 RM performance for leg press, hamstring curl, bench press and cable pull down, respectively ($F(2,19) = 38.28$, $p < 0.0001$; $F(2,19) = 13.87$, $p = 0.003$; $F(2,19) = 13.70$, $p = 0.0015$ and $F(2,18) = 7.46$, $p = 0.02$).

Conclusion: In persons with MS undergoing standard disease modifying therapy, PRT does not improve functional capacity when compared to a group performing modified physiotherapy, despite significant improvements in muscle strength.

Qualitative factors on initiation, satisfaction and adherence to aquatic exercise in the community among persons with multiple sclerosis

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Background: Increasing evidence suggests physical activity provides multidimensional benefits for persons with multiple sclerosis (MS). Water environments can help people with motor impairments involving a greater number of muscles when exercising. Although aquatic exercise community facilities usually offer a range of exercise options designed to encourage exercise adherence, we hypothesized that such facilities do not appropriately address the needs of persons with chronic conditions such as MS.

Objective: To describe the individual experiences on the initiation, satisfaction and adherence to community-based aquatic exercise routines.

Methods: A convenience sample of patients with MS was enrolled in a water-based exercise program as part of their rehabilitation therapy cycle at Cemcat. A survey exploring issues regarding benefits and factors perceived as playing a role in adherence to the program was administered.

Results: Forty-two people with MS (33.3% men) were included, with a mean age of 47.35 years and a median EDSS of 5.7; 50% had relapsing-remitting MS, 31% had secondary progressive MS and 19% a primary progressive form. Sixty-two percent of patients did not practice regularly any other physical activity, although 95.2% considered that exercise had an important role in MS management. After 12 sessions of aquatic exercise they referred subjective benefits on strength, fatigue, balance, and mood and emphasized the role of aquatic exercise as general fitness maintenance. Over half of the sample considered that sport community facilities and staff did not have enough specific expertise to train people with MS.

Conclusions: Aquatic exercise can provide an enjoyable and safe means of practicing exercise, but issues regarding MS knowledge, accessibility or the need of personal assistance played a role in adherence to this modality of physical activity.

Effect of a standardized physical therapy program on objective and subjective balance in people with multiple sclerosis: a single- group, pretest-post study

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Background: Imbalance is a frequent problem in MS and contributes to considerable patient burden, affecting outcomes such as independence, community participation and quality of life.

Objective: To evaluate the effect of a standardized exercise programme on objective and subjective balance in people with mild to moderate multiple sclerosis (MS).

Methods: Prospective data were obtained from all patients with an EDSS ≤ 6.5 who were admitted and completed a rehabilitation period at the Neurorehabilitation Unit of Cemcat during the second semester of 2016. Patients carried out a 3 days per week 5 months long outpatient rehabilitation program. The standardized physical group therapy programme included three major components modified according to each patient specific impairment and functional needs: muscular training, balance training and gait re-education strategies. Outcome measures included the Berg Balance Scale (BBS), the Timed Up and Go Test (TUG) and the Activitiespecific Balance Confidence Scale (ABC) measured before and after the rehabilitation programme.

Results: Twenty-three people with MS (30.4% men) were included with a mean age of 52.82 years and a median EDSS of 5.0. Fifty-two percent had relapsing remitting MS, 26.1% had secondary progressive MS, 17.4% had primary progressive MS and one patient, 4.3%, had a transitional form.

All outcome measures showed numerical improvements, but only the BBS reached statistical significance (BBS change of means: from 44.62 to 48.15, $p < 0.05$ – TUG change of means: 20.05s to 18.30s, $p = 0.099$ – ABC change of means: 46.31 to 48.07, $p = 0.391$). Percentage of participants improving in each of the outcome measures was: BBS (43.57%), TUG (43.5%), and ABC (56.5%).

Conclusions: Although improvement in static balance (BBS) was significant, dynamic balance (TUG) and self-related perception of imbalance (ABC) did not show clinically relevant improvements. Further studies will analyze deeply the objective outcome measures with the self-related perception of imbalance and its relation with accidental falls.

OUTCOME MEASURES

Factors associated with quality of life (EQ-VAS) in patients with multiple sclerosis

Matej Koprivnik, Jožef Magdič, Tanja Hojs Fabjan

Background: Multiple sclerosis (MS) is associated with physical and cognitive disability and impaired quality of life. Patient reported outcome measures are also important in evaluating the disease course and disability.

Objective: The aim of our study was to find out possible association between quality of life and subjective (self-reported) and objective (functional scales) outcome measures in patients with MS.

Methods: We included 258 patients with MS (66 men and 192 women), mean age was 48.4 years and mean disease duration was 12.5 years. All filled in self-rated health status scale EQ-VAS about quality of life and Modified Fatigue Impact Scale (MFIS), self-report questionnaire about fatigue. Expanded Disability Status Scale (EDSS), Berg Balance Scale (BBS) and Multiple Sclerosis Functional Composite Score (MSFC) (composed of Timed 25-Foot Walk (T25FW), 9-Hole Peg Test (9-HPT) and Paced Auditory Serial Addition Test 3 – (PASAT3)) were also performed. Pearson correlation and multiple regression analysis with ANOVA were performed.

Results: In our patients mean EQ-VAS was 70.7 ± 19.5 . Statistically significant correlations between EQ-VAS and MFIS ($r=-0.650$, $P<0.001$), EDSS ($r=-0.492$, $P<0.001$), BBS ($r=0.434$, $P<0.001$), MSFC ($r=0.441$, $P<0.001$), age ($r=-0.353$, $P<0.001$) and diseases duration ($r=-0.197$, $P=0.001$) were found. Also significant correlations between EQ-VAS and the components of MSFC were found. EQ-VAS correlated significantly with T25FW ($r=-0.424$, $P<0.001$), 9-HPT ($r=-0.402$, $P<0.001$) and PASAT3 ($r=0.191$, $P=0.002$).

With multiple regression analysis including EQ-VAS as dependent variable and MFIS, EDSS, BBS, MSFC, age and disease duration association between EQ-VAS and MFIS ($P<0.001$) and EDSS ($P=0.003$) was found. If components of MSFC were included in analysis association between EQ-VAS and MFIS ($P<0.001$), EDSS ($P=0.021$) and 9-HPT ($P=0.013$) was found.

Conclusions: In our study quality of life (EQ-VAS) was associated with disability (EDSS), fatigue (MFIS) and arm/hand function (9-HPT). The importance of subjective and objective outcome measures on EQ-VAS was confirmed.

Kinematic analysis of “hand-to-mouth” task in people with Multiple Sclerosis

Federica Corona, Massimiliano Pau, Elisa Gervasoni, Giancarlo Coghe, Eleonora Cocco and Davide Cattaneo

Background: Clinical assessment of upper limbs (UL) motor impairments in people with Multiple Sclerosis (pwMS) is commonly performed using clinical tests that are mostly unable to finely detect movement alterations in terms of duration, velocity and kinematics. On the other hand, the quantitative motion analysis, which would be suitable to test functional tasks, is rarely applied to assess UL in pwMS.

Aims: To objectively investigate the quantitative features of the “hand-to-mouth” movement, a functional task representative of important daily living activities, in a cohort of pwMS.

Methods: Twenty pwMS (age: 54.3 ± 11.3 , EDSS: 5.5 ± 1.4) and 20 age-matched healthy individuals (HC) underwent a 3D kinematic evaluation with a motion-capture system, while performing the hand-to-mouth task. Starting with one hand placed on the top of a table located in front of them, participants moved it towards their mouth and, then, return it to initial position. Total and sub-phases duration (% of movement duration), adjusting sway (AS, the length of the path followed by the hand during mouth localization) and index of curvature (IC, the ratio between 3D path of the hand and linear distance between start position and mouth) were

computed. Differences between groups were assessed using one-way ANOVA.

Results: PwMS needs a longer time to complete the task (+63% compared to HC, $p<0.001$) and especially to precisely locating the mouth (13.95% vs. 5.25%, $p<0.001$), with reduced precision (AS, 8.58 mm vs. 1.92 mm, $p<0.001$). Although pwMS showed less smooth movements (IC, 1.03 vs. 0.93), the statistical analysis failed in detecting a significant difference with HC ($p=0.469$).

Conclusions: Results suggest that the quantitative assessment of the UL impairments in pwMS during a functional task could strongly support the clinical evaluation through an accurate description of the movement features. The technique appears promising to assess the effectiveness of rehabilitation treatments and the disease progression.

Are static and dynamic balance abilities correlated in people with Multiple Sclerosis?

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Background: In people with Multiple Sclerosis (pwMS) balance assessment is essential to estimate the risk of falls, monitor disease's progression and verify the effectiveness of a rehabilitative treatment. Clinical tools and instrumental techniques are available to test static and dynamic balance, but the relationship between such abilities is still not clear. Having information about this link would be important to properly plan type and number of tests to administer.

Aims: To quantitatively and objectively assess static and dynamic balance in pwMS using force platforms and wearable inertial sensors to perform respectively static posturography and instrumented Timed-Up-and-Go test (TUG).

Methods: One hundred and six pwMS (Expanded Disability Status Scale, EDSS 0 - 6.5) divided in three sub-groups (Class 1 EDSS 0-1.5, Class 2 EDSS 2-4 and Class 3 EDSS 4.5-6.5) and 42 healthy controls (HC) participated in the study. All underwent static posturography and instrumented TUG performed using a wearable inertial sensor. Raw data were processed to extract postural sway features (sway area, sway path, COP displacements and velocities in antero-posterior and mediolateral direction), overall duration of TUG and its main sub-phases (i.e. sit-to-stand, 180° turns and stand-to-sit).

Results: All sway parameters of pwMS of Class 2 and 3, as well as total TUG duration and time necessary to perform 180° turns were found significantly higher than HC and Class 1 participants. However, weak correlations were found between sway and TUG parameters. When pwMS were considered as a single group, significant weak/moderate correlations (in the range 0.20 – 0.41) were found between all sway parameters and total TUG duration.

Conclusions: Static and dynamic balance abilities of pwMS appear scarcely correlated, although both worsen as disability increases. This implies that they should be separately assessed

using specific tests to have a complete view of the postural control performance in MS.

Smoothness of gait, but not spatio-temporal parameters, are altered in early stages of Multiple Sclerosis

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Background: In early stages of Multiple Sclerosis (MS), it is difficult to assess gait alterations using conventional clinical tools. Sophisticated techniques like 3D gait analysis may reveal subtle changes in gait, but such equipment is not commonly available for clinical routine purposes. Wearable accelerometers are inexpensive and easy to use in clinical setting, but few data are available for people with MS (pwMS) minimally impaired.

Aims: To quantitatively and objectively assess possible differences in spatio-temporal (ST) parameters and smoothness of gait between pwMS with low disability and healthy individuals using inertial sensors. Smoothness of gait was calculated from trunk accelerations, using the Harmonic Ratio (HR) parameter. Higher HR values indicate smoother and more stable trunk movement during gait.

Methods: Fifty-three pwMS (33F, 20M, 38±9.7 years) with EDSS in the range 0-1 and 41 healthy controls (21F, 20M 39±11.0 years) were enrolled for this study. A wearable triaxial accelerometer was fixed to participant's sacrum and they were requested to walk at self-selected speed for 10 m. Trunk accelerations were processed to calculate ST parameters (i.e. cadence, speed, stride length, stance, swing and double support phase duration) and smoothness of gait through the HR along anterior-posterior (AP), medial-lateral (ML) and vertical (V) directions. One-way MANOVA was performed to detect differences in ST and HR introduced by the pathology.

Results: MANOVA revealed no significant differences between the groups for any of the ST parameters. In contrast, significant reduced HR values in AP (2.97 vs 3.73, $p < 0.001$) were observed but not for ML and V directions.

Conclusions: While ST parameters of gait in pwMS are not different from those of healthy individuals, the analysis of HR showed that their gait is less smooth in the walking direction. Thus, HR might represent a useful tool to detect early gait impairments in pwMS.

Reliability of the Six Spot Step Test

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Introduction: The Six Spot Step Test (SSST) is a complex measure of gait function developed to test people with multiple sclerosis (MS). In addition to fast walking, it also encompasses acceleration, balance and coordination. Despite increasing use in clinical practice and research, no studies have so far investigated the within- and day-to-day variability.

Purpose: This study investigated the reliability in repeated measures of the SSST test within and between days in persons with MS.

Method: 38 MS-inpatients (EDSS 1-6, age 34-76, female: 68%) underwent a SSST and 5 min. later a re-test. This procedure was

repeated two days later under the same conditions. Time was measured on a handheld stopwatch. Bland-Altman analyses were used to estimate relative and absolute 95% Limits of Agreement (LOA). Sub-analyses with stratification for gait speed and assistive devices were conducted.

Results: Within-day and between-day agreements relative to the test time were ±15% and ±19% respectively ($n=38$). Variation in repeated measures tended to increase as test time increased. For tests performed in less than 20 sec. ($n=32$), absolute LOA within days and between days were ±1.5 sec. and ±2.2 sec. respectively. In tests performed without assistive devices LOA were for both outcomes ±1.7 sec. A tendency towards a learning effect from repeated measures was observed with an estimated effect of < 0.4 sec.

Conclusion: The SSST test has an acceptable within- and day-to-day reliability, despite a potential minor learning effect. For interventional purposes a change of >19% can generally be regarded as a real change. Absolute reliability tends to depend on disability level and cautious use is recommended when assistive devices is required or when the test is performed at a very slow speed.

Responsiveness of upper limb outcome measures in people with multiple sclerosis: an European RIMS multi-center study.

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Background: There is a need for studies investigating the psychometric properties of upper limb outcome measures in MS.

Objective: The aim was to investigate the responsiveness of frequently used as well as new upper limb outcome measures in MS.

Methods: 128 persons with MS (mean EDSS=5.6) from 11 centers across Europe (RIMS network) were assessed before and after rehabilitation using multiple upper limb outcome measures on the three levels of the International Classification of Functioning. On body function and structures level, maximum isometric pinch, key,

and 3 jaw grip strength were quantified as well as Visual Analogue scales of perceived spasticity, muscle weakness, sensory impairment, coordination and fatigability. On activity level, upper limb capacity was assessed by the Nine Hole Peg test (NHPT), Block and Box Test (BBT) and Coin Rotation Task. The ABILHAND, Manual Ability Measure-36 and Motor Activity Log were used to evaluate the perceived performance. Combined anchor- and distribution-based methods were used to determine responsiveness. A global rating of change scale related to the overall upper limb function, from patients' and therapists' perspective, was used as external criteria to determine the area under the receiver operating characteristic curve (AUC), minimally important change (MIC) and smallest real change (SRC).

Results: The AUC related to therapist's perspective was for all outcome measures higher than 0.50 but only significant for the NHPT (dominant 0.61, non-dominant hand 0.66) and BBT (non-dominant hand 0.64). From patients' perspective, only the AUC NHPT non-dominant hand (0.60) was significant. Clinically meaningful change (MICs) of all outcome measures were smaller than the smallest real change (SRC) except for the NHPT (sec) from patients' perspective (dominant hand MIC= 2.84 and SRC= 2.28, non-dominant hand MIC= 7.47 and SRC= 3.19).

Conclusion: The NHPT is the most appropriate outcome measure in detecting clinically meaningful improvement after rehabilitation.

Disease-specific functional disorders and falls: comparisons between Multiple Sclerosis, Parkinson Disease and Stroke.

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Background: Neurological conditions affect walking and functional resources placing affected individuals at risk of falls. Clinicians have developed pathology-specific assessment and treating approaches on the assumption that conditions such as multiple sclerosis (MS), Parkinson disease (PD) and stroke (ST) have unique characteristics. However, the functional differences between these conditions are poorly understood.

Aims: (i) comparing mobility and balance in subjects with MS, PD and ST and ii) calculating the risk of falls in these three cohorts iii) Identifying a common screening test to detect fallers.

Methods: The sample includes 299 subjects with MS (111), PD (94) or ST (94) assessed with a number of functional scales measuring gait and balance. After the baseline assessment subjects were followed for 6 months to monitor falls prospectively. To assess group differences generalized linear models were used with pathology as fixed factor and overall disability (Activity of Daily Living Nouri scale) as covariate. Cox model was used to identify predictors of falls.

Results: i) No between group differences were found for the Berg Balance Scale ($P=0.54$) and Activity Balance Scale (ABC, $P=0.41$). The 10-Meter Walking Test score was higher (Mean \pm StErrMean) for ST compared with MS and PD (ST=14.7s \pm 0.88, MS=11.6s \pm 0.8; PD= 11.3s \pm 0.9, $P=0.01$), while gait adaptability and dynamic balance were more impaired in MS (Timed Up and Go: ST=16.3s \pm 1.0, MS=19.3s \pm 0.9; PD= 13.2s \pm 0.9, $P<0.0001$), (Dynamic Gait Index: ST=15.2 \pm 0.7, MS=10.9 \pm 0.7; PD= 15.3 \pm 0.7, $P<0.0001$); ii) Proportions of fallers were higher for MS (50%) and PD (46%) compared with ST (24%); iii) The ABC score was a common predictor of falls.

Conclusions: Neurological conditions differentially affect function: while ST has an impaired gait, PD and even more MS show dynamic balance and gait adaptability disorders. These disorders in MS are not associated to a decreased perceived balance confidence. This is a possible explanation of increased fall frequency in this population.

A preliminary analysis of sleep and physical activity among inactive people with MS

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Background: People with MS are less physically active than the general population, and fatigue and depression are common symptoms. Little is known about the correlation between sleep and MS symptoms, or about the effect of exercise on sleep in people with MS.

Objectives: Post-hoc analysis of data from a randomised controlled trial (Step it Up) was conducted to investigate 1) the correlation between sleep and MS symptoms at baseline 2) the effect of a 10 week programme based on the MS exercise guidelines on sleep variables.

Methods: Sleep variables including duration of sleep episode (DSE), sleep onset latency (SOL), total sleep time (TST) and sleep efficiency (SE) were objectively measured using the Sensewear arm band which also measured Physical Activity (PA). Modified Fatigue Impact Scale (MFIS), MS Impact Scale-29 (MSIS) and Hospital Anxiety and Depression Scale (HADS) were also collected at baseline. Spearman's rho statistic was used to examine the correlations between sleep and PA variables, and paired t-tests to examine the change from baseline to post-intervention

Results: Forty seven had sleep data pre intervention and completed baseline assessment and 30 had post-intervention sleep data. The sample was predominantly female (86.7%) and had mean age 42.87 \pm SD 8.32. Mean time since diagnosis was 7.01 \pm 5.87 years mean EDSS score was 3.21 \pm 0.68. Only DSE was significantly correlated ($p<0.05$) with PA (energy expenditure $r=-0.34$, steps $r=-0.30$). SOL was significantly, correlated with MSIS-29 physical ($r=0.30$) and psychological ($r=0.30$) and approached significance for HADS anxiety ($r=0.28$, $p=0.055$). Paired t-tests demonstrated no significant change in TST (baseline 390.50 \pm 62.15 minutes) (post-intervention 387.33 \pm 76.28 minutes $p=.589$) and other sleep variables following the intervention.

Conclusion: Some sleep variables were related to impact of MS, PA and anxiety. Sleep variables neither improved nor deteriorated following exercise. The relationship between sleep and PA warrants further exploration.

Cognitive fatigue and language in MS – Quantitative and qualitative analysis of semispontaneous oral narratives

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Language disorders associated with MS have not been studied extensively from a linguistic point of view. Moreover, the effects of cognitive fatigue (i.e. deterioration of cognitive performance during sustained cognitive activity) on language in MS have not been studied at all. The aim of this study was to study whether and how cognitive fatigue, and cognitive disorders, affects language in MS.

The data of the study was twofold: 1) the neuropsychological data consists of the results of a neuropsychological test battery; 2) the linguistic data consists of three semispontaneous narratives produced. Fluency (length, number of words, number of syllables, and speech rate), as well as coherence (global connectedness, main theme, and content analysis), was studied. 21 healthy controls, and 20 persons with MS were investigated. MS group was further divided into groups with mild to moderate (n=10; EDSS <5.5) and severe disability (n=10; EDSS 6.0- 7.5) and groups with relapsing remitting MS (n=13) and secondary progressive (n=7). The quantitative analysis of the narratives revealed that the MS group's fluency was impaired compared to the controls. Based on the qualitative results, MS group produced more incorrect content units, but performed better on global coherence of the narrative than the controls. Fluency and coherence were more intact in the group with milder disability.

In the MS group, there was a correlation between objective cognitive fatigue, and a decrease in length of the narratives. In addition, there was a link between subjective fatigue in speech production and impaired narrative coherence. There was also a link between the impaired fluency of the narrative and impaired recall of linguistic material, as well as semantic word fluency. However, there was no link between narrative coherence and linguistic cognition. Cognitive fatigue tended to be related to language production more in patients with severe than with milder disability.

keywords: cognitive fatigue, language, narratives

Fatigue and motor fatigability in persons with multiple sclerosis: relation between different upper limb muscles, and with use of the arm in daily life

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Background: Upper limb motor fatigability is increasingly acknowledge as a potential symptom in persons with MS (pwMS). It is not yet known if abnormal fatigability is generalized in multiple muscle groups, how it is related to perceived fatigue and to what extent it contributes to the perceived difficulties in the use of the upper limb in daily life.

Methods: Twenty PwMS (mean EDSS 3) and twenty healthy controls performed 30" sustained maximal muscle contractions for finger abduction, hand grip, elbow flexion and shoulder abduction. Motor fatigability was reflected by a static fatigue index for each muscle group. Statistical analyses included paired t-tests between groups and muscles to investigate presence of abnormal fatigability. The relation between motor fatigability in different

muscle groups, and its relation with perceived fatigue and the perceived upper limb use in daily life, correlation coefficients were calculated.

Results: PwMS showed higher fatigue levels than healthy controls. PwMS showed preserved muscle strength compared to healthy controls, but a higher static fatigue index in the elbow flexors that was significantly correlated with that of the shoulder abductors. The motor fatigability of the elbow flexors, together with the maximal strength of the finger abductors, predicted 50% of the variation in perceived use of the upper limbs in daily life. Perceived fatigue was related to motor fatigability of the elbow flexors and shoulder abductors.

Discussion and Conclusion: Abnormal motor fatigability was found in the elbow flexors of PwMS but not in the other muscle groups, indicating that symptoms may not equally express in different muscle groups. Motor fatigability of elbow flexors was associated with both overall perceived fatigue and daily life use of the upper limb, suggesting that it needs to be incorporated in assessment and treatment protocols.

Hourly trends of physical activity in people with Multiple Sclerosis

Short title: Physical Activity in Multiple Sclerosis

Micaela Porta, Massimiliano Pau, Giuseppina Pilloni, Federica Corona, Giancarlo Coghe, Lorena Lorefice, Eleonora Cocco

Background: It is known that people with Multiple Sclerosis (pwMS) are less active than unaffected individuals, due to fatigue, depression, pain and weakness. This represents a serious issue as Physical activity (PA) is useful in improving most motor impairments due to MS and is often suggested as a supplement to the pharmacologic treatments.

Aims: This study aims to quantitatively assess the hourly trends of PA in pwMS through objective measurements performed using wearable accelerometers previously validated for MS.

Methods: Thirty-four pwMS (age 46.8±11.2) with EDSS score in the range 1-7.5 participated on a voluntary basis together with an equal number of healthy subjects age and sex matched. All participants wore a tri-axial accelerometer for 7 days; pwMS were also administered MSWS-12, MFIS and EQ-5D-3L questionnaires. Vector Magnitude Counts (VMC, the square root of the sum of the squared accelerations along the 3 axes) and Steps Counts (SC) were calculated on hourly basis from 6AM to 11PM. MANOVA was used to assess differences in PA parameters introduced by the pathology and Pearson's coefficient to verify the correlation between PA levels and MSWS-12, MFIS and EQ-5D-3L.

Results: MANOVA revealed that pwMS exhibit reduced SC within 7 PM and 9 PM (p<0.025), but not in all other slot times. PwMS also perform fewer daily steps than HC (12000 vs. 10750), and reduced VMC, although not significant. Weak to moderate correlations were found between VMC, SC and scores of EQ-5D-3L, (r=0.28 (not significant) and 0.345) and MSWS-12 (r=-0.44 and -0.53).

Conclusion: The obtained results confirm that pwMS perform a reduced amount of PA when compared with healthy individuals, particularly in after-work time which are usually devoted to PA or

leisure. This may indicate that fatigue tends to cumulate during the first part of the day and prevents pwMS to carry out sufficient PA afterwards.

How do people with MS deal with changing directions during walking? A novel approach to evaluate gait disabilities in MS

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Walking impairment is one of the most frequent clinical feature of MS with major consequences on patient's autonomy in personal and professional activities. Besides linear walking, natural locomotion includes curved trajectories that require a complex reorientation of the whole body. Common gait analysis methodologies consider subjects' performance over linear paths, ignoring all the difficulties people with MS (PwMS) might have in a more complex condition involving changing directions.

The present study aims to define a methodology to evaluate gait kinematics along a path composed of straight and curved trajectories, the "8-path" (20 m). By means of a motion capture system we acquired the kinematics of the head, shoulder, pelvis and feet. Five PwMS (mean EDSS±SD=2.5±0.9) and 9 healthy controls (HC) were tested. Along the 8-path we identified three regions of interest: straight-to-curve, curve-to-curve and curve-to-straight. We evaluated: 1) the kinematics of the center of mass, 2) the number of strides, the stride length and its variability, 3) the temporal evolution of the head direction with respect to the incoming curve. Walking duration over a 20 m-linear path was compared with that of the 8-path.

Results showed that PwMS's movements were slower and less smooth than those of HC, particularly in the curve-to-curve part. The increased number of strides observed in PwMS corresponded to a decrease in stride length and an increase in its variability. The temporal evolution of the head direction was comparable between PwMS and HC, suggesting that PwMS anticipated the changing direction as HC. Movement duration along the 20 m-linear path was comparable in the two groups but increased in PwMS along the 8-path. The present methodology allowed describing gait kinematics in a more ecological context than a straight trajectory and might be potentially able to identify subtle deficits of great interest for diagnostic and rehabilitative purposes.

Impact of brain atrophy on walking in multiple sclerosis patients with low disability: a dual task study.

Giancarlo Coghe, Massimiliano Pau, Giuseppe Fenu, Lorena Lorefice, Micaela Porta, Federica Corona, Giuseppina Pilloni,

Jessica Frau, Erica Zucca, Maria Giovanna Marrosu, Eleonora Cocco

Background: Ambulation is not a simply motor act but requires a cognitive involvement as demonstrated by the dual task paradigm. Moreover is well recognized that cognitive problems in MS are related to brain atrophy.

Aims: To evaluate the role of brain atrophy in cognitive motor interference assessed by the dual task cost (DTC) of walking in a group of MS patients with low disability.

Methods: The inclusion criteria were a diagnosis of MS, EDSS<3.5, been able to undergo to a brain MRI and a gait analysis. Spatial temporal (ST) parameters were acquired by 3D gait analysis. Brain MRI was performed with a 1.5 Tesla scanner. Normalized Brain Volume (BV), Normalized Grey matter Volume (GM) and Normalized White Matter Volume (WM) were estimated with SIENAX. Relationship between DTC of gait and MRI data were assessed by means of the Spearman product moment correlation analysis.

Results: Fourteen patients were enrolled. (mean EDSS 1.75 (SD ± 0,79), age 42.21 (SD ± 8.84)). Spearman product moment between gait parameters and BV showed significant relationship in mean velocity ($\rho=0,550$ $p=0.04$) and double support duration ($\rho=0,635$ $p=0.01$). GM showed significant relationship with DTC of Stance phase duration ($\rho=0,591$ $p=0.02$), Double support duration ($\rho=0,688$ $p=0.007$) and cadence ($\rho=0,534$ $p=0.05$). Moreover a trend toward significance was seen in the relationship between GM and DTC of velocity. None of the ST parameters considered do correlate with WM.

Discussion and conclusion: Even in MS patients with low disability brain atrophy seems to have a strong impact on ambulation performance during a cognitive task. In particular GM reduction is the key factor determining worsening of gait and thus potentially worst performances in every day life activities that implicate cognitive motor interference.

Evaluation of Stroop color word test as cognitive task to investigate cognitive motor interference during walking in Multiple Sclerosis

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Background: Dual task (DT) is the most ecological way to evaluate cognitive motor interference during ambulation in people with Multiple Sclerosis (pwMS). Executive functions are highly related with gait and the Stroop color word test is the gold standard to evaluate them. Moreover daily life activities are frequently driven by visual inputs. Despite these remarks, to our knowledge visual Stroop test has not been used yet as a cognitive task during DT in pwMS.

Aims: The aim of this study was to investigate the validity of the visual Stroop test as cognitive task during DT in pwMS.

Methods: The inclusion criteria were a diagnosis of MS and been able to walk for 100 m. Main spatio-temporal parameters were measured by 3D gait analysis. For DT condition, Stroop color word test was projected in a screen in front of the walkway. PwMS were asked to perform the Stroop test while walking at self selected speed. One-way repeated measures analysis of variance (RM-ANOVA) was performed to assess the effect of the cognitive task during gait.

Results: Twenty-two pwMS were enrolled (age: 42±10; Expanded Disability Status Scale [EDSS] score: 1-6). RM-ANOVA revealed that mean velocity and stride length were reduced during DT (0.88 vs 0.80 m/s; 1.04 vs 0.98 m; $p<0.001$). Also, duration of stance phase, double support and step width increased (62.64 vs 64.36%; 13.86 vs 16.30%; 0.21 vs 0.22 m; $p<0.05$). The DT cost on gait velocity was 9%.

Conclusions: Our study indicates that Stroop color word test is a valid cognitive task to assess DT cost in pwMS. In fact worst performance during the dual task was clearly demonstrated. Moreover our DT cost values are in line with those documented in literature with other cognitive tasks.

Cardiac autonomic function during postural changes and exercise in people with multiple sclerosis.

Elisa Gervasoni, Marco Bove, Laura Martina, Marco Rovaris, Davide Cattaneo, Giampiero Merati

Background: Autonomic dysfunction (AD) often develops (70-60%) in patients with multiple sclerosis (PwMS). Whereas the clinical manifestations of AD may be assessed using standard autonomic tests, AD detection at subclinical level is still challenging.

Aim: To evaluate basal cardiac autonomic tone and its modulations during sit-to-stand and submaximal exercise in PwMS without clinically overt AD.

Methods: 13 PwMS (age: 52.7±7.4 yrs [m±DS]; disease duration: 17.6±12.6 yrs, EDSS: 5.7±1.1) and 10 age-matched controls (HC) (55.6±5.6 yrs) were enrolled. ECG was digitally acquired by a wearable sensor (Faros 180, Finland) while sitting at rest (5 min), standing (2 min) and during a light upper-limb exercise (4 min at 5-10 W). Cardio-vagal (RMSSD [Root Mean Square of Successive Differences]), pnn50 [% of consecutive beats differing >50 ms], HF [High Frequencies: 0.15-0.40 Hz] power) and sympathetic (LF [Low frequencies: 0.04-0.15 Hz] power) parameters of heart rate variability (HRV) were calculated from the edited normal-to-normal beat series. Spearman correlations between RMSSD, disease duration and EDSS were calculated.

Results: HR was slightly but non significantly higher in PwMS in all conditions. At baseline, both parasympathetic (pNN50, $p=0.03$; RMSSD, $p=0.09$; HF, $p=0.01$) and sympathetic (LF, $p=0.12$) indexes were lower in pwMS than in HC. Conversely, during standing and exercise these differences disappeared. No correlations were found between RMSSD, disease duration ($r=-0.31$; $p=0.31$) and EDSS ($r=0.34$; $p=0.24$).

Conclusions: Although both parasympathetic and sympathetic basal tones appear to be affected by MS, HR modulation during postural challenge and exercise seems to be preserved. HRV analysis may represent a useful, and non-invasive tool to detect subclinical AD and its possible evolution towards an overt dysfunction in PwMS.

Effect of treadmill training with virtual reality in improving gait and dynamic balance in patients with Multiple Sclerosis

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Background: The ability to adapt gait to different environmental situations is important to walk safely during daily life and is often reduced in people with Multiple Sclerosis (pwMS).

A new generation of treadmills, using Virtual Reality (VR), can improve gait adaptability and dy-namic balance providing specific gait exercises including variable practice, high number of repetitions and performance feedback. However, their effect compared to traditional treadmills has not been proved.

Aims: to assess whether Treadmill training with VR (T-VR) is better than Traditional Treadmill (TT) training in improving dynamic balance in pwMS.

Methods: So far 32 subjects (age mean±standard deviation: 50.9±10.2 years, EDSS (medi-an±Interquartile range: 6±1.6) were assessed using the Timed up & go (TUG), Dynamic Gait Index (DGI) and Berg Balance Scale (BBS) before and after intervention. The group was split (1:4 ratio) in the T-VR (n=6) and TT (n=26) group. The T-VR group under-went to about 15 30-40 minutes daily treadmill sessions. They were asked to react to visual targets or obstacles projected on the treadmill belt. TT group received a similar treatment without VR. Be-tween group change scores (post-pre) were assessed using Mann-Whitney U test.

Results: No statistically significant between group differences were found at baseline. Median TUG change scores for T-VR and TT were respectively -3.4s(2.5) and -2.2s(3.0), $P=0.07$). DGI and BBS change scores for T-VR and TT were respectively 3.0(2.2) and 2.0(4.0), $P=0.16$ and 5.5(6.5) and 2.5(7.5), $P=0.23$.

Conclusions: These preliminary results suggest the use of T-VR specifically may increase the effi-cacy of TT in improving balance and gait adaptability in pwMS. Further investigations are needed confirm these results.

Developing an integrated core set for the evaluation of handwriting movement in people with multiple sclerosis

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People with multiple sclerosis (PwMS) often complain for handwriting deficits, which negatively affect their activities of daily living. However, objective measures of this function as well as validated tools to assess the effects of rehabilitative interventions are lacking.

Aim of this study was to define an evaluation methodology allowing to characterize handwriting movements in PwMS in terms of behavioural, kinematic and clinical parameters.

20 PwMS and 20 matched healthy controls (HC) were assessed by means of a test investigating grapho-motor impairments during writing (DGM-P test). DGM-P test requires to write a sentence twice, as accurate as possible and as fast as possible, and evaluates both morphological outcomes (such as letters shape) and calligraphy outcomes (such as inaccuracy of the tract and

distance from the line). Moreover, both groups underwent a kinematic evaluation of writing movements by means of a digitalized tablet measuring duration, length and height of the written sentences. Further, PwMS clinical condition was examined in terms of motor, sensory and cognitive domains.

PwMS performed worse than HC at DGM-P test when considering calligraphy errors (particularly in the accurate writing condition), while morphological parameters were similar in the two groups. Most of the altered calligraphy parameters correlated with strength and sensory deficit, reported by pinch dynamometer measures and self-perception scales of upper limb disability. Moreover, both accurate and fast writing velocity correlated with cognitive functioning, as measured by Symbol Digit Modalities Test. Kinematic evaluation supported these findings.

In conclusion, DGM-P calligraphy but not morphological outcomes are reliable parameters to objectively identify handwriting impairments in PwMS, which are likely due to motor, sensory and cognitive dysfunctions. Moreover, the digitalized tablet and DGM-P test could represent a core set for handwriting assessment to be used before and after specific rehabilitative treatments.

Influence of emotional distress factors on the severity of fatigue symptoms in patients with multiple sclerosis after induction of fatigue

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Fatigue is one of the most important and distressing symptoms of multiple sclerosis (MS). However, the causes of fatigue are still not fully understood. Emotional fatigue in particular has been neglected yet.

Due to the high comorbidity between depression and fatigue, the present study investigated the influence of different factors of emotional distress on symptoms of fatigue in 70 MS-patients.

Before and after a 60-minutes cognitive task, we measured changes 1) in the acute subjectively perceived fatigue (visual analogue scale (VAS)), 2) the acute objectively measurable fatigue (Test battery for Attention Performance - Mobility (TAP-M)) and 3) the subjects' trait fatigue (Fatigue Scale for Motor and Cognitive Functions (FSMC)). As measures for factors of emotional distress, the Beck Depression Inventory (BDI-II), the Toronto Alexithymia Scale 26 (TAS-26), the Emotion Regulation Questionnaire (ERQ), the Childhood Trauma Questionnaire (CTQ) and the Hospital Anxiety and Depression Scale (HADS-D) were administered.

Participants reported changes in the acute subjective fatigue ($t(69)=-8.87$, $p<.001$, $d_z=1.06$) and performed worse in the TAP-M ($Z=-2.25$; $p=.024$, $r=.03$) after the cognitive task, whereas the trait fatigue remained constant. Factors of emotional distress did not explain the deterioration. An exploratory data analysis was performed to examine the influence of the emotional distress factors on any of the three fatigue measures, using linear regression analyses. The results of the regression analyses were combined into two hypothetical path models. These revealed not only indirect and direct effects of the factors of emotional distress on the deterioration in both state fatigue measures after the cognitive task, but also on objective state fatigue. Factors of emotional distress might therefore influence symptomatology of fatigue as well as its deterioration after induction of cognitive strain.

These results underline the importance of considering emotional factors in the genesis of fatigue. It further argues for a potential third fatigue dimension.

Energy cost of gait and cardiovascular parameters in persons with multiple sclerosis with different levels of walking disability and their response to treatment.

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Introduction: People with Multiple Sclerosis (PwMS) have walking deficits that lead to poor conditioning and high energy cost during gait. Measurements of cardiovascular parameters are important for assessing the effect of therapeutic intervention.

1 Motl, R.W. et al. 2012. Energy cost of walking and its association with gait parameters, daily activity, and fatigue in persons with mild multiple sclerosis. *Neurorehabil. Neural Repair* 26 (8), 1015-1021.

Aim: Do cardiovascular parameters and energy cost of gait differ with different levels of EDSS and are they equally amenable to change after treadmill training?

Methods: 24 PwMS (age 52 ± 10 years, onset $16 \pm 8,18$ years, EDSS $5,5 \pm 0,95$) were recruited and underwent 15-sessions of treadmill training (3-5x week, 30 minutes). Modified Bruce test (time on treadmill), cardiovascular parameters, heart rate (HR) and Physiological Cost Index (PCI), two minute walk test (2MWT), gait speed and Berg balance test (BBS) were assessed pre (T0) and post-training (T1). For analysis the PwMS were split into two groups according to EDSS: Moderate group (MG, N=12) (EDSS 4-5,5) and severe group (SG, N=12) (EDSS 6-7). $PCI=HR$ baseline-HR after three minutes of Bruce test/treadmill velocity. Statistical differences were verified with nonparametric statistics.

Results: There were no differences at baseline in HR, PCI and the 2MWT between MG and SG while measures of equilibrium, gait speed and Bruce were significantly lower in the SG. Following rehabilitation both groups improved similarly in time on treadmill, 2MWT, BBS. Only MG improved their cardiovascular health as represented by lower HR during the Bruce test (MG: T0 HR 3min $98,5 \pm 19,1$ beats/min to T1 $85,1 \pm 15,7$ beats/min $p=0,013$ vs. SG: T0 HR 3min $94,1 \pm 13$ beats/min to T1 $92,3 \pm 11,7$ beats/min $p=0,3$) and the PCI (MG T0 $0,92 \pm 0,72$ to T1 $0,54 \pm 0,40$ $p=0,009$ vs SG T0 $0,50 \pm 0,49$ to T1 $0,48 \pm 0,43$ $p=0,7$).

Conclusion: PwMS of all disability levels respond to aerobic training with improvement in gait resistance and balance skills. However, only PwMS with moderate level of disability appear to benefit in cardiovascular health. The reliability of the PCI as a measure of energy cost of gait for PwMS needs to be further investigated.

Lower limb muscle synergies and functional gait deficits of persons with multiple sclerosis: response to rehabilitation

Johanna Jonsdottir, Tiziana Lencioni, Davide Cattaneo, Elisa Gervasoni, Alessandro Crippa, Maurizio Ferrarin

Background: Muscle synergies are hypothesized to reflect connections among motoneurons in the spinal cord activated by central commands and sensory feedback. An innovative muscle synergy and biomechanical analysis evidenced alterations in corticospinal modular activation of distal lower limb muscles of persons with multiple sclerosis concomitant with functional deficits during walking¹.

1Lencioni T, Jonsdottir J, Cattaneo D, Crippa A, Gervasoni E, Rovaris M, Bizzi E and Ferrarin M (2016) Are Modular Activations Altered in Lower Limb Muscles of Persons with Multiple Sclerosis during Walking? Evidence from Muscle Synergies and Biomechanical Analysis. *Front. Hum. Neurosci.* 10:620. doi: 10.3389/fnhum.2016.00620

Aim: see if the activation index of distal muscle synergies can be influenced by rehabilitation.

Methods: 13 PwMS walked at their natural speed(pre-post 15-20 sessions of gait rehabilitation) while 20 healthy age-matched subjects(HS) walked at matching slower speeds during which kinematic, kinetic, and electromyography(EMG) data were collected. Non-negative matrix factorization of EMG data was used to identify distal muscle synergies, their activation timing was integrated over 100% of the gait cycle and the activation percentage was evaluated in 6 phases¹.

Results: PwMS had shorter stride length, longer double support phase and smaller ankle positive work(APW) at matched speed than HS($p<0.05$) and these deficits were associated with altered activation indexes of Muscle synergy 2 related to plantarflexors(M2) in mid and terminal stance. Following rehabilitation, at increased gait velocity pre-post, PwMS increased their APW of 25%, while the HS(matched speeds pre-post), increased their APW of 6%. This was concomitant with an increased activation percentage of M2 in mid stance.

Conclusion: Parallel improvement in push off, gait velocity and activation index of muscle synergy 2, representing distal control, in PwMS is an important result of the study indicating that better gait function following rehabilitation might be traced to better motor control at the corticospinal level.

Spatio-temporal parameters of gait in teenagers with multiple sclerosis

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Background: A presentation of multiple sclerosis (MS) before the age of 18 has traditionally been thought to be rare. However, during the past decade, more cases have been reported, possibly as a result of advances in diagnostic techniques and increased awareness among pediatricians. As for gait performance, to date, no study examining gait in teenagers with MS has been found in the scientific literature. Therefore, the objective of this study was to examine gait characteristics in youngsters with MS.

Methods: We examined gait characteristics in 24 adolescents with MS (12 girls, 12 boys), mean disease duration was 20.4 (S.D=24.9) months and mean age 15.5 (S.D=1.1) years, from the Multiple Sclerosis Center, Sheba Medical Center, Tel Hashomer, Israel. Gait was studied using an electronic walkway (GAITRite™). Each participant performed six consecutive walking. The values from all six trials performed by each participant were then averaged. Outcomes were compared to gait and the gait variability index value of healthy age-matched teenagers. A gait variability index score of 100 indicates that the individual's level of variability is similar to the reference group.

Results: The mean expanded disability status scale score was 1.7 (S.D=0.7) indicating minimal disability. According to the normalized gait parameters, teenagers with MS walked slower (0.32 (S.D=0.05) vs. 0.43 (0.04)) with a wider base of support (0.12 (S.D=0.04) vs. 0.10 (S.D=0.02)) compared to age-matched healthy controls. In terms of velocity components, MS participants walked with longer steps and at a slower pace. Moreover, the gait variability index was lower in the MS group compared to the values in the healthy adolescents; 85.4 (S.D=8.1) vs. 96.5 (S.D=7.4).

Conclusion: We present for the first time, gait parameters of teenagers with MS. From a clinical standpoint, our data could improve management of walking dysfunction in this young population.

MS diagnosis: quality of life and adjustment

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Introduction: The psychological adjustment of newly diagnosed people with MS (PwMS) is influenced by both physical and psychological impact of the disease, with the illness representation playing a crucial role. We reported the baseline quantitative data of a broader longitudinal mixed methods study, aimed at evaluating the quality of life (QoL) of people throughout the first year from the diagnosis.

Methods: People that received the diagnosis of relapsing remitting MS in the last 4 months were invited to complete 5 self-administered questionnaires to evaluate the level of adjustment (MSQOL- 54, HADS, MFIS), the coping style (COPE-NVI) and the illness representation (IPQ-R). Mann-Whitney test was used to evaluate differences between groups (people who subjectively reported to give or not a meaning in having MS) in the self-reported measures. Correlations will be performed to evaluate the relation between physical (PCS) and mental (MCS) components of QoL and the other self-reported measures.

Results: A total of 20 PwMS were enrolled, mainly female (65%), mean age 31.4 years, mean time from the diagnosis 75.3 days, median EDSS 1.0 (min-max:0-3). The majority (90%) assumed a preventive treatment; 17% presented a moderate to severe level of anxiety, while only the 5% reported a clinically significant depressive symptoms. The 40% gave a meaning in having MS, they reported higher score at COPE-NVI PO (problem oriented coping strategies),

and IPQ-R Personal Control ($p < 0.039$). PCS and MCS significantly correlated with IPQ-R Treatment Control, IPQ-R Illness Coherence ($p < 0.040$), while inversely with COPE-NVI AS (avoidance strategies), HADSA, MFIS, IPQ-R Consequences ($p < 0.045$).

Conclusion: Newly diagnosed PwMS that are more confident in treatment efficacy and have a better comprehension of the disease showed higher QoL. Lower degree of QoL is related to higher level of anxiety, perceived fatigue and use of avoidant strategies, and a worst representation of MS consequences.

Estimation of verbal memory and processing speed cognitive performance according to premorbid intelligence in multiple sclerosis patients

Running title: Estimation of cognitive performance in MS

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Objective: This study aimed to estimate processing speed (PS) and verbal memory (VM) cognitive performance in multiple sclerosis (MS) patients as well as healthy controls (HC) according to their premorbid intelligence (PI) characteristics. The discrepancies between the current and the estimated cognitive performance in both groups were also analysed.

Methods: Thirty-five MS patients and 108 HC underwent a neuropsychological assessment, which included measures of PS and VM (learning and long term recall). Multivariate analysis of covariance (MANCOVA) was used to explore between-group cognitive differences. Participants' predicted cognitive scores according to their specific PI characteristics were estimated through regression-based norms. The discrepancy between the predicted cognitive performance and the raw cognitive scores were calculated for each participant and cognitive measure. Receiver-Operating Characteristic (ROC) analysis was performed for each cognitive measure including both groups' discrepancy scores in the model.

Results: MS patients showed significantly worse performance in verbal learning ($F=49.21$, $p=0.026$), verbal recall ($F=27.58$, $p<0.001$) and PS ($F=18.81$, $p<0.001$) compared to the HC. ROC analyses showed that in MS patients the discrepancy scores were significantly higher for verbal learning ($AUC=0.79$; $p<0.001$), verbal recall ($AUC=0.68$; $p=0.002$) and PS ($AUC=0.66$; $p=0.004$) when compared to the HC. Additionally, ROC analyses also revealed that the three cognitive discrepancy scores, although especially verbal learning, discriminate between MS patients and HC.

Conclusion: These findings pointed out that age, years of education and premorbid IQ could be useful indexes to estimate the predicted cognitive performance in VM and PS. Moreover, the significant differences in the discrepancy scores between the current and the predicted cognitive performance between both groups highlight the negative impact of MS on PS and VM cognitive performance. Future research should determine whether

cognitive discrepancy scores could aid to discriminate between MS patients and HC or other pathologies at early stages of the disease.

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Simplified protocols and indices of aerobic capacity among patients suffering from multiple sclerosis with mild neurological disability

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Background: Peak oxygen uptake (VO_{2peak}) is the gold standard to assess aerobic capacity. However, due to other impairments, a maximal cardiorespiratory effort is not always achievable by patients with MS. Moreover, gas exchange analyzers are roughly available in daily clinical practice.

Objective: To examine the validity of aerobic capacity indices that do not necessitate maximal exercise effort and/or gas exchange analysis among patients with MS with mild neurological disability (EDSS \leq 4).

Methods: 25 patients with MS with mild neurological disability (EDSS \leq 4) performed a maximal exercise testing on a cycle ergometer, including gas exchange measures. Criteria of maximal exercise effort were verified. Relevant indices of aerobic capacity were calculated: Peak Work Rate (PWR), Oxygen Uptake Efficiency Slope (OUES) derived from different durations (total, first 4 and 6 minutes, until RER=1), normalized Physical Working Capacity at 75% of predicted maximal heart rate (PWC75%/kg), normalized Working Capacity Index at 65% of heart rate reserve (WCI65%/kg) and normalized Peak Work Rate to Heart Rate increasing ratio (PWR/ Δ HR.kg). These indices were compared to normative values. Each index was confronted to VO_{2peak} by the means of Pearson correlation coefficient. OUES derived from different times were compared using ICC(1) and Bland-Altman plots.

Results: Twenty patients (80%) complied with the maximal exercise criteria. Indices of aerobic capacity were lower than healthy references. All OUES were highly correlated to VO_{2peak} (All $r > 0.80$, $p < 0.001$). All OUES derived from submaximal efforts appeared to have a high predictive validity for OUES derived from the total exercise duration (from ICC(1)=0.85 to ICC(1)=0.92). PWR and PWR/ Δ HR.kg correlated moderately with VO_{2peak} (respectively, $r=0.56$ and $r=0.67$, $p < 0.01$). PWC75%/kg and WCI65%/kg were not correlated to VO_{2peak}.

Conclusion: Submaximal OUES is valid among patients with MS with mild neurological disability and could substitute VO₂max in the assessment of aerobic capacity. The validity of the indices not relying on gas exchange analysis is uncertain.

Balance related explanatory factors of the six-minute walk test in persons with multiple sclerosis

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Background: There are several other measures to assess the functional exercise capacity; however, the six-minute walk test (6MWT) is the most used and well-established test. The 6MWT distance is significantly reduced in persons with MS compared with healthy subjects, which is related with an increased risk of mortality and limited mobility. Several systems affected in MS have an extremely important role in walking function as necessary to maintain balance. Although several factors affecting 6MWT have been identified, the evidence about the relationship between walking and balance in persons with MS is inadequate. The aim was to investigate the relationship between the 6MWT and balance measures in persons with MS.

Methods: Persons with MS were included in this cross-sectional study. The 6MWT was performed according to the standard guidelines. Timed up and go (TUG) test and single leg stance (SLS) test were used to determine the dynamic and static balance ability, respectively. Additionally, subjective balance confidence was assessed with the Activities-Specific Balance Confidence (ABC) Scale.

Results: In total, 102 persons with MS (81 female, 79.4%) participated in the study. The mean age was 36.9 (SD=11.4) years. There was a significant strong correlation between the 6MWT distance and TUG and ABC ($r=-0.74$ and $r=0.70$, $p<0.001$, respectively). The 6MWT distance was also moderately correlated with the SLS test ($r=0.44$, $p<0.001$, respectively). The stepwise linear regression analysis revealed that the TUG, ABC, and SLS test explained 63.2% of the variance in the 6MWT distance.

Conclusion: The 6MWT performance was explained by balance in persons with MS. The dynamic and static balance as well as balance confidence should be considered while assessing functional exercise capacity in persons with MS.

The Multiple Sclerosis Work Difficulties Questionnaire: Translation and cross-cultural adaptation into Turkish and assessment of validity and reliability

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Background: In recent years, the employment status of persons with multiple sclerosis (MS) is an increasing concern, because employment is important for quality of life. Therefore, it is important to understand the difficulties faced by persons with MS in the workplace. Despite the increasing concern about the workplace difficulties, this issue is unable to see the required interest in Turkey. Probably this is because there is no available method such as the Multiple Sclerosis Work Difficulties Questionnaire-23 (MSWDQ-23) in Turkey. Therefore, the aim was to linguistically and culturally adapt the MSWDQ-23 for use in Turkey, and to examine the reliability and validity of this adapted version.

Methods: After the standard forward-back translation the Turkish version of the MSWDQ-23, it was administered to 124 persons with MS. The random-selected participants were asked to complete the MSWDQ-23 after an interval of 2-4 weeks, to assess the test-retest reliability. Validity was evaluated using the related measures including employment measures, disability level, fatigue, walking, and quality of life.

Results: The internal consistency of each subscales of the Turkish version of the MSWDQ-23 for all items was excellent. Test-retest reliability of each subscales was high. The MSWDQ-23 and its subscales were significantly correlated with the employment measures, disability level, fatigue, walking, and quality of life.

Conclusions: The MSWDQ-23 was successfully translated and cross-culturally adapted into another language, Turkish, for the first time. Moreover, this is the first study provides evidence about the test-retest reliability of the MSWDQ-23. The MSWDQ-23 showed high reliability and adequate validity. The Turkish version of the MSWDQ-23 is the only one available questionnaire in Turkey, which had high reliability and adequate validity, to assess various domains of workplace difficulties faced by persons with MS.

Evaluation of Oropharyngeal Dysphagia in Patients With Multiple Sclerosis

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Background: In multiple sclerosis (MS) a wide variety of symptoms can be seen in relation to the area of lesion. Swallowing difficulties are one of them and relatively common. Diagnosing dysphagia at an early stage is important because it can lead to seri-

ous complications. It can reduce the quality of life and increase the risk of dehydration and aspiration pneumonia.

Purpose: To evaluate oropharyngeal dysphagia in patients with MS. **Method:** Thirty-one volunteer patients (27 female, 4 male, mean age 43.81 ± 10.15 years, mean disease duration 10.32 ± 7.38 years, mean EDSS 3.01 ± 1.94) with MS were included in the study. The demographic information of the patients was noted and patients were self-answered 'Dysphagia in Multiple Sclerosis (DYMUS)' and 'Eating Assessment Tool-10 (EAT-10)' questionnaires. DYMUS is a 10-items questionnaire; all the answers are dichotomous, coded as 1 or 0, depending on the presence or the absence of the event. The Eating Assessment Tool-10 (EAT-10) is a self-administered, analogical, direct-scoring screening tool for dysphagia.

Results: The results of the DYMUS questionnaire are shown in Table 1. According to DYMUS, all patients have dysphagia. Mean DYMUS total score was 1.77 ± 1.40 , mean DYMUS solid score was 1.42 ± 1.84 , and mean DYMUS liquid score was 0.35 ± 0.79 . Patients have serious dysphagia according to EAT-10. Mean EAT-10 score was 4.90 ± 4.07 . The results of DYMUS and EAT-10 questionnaires according to the MS types are shown in Table 2. Patients with primary and secondary progressive MS have more severe dysphagia compared with the other MS types. DYMUS

Restless legs syndrome and related factors in persons with multiple sclerosis

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Background: Restless legs syndrome (RLS) is a common neurological sensory-motor disorder that is characterized by intense restlessness and unpleasant creeping sensations deep inside the lower legs. There is evidence in recent years that the RLS is more common in persons with multiple sclerosis (pwMS) than healthy subjects. Pain, fatigue, depression, sleep quality, and physical activity levels may be associated with the presence of RLS in pwMS. The aim was to compare the pain, fatigue, depression, sleep and physical activity levels in pwMS with and without RLS.

Methods: PwMS participated in this cross-sectional study. The diagnosis of RLS used the four minimum criteria defined by the International Restless Legs Syndrome Study Group. The pain, depression, daytime somnolence, fatigue and physical activity level were assessed with the painDETECT Questionnaire, Beck Depression Inventory, Epworth Sleepiness Scale, Fatigue Impact Scale, and Godin Leisure-Time Exercise Questionnaire, respectively.

Results: In total, 46 pwMS (34 female) participated. The RLS was detected in 11 participants (23.9%). The pain and fatigue levels were significantly higher in participants with RLS than participants without RLS ($p < 0.05$). However, there was no significant difference between participants with RLS and without

RLS in terms of depression, sleep and physical activity level ($p > 0.05$).

Conclusions: This study has suggested that pwMS with RLS has significantly more pain and fatigue levels than without RLS. Moreover, the presence of RLS is high in pwMS. Because pain and fatigue are common symptoms that affect the patient's life, the increased awareness and treatment of RLS among pwMS is important for a better management of these symptoms.

Post-Exercise Heart Rate Recovery and Variability in Patients with Multiple Sclerosis.

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Background: Post-exercise heart rate recovery (PHRR) depends on efficient parasympathetic reactivation and sympathetic withdrawal. In patients with multiple sclerosis (MS) the possible development of an autonomic dysfunction may affect the recovery from exercise, increasing fatigue.

Aim: To evaluate the dynamic of PHRR in MS patients and its relationship with EDSS and subjective fatigue.

Methods: 11 MS patients (50.8 ± 6.1 yrs [$m \pm DS$]; EDSS: 5.7 ± 1.1) and 8 age-matched controls (56.1 ± 6.0 yrs) performed a sub-maximal upper-limb exercise (4 min at 5-10 W), followed by 2 min recovery. PHRR was evaluated from ECG by: 1) HR reduction 30 (HRR30) and 60 (HRR60) s after the end of exercise; 2) the time constant (τ) of the mono-exponential decay of HR; 3) the slope of the semi-logarithmic decay (T30) of HR in the first 30 s recovery and 4) the Root Mean Square of Successive Differences (RMSSD) between consecutive heart beats (index of parasympathetic tone) calculated every 30 s after exercise. Subjective fatigue during recovery was calculated by the Rate of Perceived Exertion (RPE).

Results: HRR30 (absolute and in percentage) was significantly lower ($P < 0.05$) in MS patients, whereas T30 was higher but almost significant ($P = 0.08$). HRR60, τ , and RMSSD every 30 s did not differ between groups. RPE during recovery was significantly higher ($p < 0.05$) in MS patients. No correlation was found between RMSSD, HR recovery parameters and EDSS or RPE.

Conclusions: The differences in short-term (30 s) indexes of PHRR suggest that the cardio-vagal post-exercise reactivation is affected in MS subjects, but this seems not to associate to fatigue development. The RMSSD time-course failed to describe differences in parasympathetic reactivation: other indexes of heart rate variability should be used to focus on this dynamic.

Substantial discrepancy between patient reported and actual walking distance in persons with multiple sclerosis— A part of the Danish MS Hospitals Rehabilitation Study

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Introduction: In multiple sclerosis (MS) the expanded disability status scale (EDSS) is, despite well-known limitations, widely accepted as the main assessment tool and gold standard when describing disease severity and progression. Although the EDSS is highly dependent on patients walking capacity, self-reported statements about walking are ordinarily acceptable (Kurtzke, 1983). However, this may lead to imprecise EDSS scoring due to potential patient mis-judgement and relatedly inappropriate treatment decisions. Little is known about the concordance between self-reported and actual walking distance. Thus, the purpose of this study was to compare the self-reported statements on walking performance provided during EDSS assessment with actual standardized walking performance.

Materials and Methods: 303 patients with multiple sclerosis (MS) with EDSS ≥ 4 , who was part of the Danish MS Hospitals Rehabilitation Study, were asked to estimate their walking ability according to the EDSS range $>4.0-7.5$ (>500 m; $300-499$ m; $200-299$ m; $100-199$ m; $20-99$ m; $5-19$ m; $0-4$ m) (Kurtzke, 1983). Subsequently, they performed a maximum walking distance test, which was terminated when the participant was totally exhausted or passed 500m. Finally, EDSS was determined by a trained neurologist.

Results: Complete datasets were collected from 273 out of 303 enrolled patients. A total of 145 patients (53%) misjudged their walking distance at a level that might correspond to ≥ 0.5 points on the EDSS scale. Of the 145 persons misjudging their self-reported walking distance 39 (26.9%) overestimated while 106 (73.1%) underestimated it. Persons using a walking aid (EDSS 6.0–6.5) and persons restricted to wheelchair (EDSS 7.0) more frequently misjudged their actual walking distance compared to fully ambulatory persons walking unaided (66% vs. 45%, $p=0.0005$).

Conclusion: This analysis demonstrated substantial variability between patient reported and actual walking ability affecting the validity of the EDSS in the 4–7.5 range. Particularly persons using walking aids misjudged their walking ability.

EMPOWERMENT AND SOCIAL PARTICIPATION

Creating a nationwide web-based MS-Station

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Background: MS nurses are in need of continuous education to support and guide patients with MS (PwMS). Web-based programs and tools are effective, feasible and modern methods for the purpose. Providing a web-based education program for MS nurses may result in a more comprehensive care for PwMS.

The purpose of the study was to determine which are the Finnish MS nurses' needs and expectations for professional web-based support and rehabilitation. This study was a part of the

I Care -development project of the Finnish MS Nurses Organisation. The objective was to create a web program called MS-Station.

Material and methods: The study was conducted according to the action research method during 2016. The MS nurses ($n=44$) were contacted by a questionnaire via email. The data was analyzed with SPSS statistical program. Open questions were interpreted using content analysis. The expert group of rehabilitation professionals was formed and their discussions on the results were recorded and considered in the planning of the web program.

Results: The respondents represented well the geography of Finland. Most of them worked in neurological outpatient hospital clinics (66 %). Most of them had nursing experience for more than 10 years (94 %). All of them used internet in everyday work. Nurses considered that rehabilitative patient education contains information on medication, psychological well-being and self-care. The main needs for web program were: 1) research information, 2) multi-professional networking and national co-operation, 3) national guidelines and 4) web-based professional education for MS nurses. The expert group considered the planned program to be a tangible guideline for neurological nursing.

Conclusions: MS nurses need effective, feasible and modern tool to support PwMS and their significant others. MS-Station offers an opportunity to get update research information, multi-professional networking, social participation and web-based education. The program allows an innovative approach in neurological nursing in Finland.

Sexual dysfunctions in people with MS in relation to neuropsychiatric aspects and its psychological treatment: A scoping review

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Objective: Sexual dysfunction (SD) is a significant but often underestimated and overlooked suffering in people with MS. Interventions to treat SD in MS are rare. Although the relation between SD in MS and (neuro-)psychological aspects seems evident, there has been little research. Therefore, we aim to review the existing base of knowledge on these relationship and to identify studies on psychological interventions to treat SD in people with MS.

Methods: We systematically reviewed the literature to answer the following questions: Which psychological and neuropsychological factors impact on SD in MS and vice versa? Are there psychological interventions that have been shown to improve SD in MS? A comprehensive database search in MEDLINE, PsycINFO, and CINAHL (1985-2016) and a scoping review of using Levacs methodological framework was performed.

Results: A total of 23 studies (18 cross-sectional, 2 longitudinal, 3 interventional) with a total of 13,259 people with MS and SD were included. Results showed that SD in people with MS is frequently related to psychological disorders as e.g. depression and anxiety, but also to other psychological aspects as partner relationship and quality of life. The relationship between SD and neuropsychological impairment was only rarely studied and no clear results were found. Only three psychological intervention studies to treat SD

in MS were identified, consistently showing significant improvements in SD and partly in psychological variables.

Conclusions: In people with MS, SD and its impact on psychological wellbeing should be a focus of research and service provision. In addition, there is a pressing need for the development and evaluation of interventions addressing SD in people with MS.

Non-Practitioner Based Self-Care among People with Multiple Sclerosis in Denmark - Characteristics of People with Lower and Higher Levels of Activity

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Background: People with Multiple Sclerosis are known to use a wide range of medical as well as non-medical treatments. This study aims at investigating use of self-care activities within this patient group.

Materials and Methods: The study follows a descriptive cross-sectional design based on an online survey among members of the Danish MS Society's permanent respondent panel.

Results: The results of the study indicate that the respondents carry out a wide variety of self-care activities. These activities comprise conventional activities as well as CAM-based activities. The purpose of the self-care activities are mainly non-specific and preventive. The primary source of inspiration is primarily personal or non-specific. Comparative analyses indicate that respondents with low level of self-care are characterized by high prevalence of young age group, low level of education, low level of self-assessed state of health and low level of self-assessed QoL. Respondents with high level of self-care were more often women and had a high level of self-assessed QoL.

Conclusion: A wide variety of self-care activities are carried out by PwMS, comprising conventional as well as CAM-based activities. The purposes of such activities are manifold, but they are mainly non-specific and preventive. Differences in background characteristics exist between groups of low and high levels of self-care.

Audio-visual patient information materials on key study statistics for people with multiple sclerosis: results from a web-based randomised controlled trial and a qualitative pilot study

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Increasing immunotherapy options lead to complex decision making processes for people with relapsing-remitting multiple sclerosis (PwMS), who want to participate in decision-making. An understanding of statistical parameters such as confidence intervals (CIs) and risk reduction is necessary to make informed decisions. Therefore, we developed audio-visual patient information videos on CIs as well as absolute and relative risk reduction measures.

An audio-visual patient information video on CIs was evaluated through a web-based randomised controlled trial (RCT) and one on absolute and relative risk reduction was piloted in PwMS. For the RCT, PwMS were recruited via the website of the German and the Austrian MS societies and randomised to four groups, either to one of three versions of audio-visual patient information (arm I-III) or a corresponding written standard information (arm IV). Primary endpoint was comprehension of CIs, assessed with a previously piloted six-item multiple choice questionnaire.

In total, 682 PwMS finished the study. Groups were comparable at baseline. Of 6 questions, a mean (SD) of 4.7 (1.4) were answered correctly in arm I, 4.6 (1.4) in arm II, 3.9 (1.1) in arm III, and 4.2 (1.2) in arm IV. PwMS in arms I and II answered significantly more questions correctly compared to PwMS in arm IV (Fisher's LSD, $p = 0.02$ and 0.016 , respectively).

For the qualitative pilot study, 8 PwMS were interviewed. Results showed little need for revision. PwMS responded positively regarding acceptance and comprehensibility, although not all PwMS could clearly reflect the difference between absolute and relative risk reduction.

In conclusion, audio-visual videos are well accepted by PwMS. Information about CIs promotes comprehension and can help patients comparing effects of different treatment options and making informed decisions in accordance with personal preferences. The audio-visual information on risk reduction showed promising results, but modifications are needed to further improve understanding.

Subjectively Perceived Barriers to Being Physically Active among Multiple Sclerosis Patients in Czech Republic

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Background: People with multiple sclerosis (MS) have usually lower level of physical activity compared to healthy population. Our aim was examine subjectively perceived barriers of physical activity among patients in different towns of Czech Republic. The knowledge of barriers can help to doctors and therapists to plan some interventions to facilitate and promote physical activities and active lifestyle in MS patients.

Methods: Participants completed survey during October-November 2015. Participants were contacted during educational event about importance of regular physical activity for MS. This event was organised in 16 towns in Czech Republic. The survey included demographic information and Czech version of Barriers Being Active Quiz. The Barriers Being Active Quiz is 21-item questionnaire assessing the following

barriers to physical activity: lack of time, social influence, lack of energy, lack of willpower, fear of injury, lack of skill, lack of resources.

Results: A total of 194 multiple sclerosis patients (aged 20-71 years, mean age 47 years) and 53 healthy controls (aged 19-69 years, mean age 43 years) completed the survey. Among MS patients the main subjectively perceived physical activity barrier was lack of energy. Then followed lack of willpower and lack of time. In group of healthy controls was the lack of willpower the most commonly reported barrier, followed by lack of willpower.

Conclusion: We identified lack of energy as the most common barriers in MS patients. This finding emphasizes the importance of special exercise or education programmes to manage fatigue tailored to MS patients needs.

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Singing in a choir in the Multiple Sclerosis Center of Catalonia (Cemcat): its value as a rehabilitation tool

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Objective: To analyze the effect of choir singing in a group of PwMS on mood, social participation, respiratory function, phonation and verbal initiative.

Methods: Twenty-eight participants were recruited among patients treated at Cemcat to participate in our choir. Ten MS patients completed the whole assessment. The main criteria to be included was to feel motivated to participate and to have voice/speech disturbances, mood disorders and/or low level of social participation.

Each patient performed a set of outcome measures: Leisure and Free Time Evaluation Scale (EVOTL), Hospital Anxiety and Depression Scale (HADS), ability to sustain /s:/ (respiration) and /a:/ (phonation) and the Brief Screening on Verbal Initiative (BSVI) at the beginning and the end of the study period. A Visual Analogical Scale (VAS) ranged from 0 (none) to 10 (absolutely) on the degree of satisfaction of having participated in the choir was fulfilled at the end. Participants attended a mean of 20 sessions of 90 minutes weekly led by a music therapist with a speech and language therapist.

Results: Results from EVOTL suggested that half of the patients improved in their social participation. Nine patients improved or maintained stable in their mood (anxiety and/or depression). Following Sandra Robertson's score, the ability to sustain /s:/ improved in 4 patients and the ability to sustain /a:/ improved in 2. In both cases, one patient worsened. The global result of the BSVI showed improvement in 5 patients. The mean VAS of satisfaction of have sung in the choir was 8.6.

Conclusions: Results suggest that choir singing may be a cost-effective, long-term and inclusive tool in the rehabilitation approach of PwMS. Nevertheless the number of participants is limited and there is a lack of control group.

Quality of life and symptoms of multiple sclerosis predict participation and autonomy in persons with multiple sclerosis

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Background: Participation and autonomy are viewed as important outcomes of the rehabilitation. To better support the persons with multiple sclerosis (PwMS) there is a need to know how different factors are associated with participation and autonomy.

Aim: The aim of this study was to explain how the quality of life, the impact of disease, gender and disability predict the participation and autonomy encountered by PwMS.

Methods: A total of 194 PwMS (mean age 50 years SD 9, 72% female) filled three self-administered questionnaires: Impact on Participation and Autonomy (IPA) (dependent variable), WHO Quality of Life-Bref (WHOQOL-Bref) and Multiple Sclerosis Impact Scale (MSIS-29). Furthermore the Expanded Disability Status Scale (EDSS) was evaluated by neurologist. The relationship between dependent and independent variables were evaluated with the structural equation modeling (SEM) analysis.

Results: The created model fitted well to the data (CFI: 0.983, TLI: 0.969, RMSEA: 0.054, SRMR: 0.039) and it explained 57.2 % of the variance. The factor MS-related well-being consisting of WHOQOLBref and MSIS-29 and the specific factor of WHOQOLBref subscale environmental dimension predicted participation and autonomy. EDSS predicted only the IPA subscale autonomy indoors. Gender was not associated with the experiences of participation and autonomy.

Conclusion: The results suggest that it is important to understand that experiences of different dimensions of participation and autonomy are closely associated with the experienced quality of life and impact of the disease. Moreover, results show that disability measured by the EDSS may influence the experienced participation and autonomy in indoors activities.

Scoping the Needs of Families and Carers of people living with Multiple Sclerosis (the SNOFLAC-MS study): A Rapid Realist Review and Evaluation

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Background: People living with MS frequently require support from unpaid family and friends who may experience physical, emotional and financial impacts. This can limit duration of caring in the home and require appropriate proactive interventions which may improve social participation for the whole family. Unfortunately, evidence is lacking regarding what helps, who it helps, when and how. These questions were addressed through Rapid Realist Review and Evaluation.

Method: The Rapid Realist Review of the literature was a three-stage, iterative review of academic and grey literature. Rigorous analysis of the limited evidence base generated seven theories about ways in which underpinning contexts and mechanisms of interventions influenced outcomes. The theories addressed interventions relating to: information and advice, problem-solving and coping, coordinated practical support, strengths-based training, emotional support, health-promoting activities, and peer interactions. These theories were evaluated qualitatively through face-to-face and telephone interviews and focus groups with 49 family or carers of people with MS.

Results: Contexts pertinent to participants varied dramatically (e.g. caring roles, other responsibilities, social support, finances) which affected their experiences greatly. Family and carers receive limited support and were often seen as peripheral in health care interactions. Evidence for the benefits of group peer interactions and counselling was found, and for the potential benefits of interventions addressed in all other theories. Different modes of intervention delivery should be used to overcome barriers to access, such as online.

Conclusions: The detailed analysis resulted in recommendations for the MS Society who commissioned the study to inform practice, policy and influencing activities. These are targeted at improving quality of life and delaying a ‘tipping point’ where capacity to care is overwhelmed by caregiving roles. A key message is: ‘one size does not fit all’. All interactions and interventions with family and carers of people with MS should adopt a person-centred approach.

Involving clients in content planning increases changes in their daily life

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Purpose: The aim of this study was to clarify, if involving the clients in the content planning of their own rehabilitation course, has an impact on their daily life over time.

Relevance: Due to earlier studies, rehabilitation has not been taken into the clients’ everyday lives as much as needed to change their abilities to function in the daily life. The relevance of this study was to test if client based and client centered rehabilitation courses enhance the commitment to a rehabilitative everyday life, and enhances also participation on clients own environment and society.

Participants: 235 clients, answers % = 71.5 %.

Methods: A follow-up survey was sent to clients who participated in rehabilitation courses in 2014 and 2015. The survey was sent 3 and 12 months after the course. They participated in 7 adaption training courses, 14 thematic rehabilitation courses, 5 courses for families and 3 courses for couples.

Analysis: The client’s answers were blindly linked to International Classification of Functioning, Disability and Health (ICF) by two of the authors.

Results: The clients started to move more than earlier, to eat healthier and to participate in hobbies in their neighborhood etc. These changes are found in ICF aspect of Activities and participation after both 3 and 12 months, 47 – 63 % of given descriptions of changes. Furthermore, the attitude towards the own disease and coping with it is more positive, and they are more merciful to themselves.

Conclusions: Involving the client actively in the content planning of rehabilitation courses will lead to changes in his everyday living. He will be more engaged in taking care of his health and wellbeing. When the family is feeling better it will encourage the client to be even more active and to participate even more in the daily life. The attitude towards, and coping with the own disease, changes permanently in a favorable direction.

Implications: Involving a client actively in the content planning of a rehabilitation course will link the rehabilitation content to the client’s everyday life. Rehabilitation will look like its actor.

Four themes to address when designing eHealth solutions for people with MS

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Introduction: People with multiple sclerosis (MS) report that nutrition affects perceived disease activity, but scientific literature shows no conclusive evidence with regards to an MS specific diet. The KosMuS-project will explore correlations between nutrition and disease activity by gathering big data and applying data mining methods. Participants with MS will use a smartphone application to register daily nutrition intake, changes in perceived disease activity as well as factors such as stress levels, physical activity, and sleep.

The combination of digital self-monitoring and big data analysis provides new opportunities for identifying patterns between nutrition and disease activity. However, this method requires that participants are continuously involved and consistent in their self-monitoring to ensure a sufficient dataset with regards to size and quality.

Consequently, first phase of KosMuS aims to investigate motivational factors for patients with MS to engage in technology-based research on nutrition and disease activity.

Methods: In July-August 2016, 15 interviews were conducted with people with MS. The interview guide included a combination of questions related to nutrition, eHealth literacy and empowerment. The transcribed interviews were analysed using thematic analysis.

Results: We identified four themes necessary for understanding the motivational factors among participants: technology and data collection, nutrition, lifestyle, and life with MS.

Participants experience a number of triggers and symptoms related to nutrition and lifestyle. Technology and data collection should be kept simple and provide an easy overview of the participant’s own data. Participants have different strategies and tools for handling MS in everyday life.

Conclusion: To be able to motivate participants to register daily nutrition intake and changes in disease activity, the project must address the following four themes: technology and data collection, nutrition, lifestyle, and life with MS. This must be done both in app development and communication to participants.

Understanding MRI imaging in MS (UMIMS) – development of a web-based education tool

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A web-based education tool was developed in English and German language covering all MRI aspects: diagnosis, prognosis, treatment evaluation, physics, sequences, lesion morphology, brain atrophy and neuroanatomic structures. Short video clips deliver summaries but also personal views of patients and experts aiming at demonstrating also controversial issues. Two additional training modules including feedback will help patients to read their own images as well as the MRI reports. Expert patient (n=6) as well as MS imaging expert (n=4) as a first feasibility evaluation was finished in Jan. 2017. In parallel a MRI knowledge questionnaire was refined and tested as well as a tool on personal attitudes towards MRI imaging.

While expert patients and imaging experts appreciated the profound approach of covering all MRI aspects, concern was raised that the tool might be too complex. More summary parts and links were asked for, while the overall characteristics to base patient MRI education on scientific studies was highly valued. Interviews with 6 MS patients on the MRI attitude questionnaire revealed little need for revision. A subsequent survey in 107 consecutive patients of the MS Day Hospital in Hamburg showed that the MRI results are important for patients and that patients are not much concerned about conduct of the MRI examination but partly worried about the report in relation to their MS. By December 31st, a large German wide survey applying the MRI knowledge as well as the attitude tool among n=498 patients was finished and is currently being analyzed. Education on the value of MRI is highly appreciated by MS expert patients despite its complexity. A thoroughly evaluated education tool might alter not only patients knowledge and attitudes but also increase their participation in decision making to have MRI or not and in evaluating the meaning of MRI findings.

Empowering People with Multiple Sclerosis through Physical Activity Apps

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Background: Since the creation of the Internet have appeared new forms of technology such as mobile applications (APPs), which allow to promote healthy lifestyles to prevent or control some health problems. It is the responsibility of health professionals to advise on the use of APPs to people with multiple sclerosis (PwMS) to achieve an effective self-management of their disease.

Objective: To analyze the qualitative results of the advice on the use of health APPs in a group, outdoor, regular physical activity program for PwMS.

Material and Methods: The most appropriate APPs related with physical activity were selected (according to criteria of quality, reliability, language and usefulness) by a physiotherapist and nurse specialized in MS. The goals of using the APPs were reported to the participants of a group, outdoor, regular physical activity program for PwMS through a group health education session and individualized counseling (discharge, installation and instructions for use). A questionnaire was administered after a period of 12 weeks.

Results: The group consisted of twelve participants with a mean age of 46.75 years. 83.3% used APPs during the group physical activity program. Of these, 80% moved their use out of the program. 90% were satisfied with the professional advice. 70% answered that APP motivated them to do more physical activity

and 60% had a lower distance perception than recorded. The overall assessment of the advice was 8.2 points out of 10.

Conclusions: The use of health APPs, such as Runkeeper or Wikiloc, increases the motivation and empowerment of PwMS to do regular physical activity and helps them self-manage their physical abilities. Counseling by health professionals specialized in MS allows choosing the most appropriate APPs and making them a useful tool within the personalized therapeutic plan of each PwMS.

Managing the transition to secondary progressive multiple sclerosis: a scoping review

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Background: Approximately 50% of patients with relapsing remitting multiple sclerosis (RRMS) will develop secondary progressive MS (SPMS) within 15 years of disease onset. The transition phase is characterized by a period of diagnostic uncertainty that may last several years. Evidence about transition to SPMS is scarce. The "Managing the Transition (ManTra)" project aims to develop and test a resource for people with SPMS. As a preparatory step, we aimed to perform a literature review.

Methods: A scoping review was performed to map the existing literature, using the Arksey & O'Malley framework. We searched MEDLINE, EMBASE, PsycINFO, CINAHL, Google (selective search) from inception to 2016. Trial and dissertation registers were also searched for published and unpublished studies. We included primary research focused on the process of transition from RRMS to SPMS related to patients, carers or health professionals (HPs).

Results: Five studies fulfilled the inclusion criteria and were analysed. Of these, 4 (80%) were qualitative studies conducted in UK between 2013 and 2015, and one was a retrospective cohort study conducted in US in 2014, the latter aiming to characterize the transition to SPMS. The qualitative studies investigated the lived experience of adults with SPMS and documented views of carers and HPs during transition. Main themes identified pertained to reclassification of SPMS, and its consequences on patients,

carers and HPs. Furthermore, possible strategies were identified to support these groups. The quality of reporting of the qualitative studies was good.

Conclusion: Despite the importance of this topic, only few research results have been published targeting the process of transition to SPMS, mainly focussing on qualitative studies. No interventions to empower and support patients, carers, and HPs are available and more research is needed to address this important issue. This scoping review will inform subsequent phases of the ManTra project.

International research collaboration: case study of the European life balance project team

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Introduction: A balanced person is able to spread time (and energy) optimally across the different life domains (work, leisure, self-care and rest). Especially in people with multiple sclerosis (MS) the ability to self-steer an optimal balance in daily activity may be compromised (Matuska & Erickson, 2008). Occupational therapists have an important role to assess, raise awareness about and optimize life balance.

Objective: To illustrate an international research collaboration between clinicians and researchers to study life balance in a multicultural context.

Method: The European life balance project team aims at evaluating test-retest reliability, cross-cultural and construct validity of the translated versions of the Life Balance Inventory (LBI) in people with MS within different European cultures. To reach this research aim, a team of clinicians and researchers collaborated to translate and independently back-translate the LBI in six languages. Inconsistencies have been discussed with the developer of the original (American) scale. The translated versions will be evaluated in a sample of at least 30 people with MS in all countries/language areas. To evaluate construct validity, relations of the LBI with quality of life, fatigue, depression and self-efficacy will be evaluated. LBI will be registered twice with an interval of maximum one week to evaluate test-retest reliability.

This translation and validation process of the LBI is used to illustrate how collaboration between clinicians and researchers can be set up to facilitate performing research by clinicians in an international context. A user friendly and uniform digital assessment battery was created in all versions to improve quality in data collection.

Relevance: This case study can inspire rehabilitation professionals to initiate international research collaboration. The results of the validation study contribute to the usefulness of the Life Balance Inventory in several European countries and language areas for clinical practice and international research focussing on life balance.

The Marathon of 24-hour Exercise for Multiple Sclerosis: a way to promote Physical Activity in People with Multiple Sclerosis

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Background: Marathon MaRS is a successful sports charity event in the field of Multiple sclerosis organized by Endowment Fund IMPULS (the Czech non-governmental non-profit foundation) with cooperation with physiotherapists which involves both, MS patients, their families and healthcare professionals and also the general public. The idea of an exercise event for MS patients originated in September 2011 when physiotherapists in MS Center, Department of Neurology and Center of Clinical Neuroscience at Charles University in Prague, started to organize special group lessons for MS patients (aerobic-resistance circuit training). Patients wanted to share their experience and to encourage other MS patients to exercise.

Methods: The Event has been running in a form of 24 hours of continuous indoor exercises appropriate for MS patients in dozens of cities in the Czech Republic and other countries (Slovakia, Switzerland, Poland, Turkey and France). The Prague MaRS event is running nonstop for 24 hours. Other cities join for a certain period of time according to their possibilities. The Prague headquarters is connected to other places via internet and telephone, so the participants can watch and encourage each other, which is important to maintain the idea of mutual solidarity. A supplementary program regarding healthy lifestyle, rehabilitation & sports activities is prepared in most cities. All sports events are supervised by qualified physiotherapists and trainers.

Results: This event started in 2012 with 84 participants exercising in Prague. In 2013 participated 194 people with MS and their friends and supporters. During the third year in 2014 other cities in Czech Republic participated with 630 people. In 2015 exercised more than 1000 people in 10 cities in Czech Republic, Slovakia and Switzerland. More than 2000 people took part in 2016 in 23 cities in Czech Republic, Slovakia, Switzerland and France.

Conclusion: Aim of the event is to promote exercise and physical activity among people with multiple sclerosis. The idea behind the project is the togetherness, team spirit, solidarity with people with MS and understanding for their needs. With this poster we would like to invite other countries and cities to join his event in 2008.

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EMPLOYMENT

The value of work- correlates of sustained employability in workers with Multiple Sclerosis (MS)

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Background: In MS, work participation is often compromised even at early stages of the disease. Job maintenance is found to be influenced by many different factors, including MS symptoms, financial and personal considerations, attitudes towards work and the workplace environment. Van Der Klink and colleagues have proposed a model for sustainable employability based on Amartya Sen's 'Capability Approach'. The aim of the current study was to examine the set of capabilities - valued aspects of work that are enabled and can be realized - in workers with MS and workers from the general population. We further examined relations between the capability set, work outcomes and health.

Methods: 100 workers with MS and 100 workers from the general population were matched for gender, age, educational level

and working hours. All participants completed questionnaires on demographics, health and work functioning. The capability for work questionnaire was used to explore whether a set of seven work values are considered valuable, are enabled in the work context, and can be realized by the worker. If this is the case, a work value is considered part of the worker's 'capability set'.

Results: Workers with MS have a larger capability set ($M=4.7$, $SD=0.8$) than workers from the general population ($M=3.7$, $SD=2.2$; $U=3753$, $p\leq 0.01$). In all workers we found that opportunities to achieve work value are rated lower than the importance of each work value. In workers with MS, the capability set correlated significantly ($p\leq 0.001$) with more working hours ($r=0.36$), better work ability ($r=0.38$), less absenteeism ($r=-0.32$) and presenteeism ($r=-0.38$), better self-rated health ($r=-0.34$), better cognitive/neuropsychiatric functioning ($r=-0.39$), less depression ($r=-0.46$), less anxiety ($r=-0.34$) and less fatigue ($r=-0.38$).

Conclusions: Workers with MS report a larger capability set than workers from the general population, suggesting a reappraisal of valued aspects of work in MS patients. As a larger capability set was associated with better work outcomes and better health in MS, more opportunities should be offered at work to realize important values.

Change in employment status and associations with quality of life: a longitudinal international study of people with multiple sclerosis

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Workforce participation is generally much lower in people with multiple sclerosis (MS), although recently improvements have been reported. Common MS symptoms and increasing disability are contributors to loss of employment, which has impacts on health but also financial and social costs. This study aims to estimate the causal effect of employment on quality of life (QOL), using a fixed-effects modelling approach to better control for confounding people with MS, recruited through online MS forums and MS society newsletters completed online surveys in 2012 and 2015, including items regarding sociodemographics, MS characteristics, QOL (MSQOL—54), fatigue (FSS), disability (PDDS), and employment. Here we report on those 713 people aged between 25 and 64 at follow-up with data on employment and QoL in both surveys. Fixed-effects linear regression models, which control for time-invariant confounding, were used to model the effects of changes in employment on QoL, controlling for disability level and fatigue, and time-varying sociodemographic and lifestyle characteristics. At baseline, 65.7% had relapsing-remitting MS, 19.8% were male and the average age was 45.2 years. At baseline 37.9% worked full-time, 23.7% worked part-time, 3.0% were unemployed, 16.8% were retired due to disability and 18.7% were not in the labour force. Though the proportion employed changed only from 61.6% to 58.3% at follow-up, 25.1% experienced some change in employment status. For physical QoL, the largest effects were seen for people who retired due to disability (-5.0 ; -8.4 , -1.6), whereas for mental QoL the largest effects were for unemployment (-8.2 ; -16.2 , -1) and retirement

due to disability (−6.7; −11.9, −1.5), compared to full-time employment. Interactions by other common MS symptoms and comorbidities, gender, age groups, country of residence and type of MS were explored. Losing employment was associated with clinically significant decreases in mental and physical QOL for people with MS, after adjusting for level of disability and fatigue.

Personality differences in employed and unemployed patients with Multiple Sclerosis (MS)

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Background: The majority of MS patients are unable to retain employment. MS disease features alone only account for a small part of the variance in predicting employment. Only a few studies have taken personality traits into account when predicting vocational status, but results were inconclusive. Furthermore it is known that personality influences coping and one's ability to manage illness, which in turn can influence employment. The current study examines the relationship between personality and work status in patients with MS. We further explored the relations between personality and general health and coping in patients with MS.

Methods: In the context of the MS@Work study 19 unemployed and 19 employed patients with relapsing remitting MS were blindly matched (post inclusion) for gender, age, educational level and (previous) job type. They completed the NEO-FFI personality questionnaire and various questionnaires on demographic variables, physical and cognitive functioning, fatigue, depression, anxiety and coping. Group differences were examined using t-tests. Correlation analyses were used to examine relations between personality and other variables in patients with MS. P values $\leq .05$ were considered significant. We used $p \leq .001$ for the correlation analyses.

Results: Higher levels of Neuroticism $t(36) = 2.62$, $p < .05$ and lower levels of Extraversion $t(36) = -2.27$, $p < .05$ and Conscientiousness $t(36) = -2.42$, $p < .05$ were seen in the unemployed group. Positive correlations between Neuroticism and emotion focused coping, $r(38) = .72$, $P < .001$, anxiety, $r(37) = .65$, $P < .001$, depression, $r(37) = .67$, $P < .001$, fatigue, $r(37) = .594$, $P < .001$, and negative correlations between Neuroticism and SF36 Role limitation due to emotional problems $r(36) = -.63$, $P < .001$ and SF36 Emotional wellbeing $r(38) = -.77$, $P < .001$ were reported. Extraversion was negatively correlated with depression $r(37) = -.55$, $P < .001$.

Conclusion: Personality traits differed between employed and unemployed patients with MS, matched for gender, age, educational level and (previous) job type. Higher levels of Neuroticism, lower levels of Extraversion and Conscientiousness were reported in unemployed patients with MS. In accordance with previous findings Neuroticism was related with maladaptive health behaviours. Longitudinal studies are needed to examine further relations between personality and employment.

Characteristics of PwMS depending on the level of working difficulties: a cross sectional study using the MSQ-Job questionnaire

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Introduction: Unemployment or job loss are major problems for people with multiple sclerosis (PwMS). Coherently with a biopsychosocial approach, the Multiple Sclerosis Questionnaire for Job Difficulties (MSQ-Job) addresses difficulties experienced by workers with MS accounting for both MS-related symptoms and environmental barriers (work-place features). The aim of this study is to assess the distinctive socio-demographic, clinical and cognitive characteristics of workers with MS experiencing high working difficulties.

Methods: Cross-sectional study. MSQ-Job cut-off was used to distinguish PwMS with (MSQ-Job score >15.8) or without a significant level of self-reported working difficulties. T-test was used to evaluate between groups differences in the following domains: socio-demographical (age, years of education), clinical (EDSS; disease duration) cognitive (Rao's Brief Repeatable Battery of Neuropsychological Test) and psychological (Beck Depression Inventory-II; State-Trait Anxiety Inventory). Chi square test was used for categorical variables: gender, full/part-time employment, type of contract, company size, diagnosis disclosure at work.

Results: A total of 177 employed PwMS (108 females, aged 21-63) participated and 48 of them (27.1% of the entire sample) reported high working difficulties: they were significantly older (42.9 vs 38.5), with a lower level of education (13.8 vs 15.4 years), higher EDSS score (mean 2.2 vs 1.6), more depressive symptoms (14.2 vs 5.5), higher level of state anxiety (55.7 vs 45.9) than participants that reported low difficulties. Moreover, the group with high working difficulties presented a higher percentage of people with progressive course (10.4%) compared to the group of PwMS showing low difficulties (3.1%).

Discussion: These aspects should be taken into account in planning preventive intervention to reduce premature job loss in PwMS. Particularly, anxiety and depressive symptoms should be monitored as warning signals of working difficulties

OTHER

The presence of musculoskeletal pain and its distribution among the body regions in persons with multiple sclerosis: a preliminary study

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Background: Pain is one of the common symptoms reported by persons with multiple sclerosis (MS). Although the information about neuropathic pain in MS is reasonably sufficient, the information about the characteristics of musculoskeletal pain is insufficient. The aim was to determine the presence of musculoskeletal pain and its distribution among the body regions in persons with MS.

Methods: Persons with MS participated in this cross-sectional preliminary study. The participants completed the Nordic Musculoskeletal Questionnaire to determine the presence and distribution of the musculoskeletal pain. Moreover, the demographic and clinical characteristics of the participants were determined.

Results: In total, 57 persons with MS (44 female) participated in this study. The mean age and disease duration were 38.4 (SD=10.6) and 7.4 (SD=5.3) years, respectively. The musculoskeletal pain in the last year were mostly observed in the upper back (56.1%), low back (56.1%), neck (50.9%) and knees (44.6%). The most preventing musculoskeletal pain from work was in the low back (22.8%) and knees (22.8%). One-week presence of musculoskeletal pain in low back, knees, neck, and upper back were 36.8%, 32.1%, 29.8%, and 29.8%, respectively. In the last year, the presence of low back pain was significantly higher in female participants (65.9%) than in male participants (23.1%) ($p < 0.05$). There was no significant difference between male and female participants in other body regions ($p > 0.05$).

Conclusions: The body regions where most of the musculoskeletal pain was observed were low back, neck, and knees in persons with MS. The presence of low back pain was found significantly higher in female persons with MS than males. The findings of this study suggests that various rehabilitation programs and ergonomic approaches addressing the management for the musculoskeletal pain are highly required in persons with MS.

Factors associated with dysphagia in MS: A prediction model to assist in identification of people at risk

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Purpose: Dysphagia is an early symptom of multiple sclerosis (MS). Currently, there are no clinical markers identifying people with MS at risk for dysphagia. The purpose of this study was to identify risk factors that predispose people with MS to dysphagia.

Methods: A prospective epidemiology study was completed on 113 people with MS (61 % female, mean age 48±11.9 years, median EDSS score: 4.0±4.5, EDSS range: 0-9), with and without dysphagia. Dysphagia was confirmed with videofluoroscopy rated with the Dysphagia Outcome and Severity Scale. Demographic, cognitive, neurological and swallowing function data were collated. Thirteen clinical and demographic variables were assessed as risk factors. Classification and regression tree (CART), a more clinically meaningful analysis, was also performed to determine factors discriminative for dysphagia.

Results: Gender ($p < .001$), disease duration ($p < .01$) and time interval between 1st/2nd attack ($p < .05$) remained significantly associated with dysphagia as a dichotomous trait in multivariate regression analysis. Being male (ORfemale vs male: 0.18, CI 0.06-0.50), having disease duration >15 years (OR per year: 1.09, CI: 1.01-1.17) and time interval between 1st/2nd attack (OR per month: 1.02, CI: 1.01-1.04) were all associated with increased dysphagia risk. A similar set of significant markers (disease duration >12.5 years cutoff and time between 1st/2nd relapse >54 months cutoff) was identified by CART analysis with age at diagnosis >27.5 years identified as an additional classifier for dysphagia.

Conclusions: New data on risk factors for swallowing dysfunction in MS are proposed. Gender had a strong influence on dysphagia risk. Classification and regression trees may prove useful as a predictive tool for dysphagia and be used in the referral process. Further research and clinical directions are discussed.