# Falls Risk and Utilization of Balance Training by Physical Therapists for Adults with Symptomatic Knee Osteoarthritis: A Retrospective Data Analysis

Monica Anderson, Student DPT

University of North Carolina - Chapel Hill

Division of Physical Therapy

Carla H. Hill PT DPT

Faculty Capstone Advisor

Kelli D. Allen PhD and Yvonne Golightly PT MS PhD

Capstone Committee Members

## Introduction

Knee osteoarthritis (OA) is a degenerative joint disease that involves the breakdown of cartilage and bone within the knee joint which can result in significant pain, swelling and stiffness.[1] Damage to joint cartilage increases joint laxity, allowing excessive motion within the knee.[2] In addition, when knee joint cartilage is damaged, the tissue is unable to adequately respond and adapt to mechanical stress and loading forces.[2] These deteriorations in joint integrity manifest as faulty kinematics, giving rise to a cycle of pain, functional impairments, and disability in individuals with knee OA.[2] This progressive deterioration within the joint capsule is further exacerbated during the aging process or after injury to the knee joint.[2] Knee OA is a highly prevalent joint disorder in the United States, with symptomatic knee OA occurring in 10% of men and 13% of women over the age of 60.[3] Risk factors strongly associated with the incidence of knee OA include age over 50 years, female gender, obesity (body mass index over 30), and prior trauma to the knee.[4] Due to the aging population and rising obesity rates in the United States, the prevalence of individuals affected by this disease will likely increase.[3,5] An estimated 26% of adults over the age of 18 in the United States will have a diagnosis of arthritis by 2040.[5]

The European League Against Rheumatism (EULAR) identified three signs (crepitus, restricted movement, bony enlargement) and three symptoms (persistent knee pain, brief morning stiffness, reduced function) that determine a diagnosis of knee OA during a clinical examination.[4] Reduced muscular strength and loss of physical function are common impairments found in individuals with knee OA.[6] In addition, patients with knee OA frequently experience a loss of proprioception and kinesthesia sensation due to increased articular damage and decreased quantity of joint mechanoreceptors.[7,8] These deficits contribute to inadequate neuromuscular control which decreases an individual's ability to safely perform functional activities such as walking, negotiating stairs, reaching for objects, and rising from a chair. These musculoskeletal and neuromuscular impairments increase an individual's risk for falls.[6] Falls are responsible for a substantial sum of health care costs since they frequently result in injury and hospital admission.[9] In 2015 alone, the Medicare costs for falls totaled over $31 billion.[10] Patients with physician-diagnosed arthritis are approximately twice as likely to have two or more falls compared to healthy older adults.[11] Tsonga reported a frequency of falls in older adults with knee OA to be 63.2%.[6] The falls for individuals with knee OA are also likely to be more severe, with 29.23% of the falls resulting in injury or fracture.[6] Additionally, patients who report a history of falls with a diagnosis of knee OA are more likely to have a poorer health-related quality of life compared to individuals with a history of falls or knee OA alone.[12] The rapidly aging population and increasing prevalence of arthritis will likely compound this public health problem.

Due to the increased risk for falls in this patient population, balance training and falls prevention programs may be important management strategies for individuals with symptomatic knee OA. The Centers for Disease Control (CDC) and the American and British Geriatrics Societies (AGS/BGS) Clinical Practice Guidelines describe balance exercises as effective and essential components in a falls prevention program.[13,14] However, there is currently limited evidence and controlled trials of individuals with knee OA participating in balance training programs to reduce falls risk. Several studies have demonstrated the additive effects of balance training interventions to standard exercise programs for individuals with knee OA.[7,15,16,17] Recently, Takacs et al. found improved knee pain, physical function, and fear of movement in individuals with knee OA following a ten-week dynamic balance training program.[18] Other research trials have reported positive effects of balance interventions on outcomes, including WOMAC total and subscale scores, physical function scores, global rating of change, and proprioceptive function in individuals with knee OA.[7,15,16] Furthermore, balance training interventions have been demonstrated to improve both quality of life and fear of movement within this patient population.[10,18] Despite the increased falls risk for individuals with knee OA, the American College of Rheumatology (ACR) and the EULAR recommendations for nonpharmacologic therapies do not currently include recommendations for balance exercises for individuals with knee OA due to lack of evidence indicating a need to further explore the potential of this intervention to be integrated into management for this population.[19,20]

The aim of this retrospective analysis is to determine the proportion of participants at risk for falling in the study of Physical Therapy vs. INternet-based Exercise Training for Patients with Osteoarthritis (PATH-IN) study, as well as the frequency with which participants allocated to the PT group and classified as high falls risk were prescribed balance training interventions.[21] In addition, this analysis will access the types of balance training interventions utilized by the study physical therapists. Assessment of current PT practice patterns for individuals with knee OA may offer insight into physical therapy treatment approaches to address symptomatic knee OA, specifically for individuals who are considered high falls risk. Highlighting these practice patterns may help physical therapists harness untapped potential to integrate balance training into a comprehensive plan of care for patients with knee OA, and potentially prevent future falls in this patient population.

## Participants

This retrospective data analysis included participants from a randomized control trial of adults with symptomatic knee osteoarthritis, PATH-IN.[21] Participants (N=350) had a diagnosis of knee OA and current joint symptoms (pain, aching or stiffness on most days of the week) in at least one knee. Participants were allocated to standard physical therapy, an internet-based exercise program, or a wait list control at a 2:2:1 ratio respectively. Data analysis for this study included all participants who had complete data at baseline to assess falls risk. Some analyses only included participants allocated to the standard PT intervention who had sufficient data to assess falls risk and content of physical therapy interventions. This research trial was approved by the Institutional Review Board (IRB) of the University of North Carolina at Chapel Hill and Duke University Medical Center.

## Materials and Methods

Prior to participant enrollment, physical therapists who would provide the standard PT intervention participated in an educational session on evidence-based physical therapy management for individuals with knee OA and received a handout consistent with current clinical practice guidelines to use as a reference in the clinic (APPENDIX). Participants in the standard PT intervention group received up to 8 one-hour sessions based on the physical therapist's assessment of need for skilled therapy and participant willingness to continue sessions.

All participants who consented to participate in the PATH-IN trial provided demographic and clinical information via self-report. In addition, prior to randomization, they completed a battery of self-report questionnaires and physical function tests. Physical function measures included the Four-Stage Balance Test and the Timed Up and Go Test. Participants completed the same battery of tests at 4-month and 12-month time points.

After all physical therapy appointments had been completed, a chart review was completed for participants allocated to the standard physical therapy intervention group. Electronic progress notes in the study database and written exercise flow sheets were reviewed and coded as including balance training or not for each physical therapy visit. If an exercise was unfamiliar to reviewers, the physical therapist who provided the intervention was contacted to provide a description and purpose for the exercise to allow for proper coding. Interventions were classified as balance training if the exercise included narrowing the base of support, dynamic weight shifting, multiple changes in direction, reaching with an upper or lower extremity, or overcoming external perturbations. A variety of balance training exercises were utilized by the physical therapists, which ranged from low to high level of difficulty **(Table 1).** Interventions

were not coded as balance training if they included external resistance (Thera-Band, ankle weights, free weights) based on the implication that the exercise was intended for strengthening.

An evidence-based threshold for falls risk was set to classify participants who were considered a high falls risk. The Four-Stage Balance Test (FSBT) assesses static balance whereby patients have to maintain a stance in four progressively challenging positions for a minimum of 10 seconds without moving his or her feet or requiring external support.[22] The final position of the FSBT is standing on one foot, or unilateral stance. Poor unilateral stance balance (unable to perform for five seconds) is a predictive marker for injurious falls in older adults.[23] The Timed Up and Go Test is a useful outcome measure to assess functional mobility and dynamic balance. The TUG is considered a valuable screening tool to predict frequency of falls for individuals with OA.[24] Shumway-Cook et al. reported that a time of ≥13.5 seconds could predict falls in community-dwelling older adults 90% of the time.[25] Additionally, a TUG time of ≥13.5 seconds has been confirmed by Zasadzka et al. as an indicator for falls in older adults with lower extremity osteoarthritis.[24] Based on this, a participant was categorized as high falls risk if unable to stand on one foot for at least five seconds (during the unilateral stance test) or took longer than 13.5 seconds to complete the TUG.

Data analysis included (1) prevalence of PATH-IN participants at risk for falling (overall and those in the PT intervention arm), (2) frequency in which balance training was utilized in the standard physical therapy interventions of the PATH-IN trial, (3) frequency in which balance training was provided for individuals who were considered high falls risk.

## Results

### Prevalence of Falls Risk Participants in PATH-IN Trial

Upon enrollment, 35.5% (N=344) of all participants in the PATH-IN trial and 36.2% (N=138) of participants in the standard PT intervention group were classified as high falls risk (**Table 2**). At the 4- and 12- month follow-up assessments, the prevalence of participants who were classified as falls risk progressively decreased for all PATH-IN participants and participants allocated to the standard PT group. For the participants allocated to the standard PT group, 35.4% (N=113) were classified as falls risk at the 4-month follow-up, and 21.7% (N=106) were classified as falls risk at the 12-month follow-up.

**Participant Characteristics**

The mean age of participants allocated to the standard physical therapy intervention who completed assessments for falls risk and had sufficient notes to assess for balance training (N=118) was 66.0 years (SD =9.4). Individuals who were identified as falls risk tended to be older, less likely to have a bachelor's degree, and more likely to be female, of nonwhite race, not be married, have a higher BMI and higher WOMAC total score (**Table 3**). Statistical significance between groups was not calculated due to this being an analysis of a subpopulation of the full trial which would be underpowered.

**Frequency in Which Balance Training Interventions Were Performed**

Of the 118 participants included in the standard PT group, 62.7% (N=74) received balance training interventions during their plan of care **(Table 4).** Of these, 28 were identified as falls risk (37.8%). Fourteen of the 44 participants (31.8%) who did not receive balance training were classified as falls risk. Participants allocated to the standard PT group who were classified as falls risk completed an average of 6.9 out of 8 allowed physical therapy sessions during the trial period. Of the participants who received balance training, 69% of all the physical therapy sessions incorporated balance activities.

**Conclusions**

The prevalence of falls risk in participants allocated to the standard physical therapy group (36.2%) was consistent with the prevalence of falls risk for all participants in the PATH-IN trial (35.5%), indicating that the standard PT intervention group was representative of the whole trial. The prevalence of falls risk participants in this population also correlates with prior evidence of increased falls frequency in adults with knee OA, with prior studies reporting a frequency range of 48% to 63.2%.[6,26] The prevalence of participants who were classified as having falls risk progressively decreased for participants allocated to the standard PT group, with the largest decrease in falls risk prevalence occurring between the 4- and 12- month follow-up periods. This may indicate that following PT balance can improve in a manner that would decrease falls risk in this population, however further research would need to determine if this change is due to balance training or not. The progressive decline could also have been skewed by the missing data due to patient withdrawal (N=34 at 4-months and N=50 at 12-months). The characteristics of the participants who withdrew were unknown at the time of this analysis. It is possible that patients who withdrew from the trial had greater balance and mobility deficits compared to those who completed the trial, skewing the falls risk prevalence at later time points. Nevertheless, this study confirms the high proportion of individuals with

knee OA who are at an increased falls risk, which warrants follow up to prevent future falls and associated consequences.

The findings from this retrospective analysis convey that a majority of patients allocated to the physical therapy arm of the PATH-IN trial did receive balance training (62.7%), which is in line with the physical activity guidelines for older adults.[27] The participants who received balance training during physical therapy frequently performed balance activities as an intervention (69% of PT sessions included balance training), but it is less clear how much balance training was prescribed for the home exercise component, which would impact the benefit achieved and outcomes. Physical therapists utilized a wide variety of static and dynamic exercises during balance training activities, ranging from low- to high-level exercises. A majority of patients who received balance training were not considered a high falls risk (62.2%) but still could benefit from training since the most were older adults. Some of the balance training utilized by physical therapists in this study require a greater level of physical fitness and mobility to perform correctly. Patients who performed higher-level balance activities (such as rockerboard, agility, and throwing/catching activities) were most likely not classified as being at a high falls risk. Therefore, higher-level functioning participants may have contributed to the higher proportion of patients who received balance training even though they were not considered a falls risk. Comparatively, 31.8% of the identified falls risk participants in the standard physical therapy group did not receive balance training during PT sessions. Therefore, approximately one-third of participants who were classified as a high falls risk in this trial population did not participate in balance training interventions. These patients who were classified as falls risk may have had strength and mobility deficits that took precedence over balance training during PT. It is possible that the physical therapist chose to focus on strengthening exercises instead of balance training for those participants since strength is a well documented impairment in individuals with knee OA and was specifically included in trial training for the physical therapists.

In summary, these findings suggest that physical therapists do utilize balance training frequently when treating individuals with knee OA but may not necessarily prescribe it more frequently for individuals who are considered falls risk. This may be because physical therapists understand the importance of balance training for all older adults, individuals with significant balance deficits also tend to have greater strength deficits as well, or some other reason. When providing care for individuals with symptomatic knee OA, physical therapists are encouraged to utilize balance activities that are aligned with the individual's needs and abilities. To appropriately address balance deficits in lower-level functioning patients, physical therapists may choose to utilize less challenging balance interventions, such as weight shifting, marching in place, and standing with decreased base of support. This limited retrospective study suggests

that a larger scale study is indicated to assess efficacy of balance training in preventing falls risk for individuals with knee OA.

**Clinical Relevance**

A substantial proportion of individuals with knee OA are at increased falls risk. Older adults, including those with knee OA, can benefit from balance training to reduce risk of falling. This is important due to the high personal and society costs associated with falls. The majority of participants allocated to physical therapy did receive balance training. This training included a wide variety of activities ranging from low to high difficulty, indicating the ability to adapt training to match the impairments of a specific individual.

An appreciable proportion (31.8%) of classified falls risk participants in this study did not perform balance training activities during physical therapy sessions. This indicates that balance training may be underutilized in this population. Integrating balance training into a comprehensive plan of care for patients with knee OA, especially for individuals who are considered a high falls risk may reduce future falls. When providing care for individuals with symptomatic knee OA, physical therapists are encouraged to utilize balance activities that are aligned with the individual's needs and abilities.

**Table 1.** Interventions coded as balance training activities ranging from low-level, less challenging activities to high-level, challenging activities.

| **Low-Level Balance Activities** |
| --- |
| Standing with Feet Together<br>Anterior and Posterior Weight Shifting<br>Lateral Weight Shifting<br>Sit<>Stand with SLS<br>Marching in Place<br>Lateral Walking<br>Backwards Walking<br>Standing on Uneven Surface (foam, trampoline, BOSU ball)<br>Cone Step Overs (forwards/ lateral)<br>Step Up onto Foam Surface<br>Walking with Head Movements<br>Wii Balance Games (level/difficulty varies)<br>Semi Tandem Stance<br>Tandem Stance<br>Figure Eight Walking<br>Tandem Walking<br>Grape Vine Walking<br>Unilateral Stance<br>Closed-chain Exercises on Uneven Surface: mini-squats, heel raises, toe-raises<br>Rockerboard/Slantboard/Wobbleboard Activities<br>Throwing/Catching/Reaching for Objects on Uneven Surface<br>Throwing/Catching/Reaching for Objects with Decreased Base of Support (semi-tandem, tandem, SLS)<br>Agility Ladder Exercises<br>Triangle Taps<br>Star Taps<br>Hexagon Taps |
| **High-Level Balance Activities** |

**Table 2.** Prevalence of falls risk* participants in PATH-IN trial at baseline, 4-month, and 12-month follow-up points.

| | All PATH-IN Participants | Standard PT Intervention |
|---|---|---|
| **Baseline Assessment** | 35.5% (N=344) | 36.2% (N=138) |
| **4-Month Follow-Up** | 32% (N=269) | 35.4% (N=113) |
| **12-Month Follow-up** | 25.7% (N=253) | 21.7% (N=106) |

**Falls risk defined as unilateral stance <5 seconds or Timed-Up and Go ≥ 13.5 seconds*

**Table 3.** Patient characteristics for PATH-IN participants who completed falls assessment measures (no identified falls risk vs. falls risk identified).

| Characteristic | Total (N=118) | No Fall Risk (N=76) | Falls Risk (N=42) |
|---|---|---|---|
| Age at baseline, years | 66 ± 9.4 | 64.7 ± 9.6 | 68.4 ± 8.6 |
| Bachelors Degree (%) | 68.6 | 85.5 | 38.1 |
| Female Gender (%) | 70.3 | 65.8 | 78.6 |
| Nonwhite Race (%) | 18.2 | 10 | 32.5 |
| Working (%) | 44.9 | 51.3 | 33.3 |
| Married (%) | 57.6 | 64.5 | 45.2 |
| Depressive Symptoms (PHQ-8) | 3.9 ± 4.7 | 4 ± 4.5 | 3.9 ± 4.9 |
| Brief Fear of Movement Score | 13.1 ± 2.9 | 12.8 ± 2.9 | 13.5 ± 2.9 |
| BMI | 31.7 ± 8.4 | 29.1 ± 6.2 | 36.3 ± 9.8 |
| Number Joints with Arthritis | 5.6 ± 3 | 5.5 ± 3 | 5.6 ± 3.1 |
| Symptoms Pain Duration, years | 14 ± 11.9 | 15 ± 13.4 | 12.3 ± 8.6 |
| WOMAC Total Score | 31.7 ± 17.5 | 27.7 ± 16.4 | 39.2 ± 17.3 |
| KOOS Pain subscale | 62.6 ± 16.2 | 65.9 ± 15.4 | 56.6 ± 16.2 |
| Self-Efficacy for Exercise Score | 58.5 ± 19.5 | 60.1 ± 18.7 | 55.6 ± 20.8 |

Values are mean ± SD unless indicated otherwise. WOMAC= Western Ontario & McMaster Universities Arthritis Index; KOOS = Knee Injury and Osteoarthritis Outcome Score; PHQ-8= Patient Health Questionnaire-8; Brief fear of movement score= Brief Fear of Movement Questionnaire.

**Table 4.** Frequency of balance training provided for PATH-IN participants allocated to standard PT intervention (falls risk* vs. no identified falls risk).

| | Total | Falls Risk* | Not Falls Risk |
|---|---|---|---|
| **Participants who Received Balance Training** | 74 | 28 (37.8%) | 46 (62.2%) |
| **Participants who did not Receive Balance Training** | 44 | 14 (31.8%) | 30 (68.2%) |
| **Total** | 118 | 42 | 76 |

**Falls risk defined as unilateral stance <5 seconds or Timed-Up and Go ≥ 13.5 seconds*

**References**


1. Osteoarthritis. Arthritis Foundation website. http://www.arthritis.org/about-arthritis/types/osteoarthritis/ Accessed April 5, 2017.
2. Vincent KR, Conrad BP. Fregly BJ, Vincent HK. The pathophysiology of osteoarthritis a mechanical perspective of the knee joint. *PH R*. 2012;4(50):S3-S9.
3. Zhang Y, Jordan JM. Epidemiology of osteoarthritis. *Clin Geriatr Med*. 2010; 26(3):355-369.
4. Zhang W, Doherty M, Peat G, Bierma-Zeinstra SMA, et al. EULAR evidence-based recommendations for the diagnosis of knee osteoarthritis. Ann Rheum Dis. 2010; 69:483-489.
5. Hootman JM, Helmick CG, Barbour KE, Theis KA, Boring MA. Updated projected prevalence of self-reported doctor-diagnosed arthritis and arthritis-attributable activity limitation among US adults, 2015-2040. *Arthritis & Rheumatology*. 2016; 68(7):1582-1587.
6. Tsonga T, Michalopoulou M, Malliou P, Godolias G, et al. Analyzing the history of falls in patients with severe knee osteoarthritis. *Clinics in Orthopedic Surgery*. 2015; 7:449-456.
7. Diracoglu D, Aydin R, Baskent A, Celik A. Effects of kinesthesia and balance exercises in knee osteoarthritis. *Journal of Clinical Rheumatology*. 2005;11(6):303-310.
8. Duman I, Taskaynatan MA, Hohur H, Tan AK. Assessment of the impact of proprioceptive exercises on balance and proprioception in patients with advanced knee osteoarthritis. *Rheumatol Int*. 2012; 32:3793-3798.
9. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. Web–based Injury Statistics Query and Reporting System (WISQARS) [online]. Accessed April 5, 2017.
10. Burns EB, Stevens JA, Lee RL. The direct costs of fatal and non-fatal falls among older adults—United States. *J Safety Res.* 2016; (58):99-103.
11. Barbour KE, Stevens JA, Helmick CG, Luo YH, Murphy LB, Hootman JM, et al. Falls and fall injuries among adults with arthritis--United States, 2012. *MMWR Morb Mortal Wkly Rep*. 2014;63(17):379–383.
12. Vennu V, Bindawas SM. Relationship between falls, knee osteoarthritis, and health-related quality of life: data from the Osteoarthritis Initiative study. *Clinical Interventions in Aging*. 2014; 9:793-800.
13. Important Facts About Falls. Centers for Disease Control and Prevention website. https://www.cdc.gov/homeandrecreationalsafety/falls/adultfalls.htmlUpdated February 10, 2017. Accessed April 5, 2017.
14. AGS/GBS Clinical Practice Guideline: Prevention of Falls in Older Persons. The American Geriatrics Society website. Accessed April 5, 2017. http://www.americangeriatrics.org/health_care_professionals/clinical_practice/clinical_guidelines_recommendations/prevention_of_falls_summary_of_recommendations

15. Fitzgerald GK, Piva SR, Gil AB, Wisniewski SR, et al. Agility and perturbation training techniques in exercise therapy for reducing pain and improving function in people with knee osteoarthritis: a randomized clinical trial. *Physical Therapy*. 2011; 91(4):452-469.
16. Golightly YM, Allen KD, Caine DJ. A comprehensive review of the effectiveness of different exercise programs for patients with osteoarthritis. *The Physician and Sportsmedicine*.2012;40(4):52-65.
17. Diracoglu D, Baskent A, Celik A, Issever H, Aydin R. Long-term effects of kinesthesia/balance and strengthening exercises on patients with knee osteoarthritis: A one-year follow-up study. *Journal of Back and Musculoskeletal Rehabilitation*. 2008;21:253-262.
18. Takacs J, Krowchuk NM, Garland SJ, Carpenter MG, Hunt MA. Dynamic balance training improves physical function in individuals with knee osteoarthritis: a pilot randomized controlled trial. *Archives of Physical Medicine and Rehabilitation*. 2017;[Epub ahead of print].
19. Hochberg MC, Altman RD, April KT, Benkhalti M, et al. American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee*. Arthritis Care & Research.* 2012; 64(4):465-474.
20. Fernandes L, Hagen KB, Bijlsma JWJ, Andreassen O, et al. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. *Ann Rheum Dis.* 2013; 72:1125-1135.
21. Williams QI, Gunn AH, Beaulieu JE, Benas BC, et al. Physical therapy vs. internet-based exercise training (PATH-IN) for patients with knee osteoarthritis: study protocol of a randomized controlled trial. *BMC Musculoskeletal Disorders*. 2015; 16:264.
22. The 4-Stage Balance Test. Centers for Disease Control and Prevention website. https://www.cdc.gov/steadi/pdf/4-stage_balance_test-a.pdf Accessed April 13, 2017.
23. Vellas BJ, Wayne SJ, Romero L, Baumgartner RN, et al. One-leg balance is an important predictor of injurious falls in older persons*. J Am Geriatr Soc*. 1997; 45(6):735-738.
24. Zasadzka E, Borowicz AM, Roszak M, Pawlaczyk M. Assessment of risk of falling with the use of timed up and go test in elderly with lower extremity osteoarthritis. *Clinical Interventions in Aging.* 2010; 10:1289-1298.
25. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. *Physical Therapy*. 2000; 80(9):896-903.
26. Levinger P, Menz HB, Wee E, Feller JA, et al. Physiological risk factors for falls in people with knee osteoarthritis before and early after knee replacement surgery. *Knee Surg Sports Traumatol Arthrosc*. 2011; 19(7):1082-1089.
27. Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, Minson CT, et al. American College of Sports Medicine position stand. Exercise and physical activity for older adults. *Med Sci Sports Exerc*. 2009; 41(7):1510-1530.

**Appendix.**

**PATH-IN guidance for structure and content of physical therapy visits[21]**

1. Programs, both in the clinic and at home, should be comprehensive and functional, focusing on core and lower body function, but can be tailored to meet the functional abilities, needs and deficits of each participant.
2. Each visit should emphasize therapeutic exercise and include muscle strengthening, stretching/flexibility/range of motion, and aerobic exercise.
3. Education on activity pacing, joint protection and pain management
4. A home program should be recommended during the 1st visit and should be progressed over the course of treatment.
5. Home programs should emphasize the following:
    a. Strengthening Exercises
        i. Recommend performing strengthening exercises 2-3 times per week
        ii. Include functional exercises, such as gait or stair training and neuromuscular education
    b. Stretching/flexibility/range of motion Exercises
        i. Recommend performing range of motion exercises daily
    c. Aerobic Exercises
        i. Promote "lifestyle" physical activity
        ii. Encourage moderate intensity exercise
        iii. Episodes of activity should last at least 10 minutes, if the participant is able
        iv. Episodes should be spread out throughout the week with a long-term goal of working up to a total of 150 minutes of activity per week
        v. Aerobic exercise can be weight-bearing, reduced weight-bearing or non-weight-bearing.
6. Modalities for pain management can be included during the clinic visit and as part of the home program. Modalities should be used conservatively, taking no more than 25% of the time of each clinic visit.
7. If appropriate, manual therapy can be provided during the clinic visit.
8. Shoes should be assessed during the 1st visit, and shoe recommendations should be provided, if appropriate.
9. If limb length inequality or frontal plane knee malalignment is suspected, treatment with shoe lifts or shoe wedges, respectively, should be attempted.