

## Intervention description

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The e-training exercise program consisted of twelve weeks of resistance training performed twice weekly and endurance training with one training session per week. The exercise training was home-based and supervised via the internet.

### Software platform/infrastructure

The core aim of the e-training software was the mediation of customized, progressive, strength-building exercise training via the internet. Prescription and supervision of exercises and incorporation of participants' feedback was organized via a browser-based software solution (motionNet e-Training, motionNET systems Ltd., Nuernberg, Germany, [www.motionnet-systems.de](http://www.motionnet-systems.de)) with separate therapist (back-end) and participant interfaces (front-end). No additional devices or software installation was needed. Via the e-training platform, a one-to-one support for each participant was implemented. Training support and communication took place asynchronously (not in real time) via a messaging service in the software and when required, by email and telephone (supplementary figure 1). A social network for the participants to use among themselves was not set up.

### Education

The e-training intervention began with a two-day, on-site training seminar on the content and procedures of the e-training intervention, summarized below:

- Knowledge of action and effect: basic information on MS and exercise, strength training/endurance training with MS; dose and periodization of training
- Practice sessions: execution and discussion of basic strength exercises; body awareness exercises; heart rate measurement and endurance training
- Motivation and volition: Motivational help and advice regarding action planning and barrier management for the implementation of exercise in everyday life
- Familiarization with the software: general operation of the software, documentation of training, handling of the physical activity diary

The introductory seminar contained 12 sessions with 45 minutes duration each and was conducted within 2 days and in groups of between 4 and 12 persons. The seminar was standardized with manuals and powerpoint presentations for instructors and a folder with information material for participants.

### Exercise prescription – strength training

According to the recommendation for the application of resistance, endurance and combined training available at the time of the study design and its good tolerability, strength training was declared core content of the intervention and prescribed twice weekly for a period of 12 weeks, with 2-3 sets per exercise. Repetitions were kept within an intended range of 12-20 repetitions, depending on the initial fitness levels and difficulty of the exercises. Between sets and exercises, a rest period of approximately 1–2 min was recommended.

Exercise instructions were delivered as PDF documents, containing pictures and descriptions of the most important points for performing the exercise: initial position, movement description, final position and special considerations (supplementary figure 2).

A training plan contained 5-8 exercises for the most important muscles: abdominals, lower back, upper back/arms, quadriceps, and abductors. All the exercises could be done at home, the only training aids used were latex exercise bands or large gymnastic balls. Therapists could choose from a catalogue of about 150 exercises that were systematically categorized according to trained muscle groups and difficulty level. A sample exercise scheme is presented in supplementary figure 3. Difficulty levels were determined according to required muscular effort, balance and stabilization demands (e.g. double leg stance vs. single leg stance, different support surfaces), number of involved joints (single vs. multiple joint exercises), degree of freedom of joint movements, or applied weights/resistance (e.g. additional weight in a backpack, different elastic bands).

Thus, different initial fitness levels of participants and standardized, yet individual training progression could be accounted for.

Exercises were selected from the above-mentioned muscle groups but the participants always had the opportunity to give positive or negative feedback to any of the included exercises, so that the therapist could rearrange the training plan (see supplementary figure 4). The therapist's goal was to find a training plan that fits to the patient's preferences, needs and training status.

## Progression of training load for strength training

The number of series and repetitions to be completed for each exercise were prescribed individually for each participant and training session, and were depending on fitness levels. To ensure training overload and progression, we used a standardized progression scheme ranging from at least 2 times 6 repetitions up to a maximum of 3 times 20 repetitions. The progression scheme had an increment of 2 repetitions with altering numbers of sets (between 2 and 3). Training intensity was regulated by the participant's subjective, perceived exertion, which was rated between 6 and 20 on the BORG Scale. Therapists aimed at eliciting a BORG Feedback of between 11 (fairly light) and 16 (hard). If successful, the next progression step was prescribed for the respective exercise. If the final progression stage of 3 times 20 repetitions was reached, therapists prescribed the next more demanding exercise for the same muscle group (see supplementary figure 5). This procedure enabled an individualized progression of training load that was, at the same time, standardized.

## Exercise prescription – endurance training

In addition to strength training, to facilitate effects on aerobic fitness and quality of life, endurance training with one session per week was prescribed. Based on the spiroergometric evaluation, recommendations regarding the intensity of jogging, walking, cycling and swimming were made. The training heart rate (THR) was determined via the V-Slope method, using the first ventilatory threshold (VT1) and the second ventilatory threshold (VT2):  $THR = [(VT2 - VT1) / 3] + VT1$ . The form of activity for the endurance training was freely selected by the participants; duration (between 10-60 minutes) was adjusted to individual fitness levels. In contrast to strength training progression scheme, the endurance training was not automatically progressed but in exchange with the patient. Participants, who were not able to monitor their training intensity per heart rate monitor were advised to use the BORG scale (light to moderate intensity between 11 to 15).

## Physical activity diary

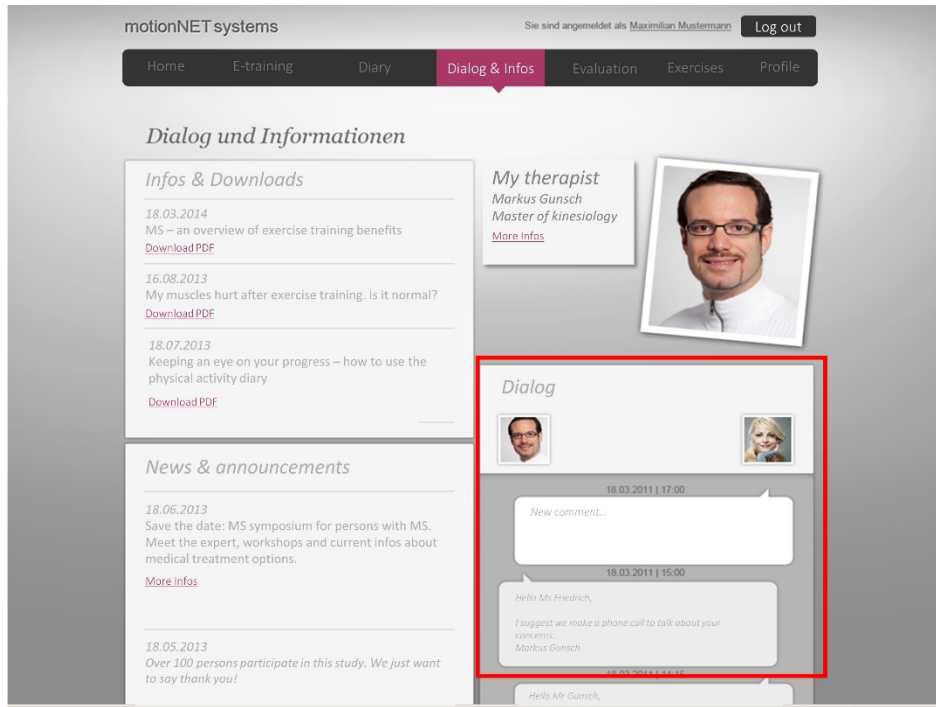
All the training sessions could be planned and documented in an online exercise journal, which could also be seen by the therapist (see supplementary figure 6) Every training session, including all the exercises and associated training load parameters, was automatically stored electronically after documentation from the participants. For positive reinforcement, a dashboard is implemented in the participant's interface to visualize the training process and progress. After performing the training session and evaluation of further physical activities in the diary, the activity goals and the actual activity are compared. Are 50% of the goals are achieved, trophies and medals are awarded (see supplementary figure 6).

## Exercise-related safety issues

None of the existing reviews has detected deleterious effects of physical activity or exercise on the course of the disease or detected any potential harm for pwMS (e.g., Pilutti, Platta, Motl & Latimer-Cheung, 2014). To lower potential risks for the participants, such safety issues were considered in this internet-based intervention study:

- the aptitude for physical exercise is ensured at the beginning of the intervention: all participants undergo an anamnesis and also physical examination prior to training
- resistance training (for example with the body weight or elastic bands) and endurance training (e.g., walking, biking) are recommended for persons with mobility impairments (Guidelines)
- exercise trainings session are thoroughly supervised by an experienced and trained physical or exercise therapist in terms of the participant's feedback
- explicit safety instructions were and by the exercise prescriptions, provided by the exercise therapist, plus modification and usage of equipment were presented to reduce potential safety risks
- and exercise intensity will be adapted to each participant's condition to ensure an adequate risk-benefit ratio

Supplementary figures




Supplementary Figure 1: The training platform contains a messaging service for the one-to-one support

## Exercise description


### Squat






**Starting position**

- Stable stance
- Knee slightly bent
- Feet pointing slightly outwards
- Abs put under tension
- Upper body straight



**Movement description**


- Movement initiation: pelvis down and backwards
- Knees bent
- Upper body is kept straight



**End position**

- Chair is slightly touched, but do not sit down!
- Upper body still straight
- Body weight is put mainly on the heels

**Additional clues**



Look slightly downwards

Shoulders lowered


Back is straight

Abs under tension

Keep knees behind toes

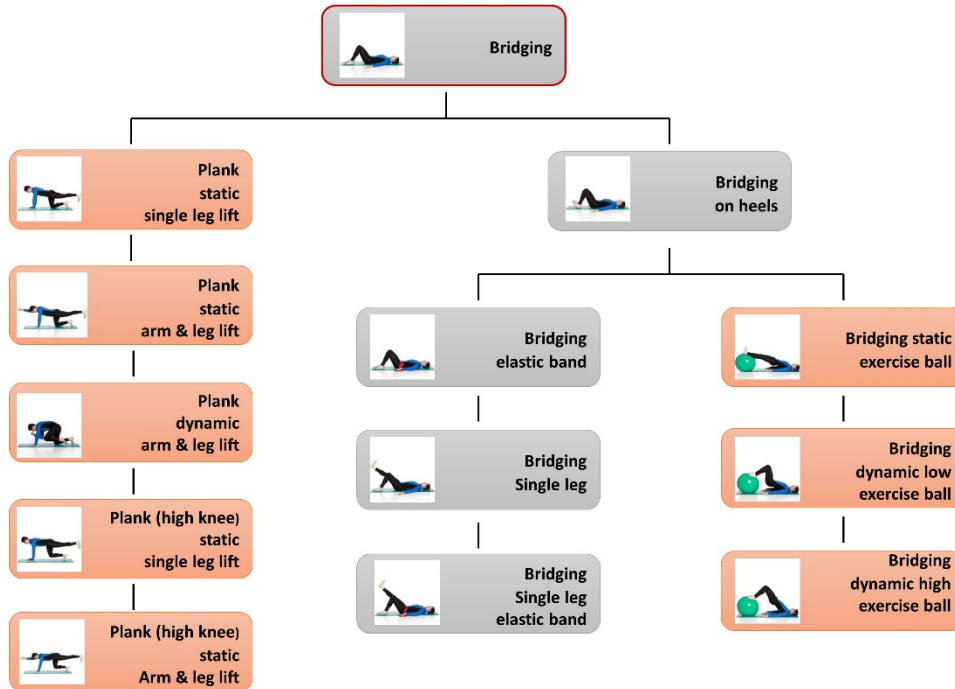
Keep distance

**Have an enjoyable and successful workout!**

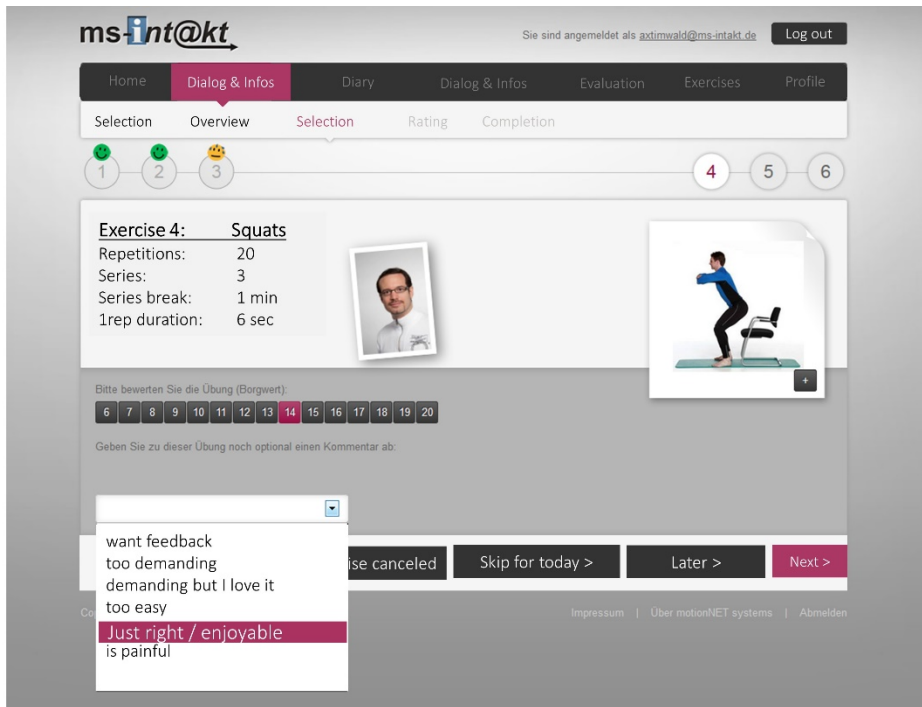


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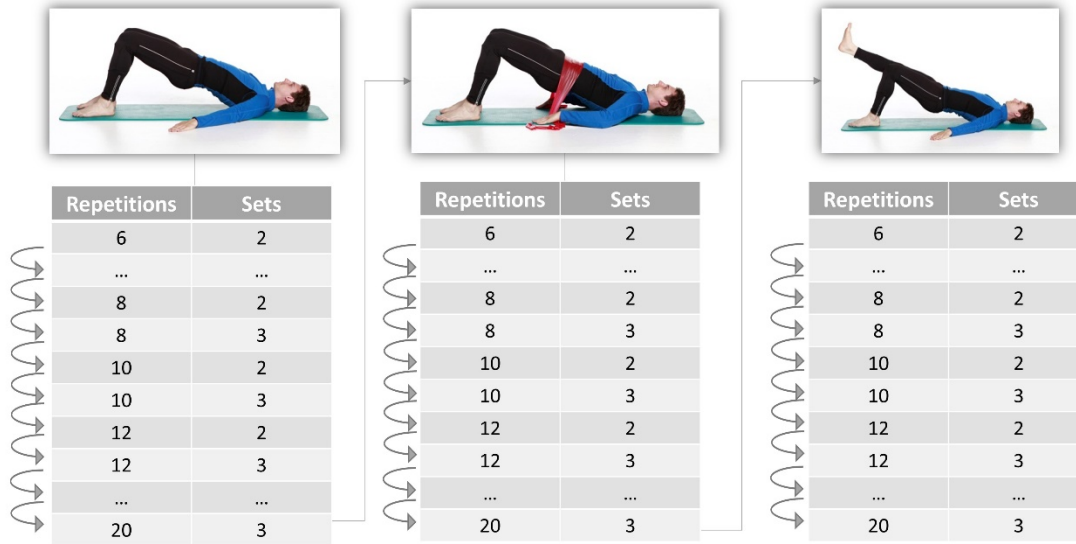
Supplementary Figure 2: Example of an exercise description (as PDF document) with initial position, movement description and end position as well as additional hints for execution



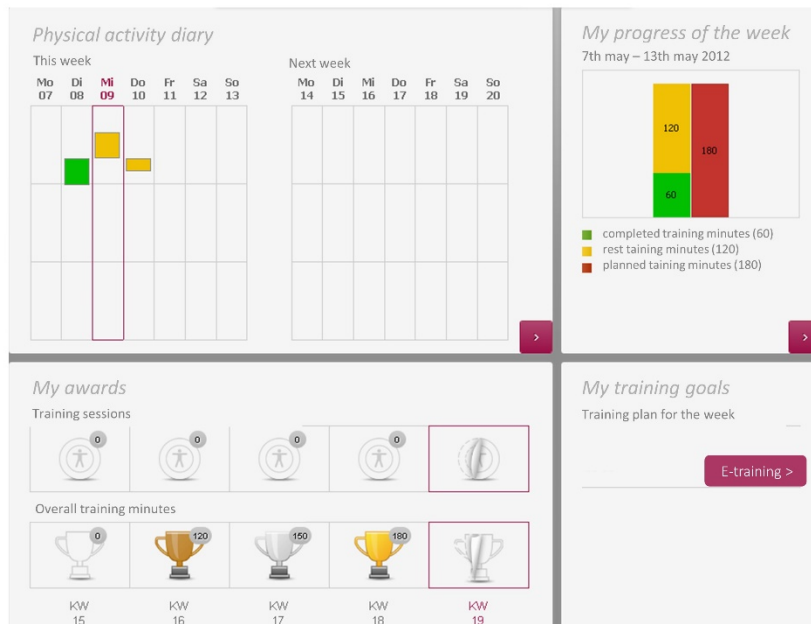
Supplementary Figure 3: Example of an exercise progression scheme for lower back and lower extremities. The gray-framed exercises represent the standard progression scheme, which could either be supplemented or replaced by alternative exercise paths (orange) depending on the patient’s preferences, physical abilities or physical limitations.



Supplementary Figure 4: Example of the training plan with six exercises including a description of the training parameters. After the exercise, participants were asked to rate their subjective perceived exertion on the BORG scale and continue with the next exercise.



Supplementary Figure 5: Example of a strength training progression scheme



Supplementary Figure 6: Example of a participant's dashboard including the physical activity diary, the current progress of the week, someone's awards and planned training goals