ARTICLE

Targeting Physical Inactivity Using Behavioral Theory in Chronic, Disabling Diseases

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PEKMEZI, D. and R. MOTL. Targeting physical inactivity using behavioral theory in chronic, disabling diseases. *Exerc. Sport Sci. Rev.*, Vol. 50, No. 3, pp. 156–161, 2022. *Physical inactivity and comorbidities (e.g., hypertension) result in poor prognoses among persons with chronic, disabling conditions including multiple sclerosis, Parkinson disease, and stroke. Theory can guide the design of behavior change interventions that can be delivered remotely for broad scale implementation. We hypothesize that theory-based behavior change interventions can increase physical activity and reduce comorbidities and associated consequences among persons with chronic, disabling conditions.* **Key Words:** physical activity, behavioral theory, multiple sclerosis, Parkinson disease, stroke, chronic disease, disability

Key Points

- Chronic, disabling diseases and conditions (multiple sclerosis (MS), Parkinson disease (PD), stroke) are rising in prevalence.
- Physical inactivity is a public health problem in these populations and increases risks of comorbidities and poor prognoses.
- The problem of physical inactivity can be targeted through behavior change intervention research for MS, PD, and stroke.
- Behavior change theory (*e.g.*, Social Cognitive Theory, Theoretical Domains Framework) can identify and address unique challenges for physical activity promotion among persons with chronic, disabling conditions.
- The delivery of theory-based behavior change interventions remotely (via Web-based technology) overcomes common barriers (*e.g.*, transportation) and may change physical activity, comorbidities, and prognoses of persons with chronic, disabling diseases/conditions.

INTRODUCTION

Persons with chronic, disabling diseases and conditions represent a large portion of the United States and worldwide populations, yet they are disproportionately targeted for health promotion, particularly physical activity behavior change, within public health. We will briefly review the magnitude of the problems of physical inactivity and related comorbidities (*e.g.*, hypertension, depression) among persons with multiple sclerosis (MS), Parkinson disease (PD), and stroke, as well as the strong evidence (and guidelines) for the safety and benefits of physical activity participation in these patient populations. We will then pinpoint gaps in the research literature in this area, including the use of 1) behavior change theory for promoting physical activity among persons with chronic, disabling diseases and conditions and determining the specific issues surrounding capability, opportunity, and motivation for physical activity behavior, and 2) technology to improve access to theory-based behavior change interventions and thereby reduce related health disparities. Our hypothesis is that scalable theory-based behavior change interventions targeting physical activity can substantially reduce comorbidities and improve prognoses for the growing numbers of individuals living with chronic, disabling diseases and conditions.

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STATEMENT OF PROBLEM

Prevalence of Chronic, Disabling Diseases and Conditions

The rise in chronic diseases and conditions represents a public health concern. Chronic diseases and conditions are leading causes of disability in society and are managed through pharmacological treatments, rehabilitation/supportive care, and modifiable lifestyle behaviors, including physical activity. Because a wide range of diseases fall under this umbrella, this review will focus on MS, PD, and stroke, the most common chronic, disabling conditions of neurological origin (1).

The prevalence of MS in the United States approached 1 million adults (913,925) in 2017; this updated prevalence is nearly 2.5 times the number of cases reported in 1975 (2). The prevalence of PD similarly increased in the United States such that there were 680,000 adults ≥45 yr of age living with PD in the United States in 2010 and 930,000 in 2020 with an estimated 1,238,000 by 2030, based on U.S. Census projections (3). Stroke remains a leading cause of death and disability in the United States, with over 795,000 strokes occurring annually in this country (4).

Globally, PD prevalence rates are expected to more than double from 4.1 to 4.6 million individuals older than 50 yr in 2005 to 8.7 to 9.3 million by 2030 in Western Europe's 5 (Germany, France, the United Kingdom, Italy, Spain) and the world's 10 most populous nations (China, India, the United States, Indonesia, Brazil, Pakistan, Bangladesh, Russia, Nigeria, Japan), respectively (5). The overall global incidence rates of stroke declined from 1990 to 2016, yet there was still a doubling in absolute numbers for people who had a stroke, died, or remained disabled from stroke and rapid increases in stroke prevalence among <50-yr-olds (6).

The changing prevalence of chronic, disabling diseases and conditions is likely explained by increased longevity/life expectancy. Indeed, persons with chronic, disabling diseases and conditions are living longer, and this may be associated with changes in diagnostic criteria and earlier diagnosis resulting in earlier disease management as well as management of superimposed comorbid conditions. Nevertheless, this may have meaningful consequences for disease prognoses and health-related quality of life, as these persons are living longer but not necessarily better.

Comorbidities among Chronic, Disabling Diseases and Conditions

Persons living with chronic, disabling diseases and conditions often face numerous comorbidities, more so than the general population. For example, a large Scottish study reported that 94.2% of stroke patients had comorbidities compared with 48% of controls (7). Persons living with PD were significantly more likely to have high numbers of comorbidities (30.9% with five or more conditions vs 13.2% for controls, $P < 0.001$) and less likely to have no comorbid conditions (7.4% vs 22.9%) than controls (8). Comorbidities are common in MS and have been associated with poor prognoses and outcomes (*e.g.*, worse quality of life and increased odds of disability) (9).

Comorbidities vary by condition, but there is a degree of overlap. For example, hypertension, diabetes, and hyperlipidemia are the primary comorbidities for stroke, with hypertension reported by 77% of patients experiencing a first stroke (10). Hypertension is common among individuals living with MS, along with depression, anxiety, hypercholesterolemia, and chronic lung disease, based on a comprehensive systematic review of 24 studies (11). Similarly, stroke, dementia, depression, and anxiety are established frequently co-occurring conditions for PD (12).

Researchers have reported increased rates of overweight and obesity among patients with MS and PD (13,14). The obesity prevalence in stroke varies by study (18%–44%), yet it is a confirmed stroke risk factor, with each additional body mass index unit associated with a 6% increase in adjusted relative risk of stroke (15). Disease-related treatment/symptomatology (medication side effects, fatigue) and general population trends in obesity may explain these findings, but some scientists posit that obesity may directly increase risks for such chronic, disabling diseases through inflammation and associated neurodegeneration (13). Regardless of the direction/nature of the relationship, obesity in MS patients has been associated with a greater risk of depression, lower functional capacity and self-rated health status, and worsening disability (16).

Comorbidities complicate diagnosis, treatment, disease course/trajectory, and survival for individuals with chronic, disabling diseases and conditions. There is ample evidence from the MS literature linking comorbidities to diagnostic delays, decreased likelihood of starting (and tolerating) disease-modifying treatments, disability progression, social/economic problems (broken relationships, low incomes, and quality of life), and higher mortality rates (11). Cardiovascular comorbidities (*e.g.*, ischemic stroke/heart disease, congestive heart failure, etc.) likely contribute to the higher mortality rates in PD and MS patient populations (17,18).

There is further financial burden associated with chronic, disabling diseases and comorbidities. The total cost of stroke in the United States was estimated at $103.5 billion per year, including direct medical costs ($35 billion) and indirect costs for underemployment ($38.1 billion) and premature death ($30.4 billion), based on Medical Expenditure Panel Survey data (19). MS ranks second behind congestive heart failure in direct all-cause medical costs, at approximately $8528 to $54,244 per patient with MS per year (20). Comorbidities increase the expenses associated with such conditions and have been associated with higher rates of physician encounters, prescriptions filled, and hospitalizations among MS patient (21).

We note that comorbidities further impose a personal burden for those living with chronic, disabling diseases and caregivers. Indeed, comorbidities often undermine employment, participation, independence, and health-related quality of life. Such a picture of prevalent and burdensome comorbidities supports the importance of identifying approaches for managing these outcomes in persons with chronic, disabling diseases and conditions.

PHYSICAL ACTIVTY AND CHRONIC, DISABLING CONDITIONS

Physical Activity Benefits and Guidelines

There is an abundance of evidence supporting the health benefits of physical activity, including reduced risks for comorbidities. Physical activity has been associated with a lower risk of all-cause mortality, cardiovascular disease, hypertension, type 2 diabetes, hyperlipidemia, certain cancers, dementia, depression, and falls, as well as improvements in cognition, quality of life, anxiety, sleep, weight control, bone health, and physical function (22). The majority of this evidence is from healthy populations; however, the available physical activity studies among individuals with chronic, disabling diseases and conditions, including Cochrane reviews, provide evidence for similar benefits in MS, stroke, and PD (23–25). There are documented improvements in aerobic endurance, muscular strength/endurance, walking ability, fatigue, depression, and quality of life with physical activity participation in these patient populations (1).

The mounting evidence for benefits in clinical populations has supported the development of physical activity recommendations and guidelines for chronic, disabling diseases and conditions. One recent review article integrated 25 available resources/guidelines and provided aerobic training guidelines for people with MS (2–3 $d \cdot wk^{-1}$, 10–30 min at moderate intensity), stroke, and PD (3–5 $d \cdot wk^{-1}$, 20–40 or 20–60 min at moderate intensity, respectively). There were further guidelines for resistance training that emphasized 1–3 sets of resistance exercise on 2–3 $d \cdot wk^{-1}$, for 8–15 repetitions for MS and stroke (maximum and 30%–50% one-repetition maximum, respectively) and 8–12 repetitions for PD (40%–50% one-repetition maximum) (1). Such advice echoes the general national guidelines (≥150 $min \cdot wk^{-1}$ of moderate-to-vigorous aerobic physical activity and 2 d·wk^{-1} of strength training) (22), yet there are some additional safety considerations.

Physical Activity Safety

Physical activity is generally safe for individuals with chronic, disabling disease and conditions. Indeed, there is a low occurrence of adverse events with exercise training in MS, PD, and stroke (23,26,27). The data support that rates of adverse events among MS populations are no higher than those observed in healthy populations and typically involve nonserious musculoskeletal issues (27). As for aerobic physical activity in PD, five studies from a review reported no adverse events, with a 2% adverse event rate in another (26).

Several physical activity resources address safety considerations for MS, stroke, and PD. The National MS Society guidelines provide additional caveats regarding comorbidities and symptom fluctuations and incremental physical activity increases based on personal abilities, preferences, and safety (28). Individuals with MS are encouraged to seek early evaluation by specialist/s (*e.g.*, physical/occupational therapists with MS experience) for individualized physical activity plans, along with adjustments to physical activity prescriptions for safety/appropriateness should disability increase. In cases where mobility is quite limited, physical activity should be facilitated by trained assistant/s. Special considerations for physical activity and PD are provided by the American College of Sports Medicine and include adaptions for comorbidities/functional limitations, fall prevention, auditory/visual cues for movement, attention difficulties (due to depression, anxiety, fatigue, cognitive impairment, dementia symptoms, etc., and level of supervision needed, and exercising near peak effect of levadopa (29).

Physical Activity Prevalence, Barriers and Facilitators

Despite the benefits, guidelines, and safety profile, rates of participation in physical activity are quite low among people with chronic, disabling conditions when compared with the general population. Fewer than 20% of individuals with MS in the United States meet national physical activity guidelines, compared with 40% of the general population, based on device-measured levels of physical activity (30). Individuals with PD are similarly underactive. Results from past studies in this area indicated that 75% of waking hours were spent in sedentary activities and only 2%–6% in moderate-to-vigorous physical activity (31). Moreover, step counts for community-dwelling, ambulatory adults with PD (approximately 5000 steps per day) and high-functioning stroke survivors (4355.2 steps per day) remain below recommendations (32).

Many factors contribute to physical inactivity among individuals with chronic, disabling diseases and conditions. The lack of facilities with disability accommodations and physical activity advice from health care providers, fatigue, and fear are common barriers for physical activity in MS based on a systematic review (33). Similar physical and mental barriers for physical activity participation have been identified by patients with PD (*e.g.*, low outcome expectations, lack of time, fear of falling, lacking someone to motivate them, fatigue, and depression) (34) and stroke (*e.g.*, lack of professional support, transport, motivation, and control; negative affect, environmental factors) (35).

There is some overlap in facilitators of physical activity across conditions. Appropriate exercise modalities/programming and feelings of accomplishment (*e.g.*, filling an empty schedule) are conducive for physical activity participation in MS and stroke (33,35) along with self-efficacy and enjoyment in PD and social support with all three patient populations (34). As for perceived positive outcomes and motivators for physical activity, social interaction and self-management/control are particularly salient in MS and stroke (33). One noteworthy problem is that few studies have developed and delivered behavior change interventions based on that evidence base regarding barriers and facilitators, as it has been generated without a guiding theory of behavior change. To that end, researchers must identify modifiable influences on physical activity behavior for the design and implementation of effective behavior change intervention among individuals with MS, stroke, and PD using behavior change theory as a guide.

TOWARD A SOLUTION

Behavior Change Interventions May Address the Problem of Physical Inactivity

Behavior change theory will be critical for promoting physical activity among persons with chronic, disabling diseases and conditions. Theory provides a conceptual framework or road map for studying complicated public health problems, developing appropriate intervention strategies, and evaluating the results. Moreover, theory-based interventions are more likely to succeed than those developed without such frameworks (36). Collectively, there has been little theory-based physical activity intervention research conducted among individuals with chronic, disabling diseases/conditions, yet frameworks such as the Social Cognitive Theory (SCT) (37) and Theoretical Domains Framework (TDF) (38) may identify unique opportunities for changing physical activity in MS, PD, and stroke and thereby changing comorbidities, health, and life with these chronic diseases and conditions. See Figure 1.

Social Cognitive Theory

The SCT (37) is an interpersonal model that posits health behavior is influenced by (and influences) personal beliefs/attitudes and social and physical environments (*i.e.*, triadic reciprocal determinism). SCT further posits human agency as a key feature in health behavior change. The key SCT constructs aligning with human agency include self-efficacy (confidence in one's ability

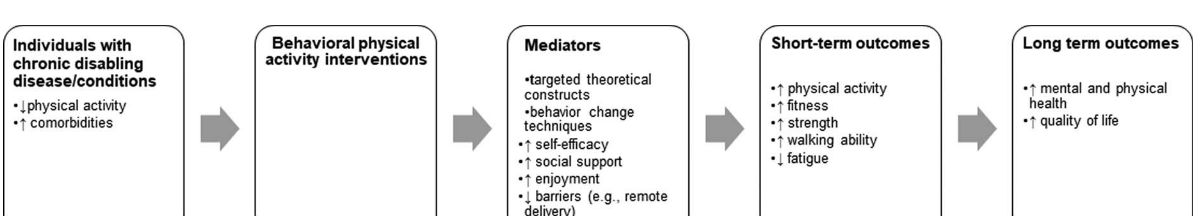

Figure 1. Conceptual model illustrating how theory-based physical activity interventions will improve health outcomes for individuals with chronic, disabling conditions.

to perform a specific health behavior), outcome expectations (anticipated results from performing a health behavior), self-regulation (planning and goal setting for health behaviors), and social support, all of which have been associated with physical activity change in past studies (39,40).

Preliminary efforts at applying SCT to physical activity promotion among individuals with chronic, disabling conditions include home-based interventions delivered via newsletters and phone calls or DVDs with educational materials and video coaching calls (41,42). Another SCT-based telehealth approach, involving six biweekly telephone sessions on goal setting and self-efficacy, produced increases in time spent in aerobic activity (+47.6 $min \cdot wk^{-1}$) among 63 stroke patients, which were sustained at 6 months (43).

Face-to-face SCT-based interventions have yielded promising results (improvements in walking endurance and speed) in MS populations when delivered via group exercise and educational classes (44). Another study reported increases in self-efficacy and health-related quality of life 6 months after a "intensive" 3-d SCT-based program (with support partners, group sessions/activities, individual consultations); however, researchers were not able to replicate these findings later on in a sample of 158 low-disability MS patients (45). Most of these MS and stroke studies involved small samples (approximately 60 or less) and short intervention durations (less than 6 months). In contrast, the PD literature boasts a large randomized controlled trial (N = 586 patients with PD) of a 2-yr SCT-based behavior change program with physical therapy sessions, personal activity coaching sessions, brochures/newsletters, goal setting, and activity monitors. Accelerometer data indicated a 12% increase in time spent in physical activity after 24 months in the ParkFit intervention despite null findings from the self-report PA measure (46).

Theoretical Domains Framework

Another relevant integrative framework is the TDF (38), which describes behavior as determined by capability, opportunity, and motivation (COM-B). These COM-B constructs are further specified/differentiated into 14 domains of facilitators and barriers to behavior change (knowledge, skills, social/professional role and identity, beliefs about capabilities, beliefs about consequences, motivation and goals, memory attention and decision processes, environmental context and resources, social influences, emotion, action planning, optimism, reinforcement, intentions), which can be mapped onto and aligned with relevant behavior change techniques using the Behavior Change Wheel.

The application of the TDF framework to physical activity promotion in chronic, disabling disease populations is still relatively new. The first TDF-based intervention for people with MS was recently developed and delivered online (Activity Matters) (47). Other researchers have used the TDF to explore perceived barriers and facilitators to physical activity among ambulatory stroke survivors (N = 13) (48). Both studies acknowledged TDF domains related to beliefs about capabilities, environmental context and resources, and social influence as critical to understanding physical activity in these populations.

Broad Dissemination Potential

Behavior change interventions that can be broadly disseminated (*e.g.*, via Internet) may be necessary considering the rising rates of chronic, disabling diseases/conditions and related public health concerns. Physical inactivity and resulting comorbidities exacerbate declines in function, health, and quality of life in these patient populations. Thus, it may not be feasible to address a problem of this scale and complexity one patient at a time. High-reach, low-cost, technology-supported approaches will likely be required. Past reviews indicate that Internet-based behavioral interventions have successfully increased physical activity and have great potential for bypassing barriers related to transportation and accessibility among individuals with chronic, disabling diseases and conditions (49). On the other hand, vision and dexterity issues are common in this patient population and could pose challenges to viewing/navigating Internet-based interventions. Some symptoms (*e.g.*, blurred/dimmed vision) may resolve with rest and cooling, whereas others persist (hand tremors in PD). Related difficulties with using the computer can often be addressed through adjustments to device settings (*e.g.*, slowing down the mouse, making the pointer more visible on-screen, adapting touchscreens to be less sensitive) and the use of assistive (voice control, speech-to-text) technology and smart home devices (*e.g.*, Alexa).

Results from several available MS studies support the use of Web-based behavioral interventions. SCT-based Internet-delivered interventions produced significant increases in physical activity among individuals with MS in a 12-wk pilot study (N = 54) (50), which were replicated and expanded to fatigue, depression, and anxiety in a 6-month randomized controlled trial (N = 82) (51). More recent SCT-based physical activity randomized controlled trials for MS have supplemented such Web sites with interactive e-learning video courses (30) and video calls with behavioral coaches (52) to good effect, for example, significant improvements in self-reported physical activity, fatigue, walking impairment, and disability status.

CONCLUSIONS

Behavior change interventions targeting physical activity are a necessary avenue of research and application for persons with chronic, disabling diseases and conditions. This is based on a) the physical activity benefits and safety profile for persons with chronic, disabling diseases and conditions; b) physical inactivity and comorbidity rates among persons with chronic, disabling diseases and conditions; and c) the opportunity for developing theory-based behavior change interventions for reducing comorbidities among persons with chronic, disabling diseases and conditions. This supports our hypothesis that theory-based behavior change interventions can increase physical activity and reduce comorbidities among persons with chronic, disabling conditions. This can occur through behavioral theory and frameworks that will be critical for informing best practices in promoting and sustaining physical activity among persons with chronic, disabling diseases and conditions, and further determining the specific issues surrounding capability, opportunity, and motivation for physical activity in these populations.

Indeed, the evidence is clear that physical activity is safe and beneficial for all, yet few programs/resources exist for those who need it most (individuals living with chronic, disabling diseases and conditions), despite available recommendations and links with comorbid conditions that accelerate disease progression and undermine independence and QOL. Behavior change theory should be used to guide the development and adaption of evidence-based physical activity interventions to the unique needs of individuals with MS, PD, and stroke and accommodate varying profiles of function, disability, and symptoms. Technology should play a central role in reducing barriers for accessing such behavioral interventions in these populations, reaching those who are at risk and thereby mitigating the underlying public health issues. Future directions should focus on extending scalable/disseminable behavioral interventions more broadly. The body of work in this area is growing in MS, but has yet to reach many other chronic, disabling disease populations (stroke, PD) (53). We can only address our hypothesis that theory-based behavior change interventions can increase physical activity and reduce comorbidities among persons with chronic, disabling conditions through targeted research, and this may change the public health landscape of MS, PD, and stroke.

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