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ORIGINAL ARTICLE

Social cognitive theory variables are stronger correlates of moderate-to-vigorous physical activity than light physical activity in older adults with multiple sclerosis

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Abstract

Purpose Physical activity may be effective for managing the consequences of aging with multiple sclerosis (MS), yet physical activity participation is exceedingly low among older adults with MS. This study examined variables from social cognitive theory (SCT) as correlates of physical activity in older adults with MS as an important first step for informing the design of behavior change interventions.

Methods We focused on identifying correlates of light (LPA) and moderate-to-vigorous physical activity (MVPA) based on intensity-dependent benefits of physical activity. Older adults with MS (≥ 60 years, $N = 441$) completed an online survey including demographic and clinical characteristics, SCT variables (self-efficacy, exercise goal setting, social support, and outcome expectations), and physical activity (LPA, MVPA).

Results Bivariate correlation analyses indicated that all SCT variables correlated with both LPA and MVPA; however, correlations were stronger in magnitude for MVPA (range $r = 0.25$–0.56) than for LPA (all $r = 0.11$–0.20).

Conclusion Our results suggest that behavior change interventions informed by SCT may be a promising approach for increasing physical activity, particularly MVPA, in older adults with MS, and this should be a focus of future research in this segment of MS.

Keywords Physical activity · Social cognitive theory · Behavior change · Multiple sclerosis

Introduction

Adults 55 years of age or older account for nearly half of the estimated 1 million cases of multiple sclerosis (MS) in the United States [1]. This aging segment of the MS population faces increasing physical and cognitive disability [2–5], yet the disease modifying drugs that represent the first line of defense for managing MS may not be efficacious in this age group [6]. Physical activity has emerged as an evidence-based approach for managing the many consequences of MS in older adults [7]. Indeed, older adults with MS who engaged in more physical activity had better physical function, including longer walking endurance, faster walking speed, and better lower-extremity function than those who engaged in less physical activity [2–4]. Additionally, interventions for increasing physical activity in older adults with MS have yielded benefits to quality of life, physical function, and cognitive function [8, 9]. However, despite increased knowledge of the benefits of physical activity in older adults with MS, participation in such behavior is exceedingly low [10], particularly in this older demographic [11].

One approach for increasing physical activity participation in people with MS involves implementing behavior change interventions that are informed by behavior change theory such as Social Cognitive Theory (SCT) [12]. SCT provides a framework of health behavior change based on assumptions of triadic reciprocal determinism and human agency, and it identifies self-efficacy (i.e., confidence), outcome expectations (i.e., benefits), goals (i.e., intentions), and social-structural factors (i.e., social support and impediments) as important determinants of behavior and its change [13]. Among the

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general MS population, SCT variables have been consistently correlated with physical activity levels [14, 15], and interventions that have included behavior change techniques (e.g., self-monitoring and goal setting) informed by the key constructs of SCT have yielded increased physical activity participation [16, 17]. Indeed, a recently developed Internet-delivered physical activity intervention that is based on SCT has been rigorously tested in comparatively younger adults with MS, and yielded positive effects on both self-reported and objectively measured physical activity behavior [18, 19]. The evidence of the efficacy of SCT-based behavior change interventions for increasing physical activity in persons with MS is promising, but the current interventions are not designed for older adults with MS. The design and delivery of such interventions requires examining the SCT correlates of physical activity behavior in older adults with MS, as this is a crucial first step in developing and implementing behavior change interventions among the targeted population of interest [20].

There may be additional importance in examining SCT variables as correlates of different intensities of physical activity in older adults with MS. This is based on the observation that there may be an added benefit of more intense moderate-to-vigorous physical activity (MVPA) compared with less intense light physical activity (LPA) in both the general MS population and older adults with MS. Indeed, MVPA generally corresponds with health-promoting physical activity, reflects current public health guidelines for physical activity [21–24], and has been associated with walking performance and cognitive processing speed in older adults with MS [2, 3]. Accordingly, behavior change interventions may specifically target MVPA, and this underscores the importance of distinguishing the SCT correlates of MVPA from those of LPA for designing interventions.

The current study examined variables from SCT as correlates of LPA and MVPA in older adults (≥ 60 years of age) with MS. We expected that all SCT variables would correlate with physical activity behavior (both LPA and MVPA), but the correlations would be larger in magnitude for MVPA than LPA—this is based on SCT variables being stronger predictors under conditions requiring greater demands on undertaking a behavior [25]. This study provides important evidence that may inform future behavior change interventions for individuals aging with MS that are increasingly in greater need for effective rehabilitation approaches.

Methods

Participants and procedures

All study procedures were approved by the University Review Board. An email was distributed by the National MS Society (NMSS) among its list serve informing individuals of a cross-sectional study examining the correlates of physical activity in older adults with MS. The email provided a brief description of the study and a link inviting participation by older adults with MS in an online survey. To be included, participants self-reported being both diagnosed with MS and 60 years of age or older, and consented for participation. After providing consent and confirming age and MS diagnosis, participants were given access to the full survey of questionnaires supported by Qualtrics survey software. Following completion of the questionnaires, participants were able to provide a mailing address to receive $10 USD remuneration.

Measures

Demographics and clinical characteristics

Participants reported age, sex, race, type of MS, and disease duration (years). Disability was measured with the Patient Determined Disease Steps (PDDS) scale [26, 27].

Physical activity

Participants completed the Godin Leisure-Time Exercise Questionnaire (GLTEQ) as a measure of physical activity [28–30]. Participants were asked to report the number of bouts (≥ 15 min) of mild (e.g., easy walking and yoga), moderate (e.g., fast walking and easy bicycling), and strenuous (e.g., jogging and vigorous swimming) activity typically completed in one week. The frequency of bouts was multiplied by weights of 3, 5, and 9, respectively, as these represent the metabolic equivalents of task per activity intensity. LPA was defined as the weighted value for mild activity only (range 0–21), and MVPA was defined by the GLTEQ Health Contribution Score [21]; this is the sum of the moderate and strenuous weighted values (range 0–98). Higher scores represented more LPA and MVPA.

Self-efficacy

Task-specific exercise self-efficacy was measured by the 6-item Exercise Self-Efficacy Scale (EXSE) [31, 32]. Participants rated their confidence level from 0 (not at all confident) to 100 (highly confident) for accumulating ≥ 30 min of MVPA on most days of the week in 1 month increments across the next 6 months. Scores were averaged across the six items providing a total exercise self-efficacy score that ranged from 0 to 100 with higher scores indicating greater self-efficacy.

The Barriers Specific Self-Efficacy scale (BARSE) measured a participant's perceived capabilities to engage in physical activity when facing commonly identified barriers to participation such as disinterest or discomfort with the activity [33]. Each of the 13 items is scored on a 100-point scale ranging from 0 (not at all confident) to 100 (highly confident). Item scores were averaged providing a total score (range 0–100) where higher values represent greater confidence to overcome barriers of physical activity engagement.

Outcome expectations

The Multidimensional Outcomes Expectations for Exercise Scale (MOEES) assessed beliefs about the benefits of regular participation in exercise and physical activity [34, 35]. The MOEES consists of 19-items each scored on a scale of 1 (strongly disagree) to 5 (strongly agree). Scores from each item were summed (range 19–95) with higher scores representing greater perceived benefits of regular exercise and physical activity.

Social/structural support

We operationalized the social/structural domain of SCT using the Social Provisions Scale (SPS). The SPS assessed one's current relationships/support for physical activity behavior [36, 37]. The measure consists of six items, and each item is scored on a four-point scale ranging between 1 (strongly disagree) and 4 (strongly agree). Item scores were summed (range 6–24) to provide a total social support score with higher values indicating greater perceived support for physical activity.

Goal setting

The Exercise Goal Setting scale (EGS) is a 10-item measure that assesses goal-setting behaviors for physical activity [38]. Items are rated on a five-point scale ranging between 1 (does not describe me) and 5 (completely describes me). Scores were summed across the items (range 10–50) with a higher score reflecting more goal-setting behavior for exercise and physical activity engagement.

Data analysis

Data were analyzed using SPSS Statistics 25 (IBM, Inc., Armonk, NY). Descriptive statistics are presented as mean (SD) or % (*n*) as appropriate. The associations between SCT variables and physical activity (LPA and MVPA) were examined with partial Spearman's rank-order correlations controlling for disability status (PDDS). We used non-parametric correlations to limit the known effects of outliers and non-normality on correlation coefficients [39], and controlled for disability status to determine if the associations were independent of perceived disability [40, 41]. The magnitude of correlations was interpreted as small, medium, and large based on values 0.1, 0.3, and 0.5, respectively [42].

Results

Participant characteristics

Demographic and clinical characteristics of the 441 persons that provided usable data (i.e., completed the GLTEQ) are presented in Table 1. The sample had a mean age of 66.2 (4.7) years, and was mostly female (78.5%) and Caucasian (93.2%). The mean disease duration was 19.8 (11.3) years, and the sample primarily presented with a relapsing–remitting disease course (57.6%) with moderate disability (median PDDS = 3.0, may need unilateral support for longer distances). Descriptive statistics for LPA, MVPA, and the SCT variables are provided in Table 2.

Associations between physical activity and SCT variables

The correlations between physical activity and SCT variables are provided in Table 3. All SCT variables were significantly correlated with both LPA and MVPA. The associations between SCT variables and LPA were small in magnitude (range 0.11–0.20), whereas the associations between SCT variables and MVPA were medium or large in magnitude (range 0.25–0.56). The two measures of self-efficacy (EXSE = 0.56, BARSE = 0.51) were the SCT variables most strongly associated with MVPA. The non-overlapping confidence intervals demonstrate that the SCT variables were significantly stronger correlates of MVPA than LPA.

Table 1 Demographic and Clinical Characteristics (*N* = 441)

Variable, units, (*n*)	
Age, mean years (SD), (*430*)	66.2 (4.7)
Sex, % (*n*), (*441*)	
Female	78.5 (346)
Male	21.5 (95)
Race, % (*n*), (*440*)	
Caucasian	93.2 (411)
African American	2.3 (10)
Other	4.4 (19)
Type of MS, % (*n*), (*437*)	
RRMS	61.3 (268)
SPMS	26.5 (117)
PPMS	11.8 (52)
Disease Duration, mean years (SD), (*439*)	19.8 (11.3)
PDDS score, median (IQR), (*441*)	3.0 (4.0)

RRMS relapsing–remitting multiple sclerosis, *SPMS* secondary progressive multiple sclerosis, *PPMS* primary progressive multiple sclerosis, *PDDS* patient determined disease steps

Table 2 Mean scores of physical activity and SCT variables

Variable, (*n*)	Scale	Scale range	Mean (SD)
Light physical activity, (*441*)	GLTEQ-Q1	0–21	10.1 (7.8)
Moderate-to-vigorous physical activity, (*441*)	GLTEQ-HCS	0–98	14.4 (19.4)
Exercise self-efficacy, (*428*)	EXSE	0–100	50.2 (38.2)
Barriers self-efficacy, (*414*)	BARSE	0–100	47.6 (27.8)
Outcome expectations, (*418*)	MOEES	19–95	60.7 (7.9)
Social support, (*437*)	SPS	6–24	17.6 (3.2)
Goal setting, (*413*)	EGS	10–50	25.2 (10.7)

SCT Social Cognitive Theory, *GLTEQ-Q1* Godin Leisure-Time Exercise Questionnaire-Question 1, *GLTEQ-HCS* Godin Leisure-Time Exercise Questionnaire Health Contribution Score, *EXSE* Exercise Self-Efficacy Scale, *BARSE* Barriers Specific Self-Efficacy Scale, *MOEES* Multidimensional Outcomes Expectations for Exercise Scale, *SPS* Social Provisions Scale, *EGS* Exercise Goal Setting

Table 3 Correlations between SCT variables and physical activity controlling for disability

SCT variable	LPA		MVPA	
	r_s	95% CI	r_s	95% CI
EXSE	0.12*	0.03, 0.21	0.56***	0.49, 0.62
BARSE	0.20***	0.11, 0.29	0.51***	0.44, 0.58
MOEES	0.15**	0.06, 0.24	0.32***	0.23, 0.40
SPS	0.12*	0.03, 0.21	0.25***	0.16, 0.34
EGS	0.11*	0.01, 0.20	0.43***	0.35, 0.51

SCT Social Cognitive Theory, *LPA* Light Physical Activity, *MVPA* Moderate-to-Vigorous Physical Activity, *EXSE* Exercise Self-Efficacy Scale, *EGS* Exercise Goals Setting Scale, *SPS* Social Provisions Scale, *MOEES* Multidimensional Outcomes Expectations for Exercise Scale, *EPS* Exercise Plans Scale, *BARSE* Barriers Self-Efficacy Scale

***$p \leq 0.001$; **$p \leq 0.01$; *$p \leq 0.05$

Discussion

As the population of those aging with MS grows in prevalence, it is imperative that researchers design and implement physical activity behavior change interventions among this unique cohort. We further emphasize the importance of focusing on MVPA, as many of the beneficial effects of physical activity are intensity-dependent [2, 3, 22]. There is an abundance of evidence supporting the use of theory-based behavior change interventions for increasing physical activity in comparatively younger adults with MS [12], but there is limited research in older adults with MS. We examined SCT variables as correlates of LPA and MVPA in older adults with MS as a critical first step in designing future behavior change interventions for this age group [20].

Our results indicated that the correlations between SCT variables and physical activity were larger in magnitude for MVPA than LPA. This suggests that the SCT variables associated with behavior change have a potential for greater influence on MVPA behavior than LPA behavior. This may be explained by the social cognitive perspective on lower vs. upper level control systems, wherein more challenging behaviors (i.e., MVPA) require greater cognitive control [25, 43]. Those who have a stronger belief in capabilities are better able to overcome difficulties and exert greater effort to master a challenging behavior [25]. When considering intervention design, it is important to identify these distinctions between LPA and MVPA, so that future interventions for older adults with MS can specifically target MVPA. Low levels of MVPA have partially contributed to the deficits in physical and cognitive function between older adults with MS and older adults without MS [2], MVPA has been strongly correlated with walking performance in older adults with MS [3], and public health guidelines that are established to promote health and wellness are based on MVPA [23, 24]. The comprehensive benefits of MVPA in older adults with MS highlight MVPA as an outcome of great importance for future behavior change interventions.

The correlations between the SCT variables and LPA were not as large in magnitude as MVPA, yet it is important to note that all SCT variables were correlated with LPA. As LPA is objectively a less demanding behavior than MVPA, it is possible that less upper level cognitive control is required for behavior change, and therefore, SCT variables are not as strongly associated with LPA [25]. Although there are many advantages of MVPA, it is important to acknowledge that LPA is associated with numerous health benefits in older adults with MS [2–4, 7]. Additionally, it is essential to recognize the importance of LPA as a stepping stone on the path to accumulating more MVPA. With such high rates of sedentary behavior among older adults with MS [11], it is unlikely that many would be capable of accumulating the recommended amount of MVPA without first increasing LPA. This aligns with physical activity guidelines for individuals with MS that suggests physical activity intensity gradually progress based on tolerability [24].

The two measures of self-efficacy were the strongest correlates of MVPA. This result aligns with the previous research in older adults with MS that identified exercise self-efficacy as an independent predictor of MVPA [41], and with numerous studies in comparatively younger adults with MS that consistently demonstrated an association between self-efficacy and physical activity participation [14, 15]. Self-efficacy is a key factor in the SCT framework as it influences the health behavior outcome directly and through its effect on other determinants [13]. Therefore, increasing self-efficacy, or the belief in one's ability to successfully be physical active, has a direct effect on physical activity behavior, but further influences physical activity behavior through factors such as goal-setting and outcome expectations [44]. For example, it is proposed that individuals with greater self-efficacy set higher goals for themselves are more capable of overcoming setbacks, and expect more favorable outcomes [44]. All of these behaviors and beliefs promote health behavior change and increased physical activity.

Importantly, self-efficacy is a modifiable construct and there are known sources or influences of self-efficacy that can be incorporated into behavior change interventions to increase self-efficacy [13]. Such sources include mastery and vicarious experiences where both personally experiencing success and seeing others similar to you succeed can increase self-efficacy. This might be applied to a behavior change intervention by having older adults with MS who have experienced the benefits of physical activity share their personal stories [18]. Other sources of self-efficacy include social support, verbal encouragement, reducing stress, and minimizing negative emotional responses [13]. Strategies for implementing these constructs into behavior change interventions include techniques such as having a coach or friend to provide social and emotional support, setting goals and monitoring progress, and identifying barriers of physical activity and proactively planning ways to overcome them.

There are several noteworthy limitations in the current study. The cross-sectional design prevents the inference of causality, and further does not permit assumptions about the direction of the relationship between SCT variables and physical activity. Another potential limitation is the self-report nature of the study; however, only questionnaires that have been validated in MS were utilized and this was a nation-wide study of older adults with MS, thereby restricting objective assessments of behavior. The lack of racial diversity in the current sample may limit the generalizability of our results—a sample that more accurately reflects the racial makeup of the MS population may be more appropriate in future studies.

As the benefits of physical activity in older adults with MS continue to amass, it is becoming increasingly important to develop effective interventions designed to increase physical activity rates among this largely inactive group. Our results suggest that behavior change interventions informed by SCT may be an effective approach for increasing physical activity, particularly MVPA, in older adults with MS. This distinction between LPA and MVPA is important given that many of the benefits of physical activity are intensity-dependent. Future research should consider designing and assessing SCT-based behavior change interventions for increasing MVPA in older adults with MS.

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Declarations

Conflict of interest The authors have no conflicts of interest to declare.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This was approved by IRB of University of Alabama at Birmingham under # 300000939.

References

1. Wallin MT, Culpepper WJ, Campbell JD, Nelson LM, Langer-Gould A, Marrie RA et al (2019) The prevalence of MS in the United States: a population-based estimate using health claims data. Neurology 92(10):e1029–e1040
2. Bollaert RE, Motl RW (2019) Physical and cognitive functions, physical activity, and sedentary behavior in older adults with multiple sclerosis. J Geriatr Phys Ther 42(4):304–312
3. Baird JF, Cederberg KL, Sikes EM, Silveira SL, Jeng B, Sasaki JE et al (2019) Physical activity and walking performance across the lifespan among adults with multiple sclerosis. Mult Scler Relat Disord 35:36–41
4. Cederberg KL, Motl RW, McAuley E (2018) Physical activity, sedentary behavior, and physical function in older adults with multiple sclerosis. J Aging Phys Act 26(2):177–182
5. Baird JF, Cederberg KL, Sikes EM, Jeng B, Sasaki JE, Sandroff BM et al (2019) Changes in cognitive performance with age in adults with multiple sclerosis. Cogn Behav Neurol 32(3):201–207
6. Weideman AM, Tapia-Maltos MA, Johnson K, Greenwood M, Bielekova B (2017) Meta-analysis of the age-dependent efficacy of multiple sclerosis treatments. Front Neurol 8:577
7. Motl RW, Sebastião E, Klaren RE, McAuley E, Stine-Morrow EA, Roberts BW (2016) Physical activity and healthy aging with multiple sclerosis: literature review and research directions. US Neurol 12(1):29–33
8. McAuley E, Wójcicki TR, Learmonth YC, Roberts SA, Hubbard EA, Kinnett-Hopkins D et al (2015) Effects of a DVD-delivered exercise intervention on physical function in older adults with multiple sclerosis: a pilot randomized controlled trial. Mult Scler J-Exp Transl Clin 1:2055217315584838
9. Sebastião E, McAuley E, Shigematsu R, Adamson BC, Bollaert RE, Motl RW (2018) Home-based, square-stepping exercise program among older adults with multiple sclerosis: results of a feasibility randomized controlled study. Contemp Clin Trials 73:136–144
10. Kinnett-Hopkins D, Adamson B, Rougeau K, Motl R (2017) People with MS are less physically active than healthy controls but as active as those with other chronic diseases: an updated meta-analysis. Mult Scler Relat Disord 13:38–43
11. Klaren RE, Sebastiao E, Chiu C-Y, Kinnett-Hopkins D, McAuley E, Motl RW (2016) Levels and rates of physical activity in older adults with multiple sclerosis. Aging Dis 7(3):278
12. Motl RW, Pekmezi D, Wingo BC (2018) Promotion of physical activity and exercise in multiple sclerosis: Importance of

behavioral science and theory. Mult Scler J-Exp Transl Clin 4(3):2055217318786745
13. Bandura A (1998) Health promotion from the perspective of social cognitive theory. Psychol Health 13(4):623–649
14. Streber R, Peters S, Pfeifer K (2016) Systematic review of correlates and determinants of physical activity in persons with multiple sclerosis. Arch Phys Med Rehabil 97(4):633–45. e29
15. Casey B, Coote S, Shirazipour C, Hannigan A, Motl R, Ginis KM et al (2017) Modifiable psychosocial constructs associated with physical activity participation in people with multiple sclerosis: a systematic review and meta-analysis. Arch Phys Med Rehabil 98(7):1453–1475
16. Motl RW, Dlugonski D, Wójcicki TR, McAuley E, Mohr DC (2011) Internet intervention for increasing physical activity in persons with multiple sclerosis. Mult Scler J 17(1):116–128
17. Pilutti L, Dlugonski D, Sandroff B, Klaren R, Motl R (2014) Randomized controlled trial of a behavioral intervention targeting symptoms and physical activity in multiple sclerosis. Mult Scler J 20(5):594–601
18. Motl RW, Sandroff BM, Wingo BC, McCroskey J, Pilutti LA, Cutter GR et al (2018) Phase-III, randomized controlled trial of the behavioral intervention for increasing physical activity in multiple sclerosis: project BIPAMS. Contemp Clin Trials 71:154–161
19. Motl RW, Hubbard EA, Bollaert RE, Adamson BC, Kinnett-Hopkins D, Balto JM et al (2017) Randomized controlled trial of an e-learning designed behavioral intervention for increasing physical activity behavior in multiple sclerosis. Mult Scler J-Exp Transl Clin 3(4):2055217317734886
20. Sheeran P, Klein WM, Rothman AJ (2017) Health behavior change: Moving from observation to intervention. Annu Rev Psychol 68:573–600
21. Motl RW, Bollaert RE, Sandroff BM (2018) Validation of the Godin Leisure-Time Exercise Questionnaire classification coding system using accelerometry in multiple sclerosis. Rehabil Psychol 63(1):77
22. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee I-M et al (2011) American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc 43(7):1334
23. Tudor-Locke C, Craig CL, Aoyagi Y, Bell RC, Croteau KA, De Bourdeaudhuij I et al (2011) How many steps/day are enough? For older adults and special populations. Int J Behav Nutr Phys Act 8(1):80
24. Kim Y, Lai B, Mehta T, Thirumalai M, Padalabalanarayanan S, Rimmer JH et al (2019) Exercise training guidelines for multiple sclerosis, stroke, and Parkinson disease: rapid review and synthesis. Am J Phys Med Rehabil 98(7):613–621
25. Bandura A (1989) Human agency in social cognitive theory. Am Psychol 44(9):1175
26. Learmonth YC, Motl RW, Sandroff BM, Pula JH, Cadavid D (2013) Validation of patient determined disease steps (PDDS) scale scores in persons with multiple sclerosis. BMC Neurol 13(1):37
27. Marrie R, Goldman M (2007) Validity of performance scales for disability assessment in multiple sclerosis. Mult Scler J 13(9):1176–1182
28. Godin G (2011) The Godin-Shephard leisure-time physical activity questionnaire. Health Fit J Can 4(1):18–22
29. Sikes EM, Richardson EV, Cederberg KJ, Sasaki JE, Sandroff BM, Motl RW (2019) Use of the Godin leisure-time exercise questionnaire in multiple sclerosis research: a comprehensive narrative review. Disabil Rehabil 41(11):1243–1267
30. Motl RW, McAuley E, Snook EM, Scott JA (2006) Validity of physical activity measures in ambulatory individuals with multiple sclerosis. Disabil Rehabil 28(18):1151–1156
31. McAuley E (1993) Self-efficacy and the maintenance of exercise participation in older adults. J Behav Med 16(1):103–113
32. Motl RW, Snook EM, McAuley E, Scott JA, Douglass ML (2006) Correlates of physical activity among individuals with multiple sclerosis. Ann Behav Med 32(2):154
33. McAuley E (1992) The role of efficacy cognitions in the prediction of exercise behavior in middle-aged adults. J Behav Med 15(1):65–88
34. McAuley E, Motl RW, White SM, Wójcicki TR (2010) Validation of the multidimensional outcome expectations for exercise scale in ambulatory, symptom-free persons with multiple sclerosis. Arch Phys Med Rehabil 91(1):100–105
35. Wójcicki TR, White SM, McAuley E (2009) Assessing outcome expectations in older adults: the multidimensional outcome expectations for exercise scale. J Gerontol B Psychol Sci Soc Sci 64(1):33–40
36. Konopack JF, McAuley E (2012) Efficacy-mediated effects of spirituality and physical activity on quality of life: a path analysis. Health Qual Life Outcomes 10(1):57
37. McAuley E, Jerome GJ, Marquez DX, Elavsky S, Blissmer B (2003) Exercise self-efficacy in older adults: social, affective, and behavioral influences. Ann Behav Med 25(1):1
38. Rovniak LS, Anderson ES, Winett RA, Stephens RS (2002) Social cognitive determinants of physical activity in young adults: a prospective structural equation analysis. Ann Behav Med 24(2):149–156
39. Rousselet GA, Pernet CR (2012) Improving standards in brain-behavior correlation analyses. Front Hum Neurosci 6:119
40. Weikert M, Motl RW, Suh Y, McAuley E, Wynn D (2010) Accelerometry in persons with multiple sclerosis: measurement of physical activity or walking mobility? J Neurol Sci 290(1–2):6–11
41. Baird JF, Silveira SL, Motl RW (2021) Social cognitive theory and physical activity in older adults with multiple sclerosis. Int J MS Care 23(1):21–25. https://doi.org/10.7224/1537-2073.2019-071
42. Cohen J (2013) Statistical power analysis for the behavioral sciences. Academic press
43. Doerksen SE, Umstattd MR, McAuley E (2009) Social cognitive determinants of moderate and vigorous physical activity in college freshmen. J Appl Soc Psychol 39(5):1201–1213
44. Bandura A (2004) Health promotion by social cognitive means. Health Educ Behav 31(2):143–164