Supplementary Table S1

Items of the self-developed scales

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Source of Behaviour | TDF Domains | Construct | Scale/Instrument/Items | No. of items | Reference |
| Capability - Physical | Skills | Practice | Exercise history (year before diagnosis) - screening with one question: regular, irregular, inactive;  3 more questions for those, who were regularly or irregularly active.   * Please indicate the type of physical/athletic activities you regularly took part in in the year before your MS diagnosis. * Which of the physical/athletic activities did you have to give up because of MS? * For how long following your MS diagnosis were you able to continue with the named physical/athletic activities? | 1  3 | Self-developed on the basis of our interview study [1] |
| Capability - Psychosocial | Knowledge | Physical activity and MS related information provision and knowledge | Information provision and knowledge   * Has your doctor ever told you that physical activity or participating in sports is beneficial for patients with MS? * Have you ever been advised by other health care specialists with regard to your physical activity or participation in sports? * Have you ever received information concerning physical activity or sports from the self-help organisation (DMSG)?   (response range: 1 (no) to 4 (yes, comprehensively)   * Are you familiar with the guidelines for physical or athletic activity for MS patients? * Do you know which exercises you should carry out?   (response range: 1 (yes) to 2 (no) | 5 | Self-developed on the basis of our interview study [1] |
| Motivation – Reflective | Beliefs about consequences | Risk Perception | Risk perception - Probability  1. Imagine that you remain as physically active as you are now. How probable do you find it that your current physical activity level will influence the risk of….  …developing brain capacity problems  …developing mobility problems,  …developing chronic fatigue  …gaining weight  …developing a cardiovascular disease.  response range: 1 (highly improbable) to 7 (highly probable)  Risk perception - Seriousness  2. How serious a matter for your health do you consider the following to be  …brain capacity problems  … mobility problems  chronic fatigue  …weight gain  …cardiovascular diseases  response range: 1 (not serious) to 7 (very serious) | 10 | Self-developed in line with HAPA risk perception items [2, 3] |
| Opportunity - Physical | Environmental Context and Resources | Barriers and facilitators | Barriers of the physical and social environment  The following obstacles prevent me from undertaking regular physical activity:  Physical Environment   * Existing leisure or sports facilities are not handicapped-suited. * In my environment there is a lack of opportunities for regular physical activity or athletic exercise. * Available sports programmes are inappropriate or aren't fun. * I have problems getting to the existing sports facilities (e.g. absence of public transport, absence of disabled parking spaces, too far away). * I can't afford the fees for the available sports programmes (e.g. membership fees in the sports clubs)   Social Environment   * There is a lack of encouragement for physical activity from health care specialists. * I feel socially alienated because members of sports clubs and trainers don't encourage people with disabilities to participate. * Staff in sports facilities either are not supportive or aren`t knowledgeable in MS specific problems. * People around me (e.g. other MS patients, family, colleagues) have negative attitudes about physical activity.   response range: 1 (Is not applicable) to 4 (applicable) | 9 | Self-developed on the basis of our interview study [1, 4, 5, 6] |

Supplementary Table S2

Determining stages of change with the modified Physical Activity staging Questionnaire [7]

**Introduction to and questions of the modified PASQ instrument**

For physical activity to be regular it must be done for 30 min. (or more) per day, and be done at least 4 days per week. For example, you could take a 30-minute brisk walk or ride a bicycle for 30 minutes. Physical activity includes such activites as walking briskly, biking, swimming, line dancing, and aerobics classes or any other activities where the exertion is similar to these activities. Your heart rate and /or breathing should increase, but there is no need to exhaust yourself. Please answer all questions with either Yes or No.

According to the definition above:

1. Do you currently engage in regularphysical activity?
2. Do you intend to engage in regular physical activity in the next 6 months?
3. Do you intend to engage in regular physical activity in the next 30 days?
4. Have you been regularly physically active for the past six months?
5. Have you been regularly physically active for the past 12 months?

*Stages of change with the modified Physical Activity staging Questionnaire (PASQ)*

|  |  |
| --- | --- |
| Original Staging | Combined Categories |
| Pre-Contemplation | not regularly active |
| Contemplation |
| Preparation |
| Action | currently regularly active |
| Maintenance |
| Long term maintenance | long-term regularly active |

Supplementary Table S3

*Description of Scales*

|  |  |  |  |
| --- | --- | --- | --- |
| TDF Domain | Construct | Scale Description | Reference |
| Skills | Practice | Based on the results of our interview study we hypothesized that people with a positive exercise history, who had been regularly physically active in the year before their MS diagnosis, might thereby have acquired skills and practice that helped them to continue being active after diagnosis. A single item measured exercise history: regularly physically active (30 minutes or more per day on at least 4 days of the week), irregularly physically active (less than 30 minutes per day or on less than 4 days per week) or inactive in the year before their MS diagnosis. For those, who reported to have been regularly or irregularly physically active, three more items asked for more details (e.g. type and intensity of physical activity, need to give them up due to the MS disease). Items are provided in Supplementary Table S1. | Self-developed on the basis of our interview study [1] |
| Knowledge | Physical activity and MS related information provision and knowledge | Three researcher-devised items based on our interview study assessed if and to what extent study participants received information about physical activity and MS from health care professionals or self-help organizations. Items were rated on a 4-point scale from 1 (no) to 4 (yes, comprehensively) with higher scores indicating more information provided. Additionally, two researcher-devised items asked, if study participants were aware of physical activity guidelines for people with MS or if they knew, which exercises were appropriate for them. Items are provided in Supplementary Table S1. | Self-developed on the basis of our interview study [1] |
| Memory, Attention and Decision Processes | Cognitive overload/ Tiredness | The Hamburg Quality of Life Questionnaire in Multiple Sclerosis (HAQUAMS) – Subscale Cognition measures cognitive function with 4 items; response range is from 1 (not at all) to 5 (very much) [8, 9]. Higher scores indicate less cognitive function. The HAQUAMS Subscale Fatigue measures cognitive function with 4 items; response range is from 1 (not at all) to 5 (very much) [8, 9]. Higher scores indicate more fatigue. | [8, 9] |
| Behavioural Regulation | Action Planning | Action Planning was measured with items that have been developed and used in research within the Health Action Process Approach [10]. We used 5 items rated on a 4-point scale from 1 (not true) to 4 (completely true). Higher scores reflect stronger action planning. | [10] |
| Action Control | Action Control was measured with items that have been developed and used in research within the Health Action Process Approach [11]. We used 6 items rated on a 4-point scale from 1 (not true) to 4 (completely true). Higher scores reflect stronger action control. | [11] |
| Coping Planning | Coping Planning was measured with items that have been developed and used in research within the Health Action Process Approach [10]. We used 5 items rated on a 4-point scale from 1 (not true) to 4 (completely true). Higher scores reflect stronger coping planning. | [10] |
| Intention | Intention | Intention was measured with items that have been developed and used in research within the Health Action Process Approach [10]. We used 5 items rated on a 4-point scale from 1 (not true) to 4 (completely true). Higher scores reflect greater intention to become physically active. | [10] |
| Goals | Goals (autonomous/controlled) | We used the Self-regulation questionnaire - motivation for exercise (SRQ-E) which has been developed within Self-Determination Theory (SDT) by Deci and Ryan [12, 13, 14]. SDT principally postulates that an understanding of human motivation and behaviour requires the consideration of three basic psychological needs: competence, relatedness and autonomy of motivation and self-regulation [12]. Especially the concept of autonomy of motivation and self-regulation has been widely applied in a range of health-related behaviours [15]. The SRQ-E is a 16-item scale that explores the reasons why people exercise regularly. Items are rated on a 7-point scale ranging from 1 (not at all true) to 7 (very true). Four subscales that represent the continuum from external to intrinsic motivation and self-regulation with 4 items each were calculated: external, introjected, identified and intrinsic regulation. Moreover, to assess the overall autonomy of motivation and self-regulation the Relative Autonomy Index (RAI) [13] was calculated by combining the subscales with higher scores indicating more autonomy. | [14] |
|  | Goal/Target setting | The Exercise Goal-Setting Questionnaire [16] was used to measure exercise goal setting. The questionnaire contains ten items rated on a 5-point scale from 1 (does not describe) to 5 (describes completely). Due to a programming error in our survey tool, two items (8+9) have inadvertently been combined into one. Therefore, the sum of item scores of our instrument resulted in an overall score ranging from 9 to 45 instead of 10 to 50. Higher scores reflect a stronger tendency for setting exercise goals. | [16] |
| Beliefs about Capabilities | Self-efficacy | Perceived self-efficacy has been important for health behaviour change and maintenance. However, depending on the stage of change different domains of self-efficacy might be relevant: action self-efficacy, maintenance self-efficacy and recovery self-efficacy [17, 18]. We measured the three domains of self-efficacy with short scales that have been used in various research studies evaluating health behaviours with the Health Action Process Approach [17, 18, 19]. All items were rated on a 4-point scale from 1 (not true) to 4 (completely true) with higher scores indicating greater self-efficacy. | [17, 18] |
|  | Illness Perception | The Brief Illness Perception Questionnaire (Brief IPQ) is an eight- item scale, which has been designed to assess cognitive and emotional illness representations [20]. All items were rated on a 10-point scale. Each item measures one dimension of illness perception (e.g. consequences, timeline, personal control). A systematic review and meta-analysis has shown, that the Brief IPQ is a valid and reliable measure of illness perceptions in patients with various conditions, including MS[21, 22]. An overall score can be computed with higher scores reflecting a more threatening view of the illness. | [20] |
| Beliefs about Consequences | Outcome Expectations | The Multidimensional Outcome Expectations for Exercise Scale (MOEES) [23] measures outcome expectations for exercises. This scale consists of 15 items that reflect three subdomains: physical outcome expectations (6 items), social outcome expectations (4 items) and self-evaluative outcome expectations (5 items). All items were rated on a 5-point scale from 1 (strongly disagree) to 5 (strongly agree) and were summed to form the three subscales with higher scores per subscale reflecting greater physical, social, or self-evaluative outcome expectations. | [23] |
| Risk Perception | We developed ten risk perception items that seemed adequate to the situation of people with MS on the basis of previous research evaluating the Health Action Process Approach [2, 3]. We assessed two subdomains: First, the probability to get certain health problems in the future (probability items) and secondly, how serious participants rated the threat to their health by certain health conditions (seriousness items). All items were rated on a 7-point scale from 1 (very unlikely) to 7 (very likely) for the probability items and 1 (not seriously) to 7 (very seriously) for the seriousness items. Higher scores in the two subdomains indicate greater risk perception. Items are provided in Supplementary Table S1. | Self-developed in line with HAPA risk perception items [2, 3] |
| Optimism | Optimism | The Life Orientation Test -Revised (LOT-R) is a 10-item measure of optimism versus pessimism [24]. A representative population survey in Germany showed that the psychometric properties of the instrument were satisfactory and it can be used to measure dispositional optimism or pessimism in individual diagnostics as well as in epidemiological research [25]. An overall score can be computed with lower scores reflecting more optimism. | [24] |
| Reinforcement | Outcome experiences | Outcome experiences of participants being physically active after MS diagnosis were measured with a 16-item scale developed by Fuchs et al. within the Motivation/Volition concept [26, 27]. The construct reflects the personal experiences and appraisals regarding a certain behaviour e.g. physical activity. Items were rated on a 4-point scale from 1 (is not applicable) to 4 (is applicable). Higher scores reflect more positive outcome experiences. | [26] |
| Emotions | Mood/Depression | The Hamburg Quality of Life Questionnaire in Multiple Sclerosis (HAQUAMS) – Subscale Mood measures mood with 5 items rated on a 5-point scale from 1 (not at all) to 5 (very much) [8, 9]. Higher scores indicate more depression. | [8, 9] |
| Environmental Context and Resources | Barriers and Facilitators | Items to assess barriers and facilitators to long-term physical activity from the physical and social environment were developed based on previous research [1, 4, 5, 6]. Five items addressed possible barriers from the physical environment, 4 items barriers from the social environment. All items were rated on a 4-point scale from 1 (is not applicable) to 4 (applicable) with higher scores reflecting the perception of greater barriers. Items are provided in Supplementary Table S1. | Self-developed on the basis of our interview study [1, 4, 5, 6] |
| Social influences | Social support | Physical activity related social support was measured with a 7-item scale developed by Fuchs et al. within the Motivation/Volition concept (Fuchs et al., 2008). Items are rated on a 4-point scale ranging from 1 (almost never) to 4 (almost) always) with higher scores indicating more physical activity related social support. | [28] |

TDF = Theoretical Domains Framework

Supplementary Table S4

*Self-reported Physical Activity (GLTEQ Score Health) in relation to Disability (PDDS)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Disability  (PDDS) | N | GLTEQ Score Health (%) | | |
| insufficiently active | moderately active | active |
| 0 | 222 | 16.2 | 18.0 | 65.8 |
| 1 | 225 | 28.4 | 22.7 | 48.9 |
| 2 | 199 | 36.2 | 18.6 | 45.2 |
| 3 | 158 | 44.3 | 19.6 | 36.1 |
| 4 | 103 | 52.4 | 18.4 | 29.1 |
| 5 | 47 | 48.9 | 21.3 | 29.8 |
| 6 | 42 | 76.2 | 9.5 | 14.3 |
| 7 | 30 | 43.3 | 16.7 | 40.0 |
| 8 | 1 | 100 | - | - |

PDDS = Patient Determined Disease Steps; GLTEQ Score Health = Godin Leisure Time Exercise Questionnaire Score Health

**References**

1. Riemann-Lorenz K, Wienert J, Streber R, et al. Long-term physical activity in people with multiple sclerosis: exploring expert views on facilitators and barriers. Disability and Rehabilitation. 2019:1-13.

2. Renner B, Schwarzer R. The motivation to eat a healthy diet: How intenders and nonintenders differ in terms of risk perception, outcome expectancies, self-efficacy, and nutrition behavior. Polish Psychological Bulletin. 2005;36:7-15.

3. Schwarzer R, Lippke S, Luszczynska A. Mechanisms of health behavior change in persons with chronic illness or disability: the Health Action Process Approach (HAPA). Rehabilitation psychology. 2011;56:161-70.

4. Hale LA, Smith C, Mulligan H, et al. “Tell me what you want, what you really really want….”: asking people with multiple sclerosis about enhancing their participation in physical activity. Disability and Rehabilitation. 2012;34(22):1887-1893.

5. Learmonth YC, Motl RW. Physical activity and exercise training in multiple sclerosis: a review and content analysis of qualitative research identifying perceived determinants and consequences. Disability and Rehabilitation. 2016;38:1227-42.

6. Mulligan HF, Hale LA, Whitehead L, et al. Barriers to physical activity for people with long-term neurological conditions: a review study. APAQ. 2012;29:243-65.

7. Nigg C, Hellsten L, Norman G, et al. Physical activity staging distribution: establishing a heuristic using multiple studies. Annals of behavioral medicine. 2005 ;29: Suppl:35-45.

8. Gold SM, Heesen C, Schulz H, et al. Disease specific quality of life instruments in multiple sclerosis: validation of the Hamburg Quality of Life Questionnaire in Multiple Sclerosis (HAQUAMS). Mult Scler. 2001;7:119-30.

9. Gold SM, Schulz H, Stein H, et al. Responsiveness of patient-based and external rating scales in multiple sclerosis: head-to-head comparison in three clinical settings. Journal of the neurological sciences. 2010;290:102-6.

10. Sniehotta FF, Schwarzer R, Scholz U, et al. Action planning and coping planning for long-term lifestyle change: theory and assessment. European Journal of Social Psychology. 2005;35:565-576.

11. Sniehotta FF, Scholz U, Schwarzer R. Bridging the intention–behaviour gap: Planning, self-efficacy, and action control in the adoption and maintenance of physical exercise. Psychology & Health. 2005;20:143-160.

12. Deci EL, Ryan RM. The “What” and “Why” of Goal Pursuits: Human Needs and the Self-Determination of Behavior. Psychological Inquiry 2000;11(4):227-268.

13. Grolnick WS, Ryan RM. Parent Styles Associated With Children's Self-Regulation and Competence in School. Journal of Educational Psychology. 1989;81(2):143-154.

14. Rose EA, Markland D, Parfitt G. The development and initial validation of the Exercise Causality Orientations Scale. Journal of sports sciences. 2001;19:445-62.

15. Ng JY, Ntoumanis N, Thogersen-Ntoumani C, et al. Self-Determination Theory Applied to Health Contexts: A Meta-Analysis. Perspectives on psychological science : a journal of the Association for Psychological Science. 2012;7:325-40.

16. Rovniak LS, Anderson ES, Winett RA, et al. Social cognitive determinants of physical activity in young adults: a prospective structural equation analysis. Annals of behavioral medicine. 2002;24:149-56.

17. Luszczynska A, Sutton S. Physical activity after cardiac rehabilitation: Evidence that different types of self-efficacy are important in maintainers and relapsers. Rehabilitation psychology. 2006;51:314-321.

18. Schwarzer R, Luszczynska A, Ziegelmann JP, et al. Social-cognitive predictors of physical exercise adherence: three longitudinal studies in rehabilitation. Health psychology. 2008;27:Suppl: 54-63.

19. Schwarzer R. Modeling Health Behavior Change: How to Predict and Modify the Adoption and Maintenance of Health Behaviors. Applied Psychology. 2008;57(1):1-29.

20. Broadbent E, Petrie KJ, Main J, et al. The brief illness perception questionnaire. Journal of psychosomatic research. 2006 Jun;60(6):631-7.

21. Dennison L, Moss-Morris R, Silber E, et al. Cognitive and behavioural correlates of different domains of psychological adjustment in early-stage multiple sclerosis. Journal of psychosomatic research. 2010;69(4):353-61.

22. Broadbent E, Wilkes C, Koschwanez H, et al. A systematic review and meta-analysis of the Brief Illness Perception Questionnaire. Psychol Health. 2015;30(11):1361-85.

23. McAuley E, Motl RW, White SM, et al. Validation of the multidimensional outcome expectations for exercise scale in ambulatory, symptom-free persons with multiple sclerosis. Arch Phys Med Rehabil. 2010;91(1):100-5.

24. Glaesmer H, Hoyer J, Klotsche J, et al. Die deutsche Version des Life-Orientation-Tests (LOT-R) zum dispositionellen Optimismus und Pessimismus. Zeitschrift für Gesundheitspsychologie. 2008;16(1):26-31.

25. Glaesmer H, Rief W, Martin A, et al. Psychometric properties and population-based norms of the Life Orientation Test Revised (LOT-R). British Journal of Health Psychology. 2012;17(2):432-445.

26. Fuchs R. Sportbezogene Konsequenzerfahrungen: Das Konstrukt und seine Messung. Freiburg: Universität Freiburg; 2013.

27. Fuchs R, Goehner W, Seelig H. Long-term effects of a psychological group intervention on physical exercise and health: the MoVo concept. J Phys Act Health. 2011;8(6):794-803.

28. Fuchs R, Göhner W, Mahler C, et al. Aufbau eines körperlich-aktiven Lebensstils im Kontext der medizinischen Rehabilitation: Ein motivationalvolitionales Interventionskonzept. Freiburg: Universität Freiburg; 2008.