**PHYT 854 Capstone Project**

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**Role of Balance Confidence on Mobility Performance In Community Terrain**

INTRODUCTION -

Mobility impairments and gait deviations are common among individuals seeking physical therapy services. The underlying causes of mobility impairments may include neuromuscular disorders like Multiple Sclerosis (MS) or Parkinson’s Disease (PD). Additionally, musculoskeletal problems such as limb loss (use of a prosthetic limb) or hip fracture likewise negatively impact mobility. Mobility impairments, regardless of origin, impact lives in a number of detrimental ways. Overall deconditioning may result with decreased mobility. Lack of exercise that accompanies decreased mobility, even after relatively short periods of time lead to decreased cardiovascular functioning and conditioning.1 Social isolation and reduced participation in typical life roles also may occur with decreased mobility.2 Sebastiao et al. showed a link between mobility deficits and increased falls risk.3 Unstable surfaces require more balance and coordination to avoid falls.4 Community ambulation requires the ability to navigate curbs, steps, slopes, and soft surfaces like grass or gravel, without a loss of balance. When facing these surfaces, it is important to have adequate strength, coordination, and confidence in one’s ability in order to safely traverse these variations.

According to Barnett5, gait speed is a good measure of mobility performance. The risk of falls increases with ambulation on slopes, with declines presenting a particular challenge.6 Compared to level walking, slopes (both incline and decline) increase joint compressive forces in ankles, knees, and hips depending on slope angle.7 Slope walking also may present a challenge to those with balance deficits. Of concern is that balance confidence decreases with age, and correlates with balance performance measures in 70-84% of participants in a study by Medley, where low confidence matched poor performance.8 Interestingly, the Medley article used the TUG and L-Test, both clinical measures on flat, stable surfaces, so performance on community terrain in relation to confidence has not been shown.

The purpose of this study was to determine the relationship between balance confidence and the ability to seamlessly transition gait from a smooth clinic surface to outdoor, uneven terrains. Understanding this relationship will benefit PTs and patients in identifying potential interventions and providing a foundation for safe community ambulation, that is, across a variety of slopes, curbs, and other surface variations that exist. We hypothesized that those with decreased confidence in their activity balance would demonstrate reduced gait speed, step length and cadence when walking over uneven terrains, in comparison to clinical gait measures.

METHODS

*Participants:*

Data were collected from 50 community-dwelling adults utilizing outpatient PT services. Subjects were recruited via study advertisements in the lobby of the UNC Center for Rehabilitation Care (CRC) in Chapel Hill, NC and by referral from staff Physical Therapists. All subjects were participating in PT services to address mobility deficit within their treatment plan. Subjects were eligible to complete the study regardless of mobility deficit origin, and represented primarily neuromuscular or musculoskeletal conditions. Potential participants were excluded if they lacked sufficient mobility skills to ambulate with contact guard assistance on an outdoor community course. All participants were provided information about the study, signed informed consent documents approved by the IRB at UNC Chapel Hill.

*Data Collection:*

Participants completed a 10-meter walk test (10MWT) to determine their ‘baseline’ gait speed. Many subjects reported using assistive devices in community ambulation but were neither required to use them nor excluded from the study if used. Testing included a 2-meter acceleration/ deceleration area at each end and was performed in a well-lit, obstacle free area of the PT clinic. The participants were provided instruction to walk at their chosen pace safely to the end of the test. During walking, we recorded the test using a standard video recorder from behind for later post-processing. The distance was clearly marked with blue tape on the floor, and a tester walked slightly behind each subject. The tester used a hand signal for when the test began and ended to coincide with the subject crossing start and end lines.

Gait parameters from terrains commonly encountered in community settings were obtained on an outdoor course adjacent to the CRC. Similar directions were provided for the community course. Subjects traversed a path that included large, flat cobblestones, sand, gravel (with a slope, downward for the first loop), mulch, smaller stable cobblestones, and a wooden boardwalk. Wooden steps connected the small cobblestones with the wooden boardwalk, but were not timed as part of the study. This course was followed (approximately 201’ 10” total) twice, once in each direction of the circular loop. Each terrain was measured independently and marked with flags to indicate the beginning and end of each section. Participants walked continuously through the course and were not instructed to start and stop each section separately. As participants traversed the course, we videotaped them from behind for later post-processing.

The final 26 subjects completed an additional self-report measure, The Activities-specific Balance Confidence scale (ABC) to determine self-perception of balance. Two were translated into Spanish and filled out by the interpreter and 1 subject had items read and provided verbal responses due to not having her reading glasses available.

*Data Management and Analysis*

After all data were collected the investigators observed all videos. A stop watch was used to track time to the tenths of a second, and MS Movie Maker application also provided timing to the tenths of a second. Speed, cadence, and average step length was calculated for each subject. Investigators observed number of steps for each section and entered into SPSS v24 for computation.

The procedure for counting steps included definition of the first step (whichever foot landed over the blue line, or was more than ½ over the line. For the final step on each segment or the end of the 10MWT, we used the reverse idea, that is, the step counts if less than ½ of the foot is over the line. For timing, we used an estimate of when the midline of the torso crossed over the line for start and stop times of that segment. The final 26 subjects completed the ABC scale after the completion of the clinic and community ambulation tasks.

RESULTS –

Forty-nine individuals were included in this research project (27 female / 22 male; 64.6 ± SD years old (range 23-86), see Table 1). Participants included a mix of neurologic and musculoskeletal diagnoses (each 23) along with 3 “other” diagnoses. Of the 30 participants who identified as using assistive devices, only 10 did so for the study, and 8 participants used an orthosis. Twenty-three participants reported a fall in the prior 12 months, including 13 with two or more falls.

**TABLE 1:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Gender**  (F: M) | **Age**  Range (Avg.) | **Diagnosis**  (Neuro: MSK: Other) | **Use of AD**  (usual: test: orthotic) | **Falls past year**  (0: 1: >=2) | **ABC scale**  (Range in %) n=26 |
| 27F : 22M | 23-86 (64.6) | 23: 23: 3 | 30: 10: 8 | 26: 10: 13 | 31.9 – 98.8 |

Participant’s confidence in their balance was not related to participant’s changes in gait speed (all p >0.202), step length (all p>0.064), or cadence (all p>0.507) between the clinical 10MWT setting and the more challenging outdoor terrains. However, we did observe that participant’s typical walking speed during indoor ambulation was significantly related to the change in gait speed between the indoor clinical setting and walking across sand (p=0.009; r=0.370), walking down the gravel path (p=0.001; r=0.449), and walking back up the gravel path (p<0.001; r=0.619). With regard to cadence, there was no significant relationship between original clinic walking speed and any of the outdoor terrain conditions (all p > 0.141). There were two outdoor conditions where baseline velocity was correlated with the change in step length, namely, walking on gravel both uphill (p=0.014; r=0.348) and downhill (p=0.001; r=0.558).

DISCUSSION –

We hypothesized that balance confidence would influence how people with mobility deficits walk in outdoor community terrains when compared to their baseline clinic mobility measures. The results of our study, however, do not support that hypothesis. Instead, we observed that ABC scores were not correlated with any change in gait parameters between clinic (10MWT) versus community outdoor terrain measures. This suggests that other important factors contribute to how individuals adapt to outdoor terrains.

Reducing falls in the community is a major objective for patients and PTs. Since there is a wide variation in response to community ambulation, our results suggest that the ABC scale cannot be used in isolation to fully predict gait performance in outdoor settings. Prior literature points to additional factors, such as fear, age, prior falls experience, strength, coordination, and pain, which may all contribute to performance differences between clinic and community terrain.8,9 However, there are inconsistencies in the literature. For example, low ABC scored confidence was associated with poor ADL functioning, decreased independence, and mobility imparments.10 And, for those with higher ABC scores, a link was established with increased gait speed.11 Conversely, Liphart et al. found that within a post-stroke population, there may be “concordance” or “discordance” between confidence level and performance in balance measured. In other words, for both high and low perceived balance confidence, subjects fell into both categories (high or low) of measured balance performance.12 Our data seem to coincide with the Liphart study in that ABC scores did not predict measures of community mobility.

The 10MWT however, did show some interesting correlations: Faster indoor walkers demonstrated the greatest reduction in mobility parameters in a number of measures during outdoor terrains. These walkers tended to have a greater change in velocity when walking on sand and both uphill and downhill gravel conditions. Likewise, reductions in step length were greatest for faster walkers when traveling up and downhill gravel slopes. Explaining this finding could be related to the fact that faster walkers recognize the inherent falls risk on unstable and sloped surfaces, whereas slower walkers are less adaptable and move at a slow pace regardless of surface. Faster walkers may also have better awareness (conscious awareness or proprioceptive signals) that signal environmental risks and elicit more stable mechanics to counter the falls risk.

Limitations of the study include that subjects were all recruited from a population of physical therapy patients without healthy controls to compare against. ABC scores were obtained by the final 26 participants only, and additional information may have been gained had all 49 subjects completed the questionnaire. Likewise, many of the subjects tested may have had exposure to the community ambulation course, reducing the novelty effect, and potentially improving both performance and confidence in the course completion. Finally, while this was a study to observe mobility, all subjects were within arm’s reach of a therapist or researcher, and this may have improved performance or confidence in ways that would not be seen with independent ambulation in the community.

Strengths of the study include that a wide variety of diagnoses were included, increasing the generalizability of the results to a large patient profile. Also, with removal of perceived confidence as a predictor of performance, clinicians can encourage reluctant patients to engage in activities that will help improve their mobility performance.

CONCLUSION –

For patients with mobility deficits, primary PT goals include improving mobility performance. Through this effort, clinicians may help patients reduce falls risk, increase activity participation, and improve cardiovascular conditioning. Most studies have used clinic measures without comparison to community terrain conditions, or used artificial terrain such as inclined treadmills or foam surfaces within clinics to draw conclusions.4,7 Our study compared clinic speed to outdoor community terrain, and found that ABC confidence levels do not correlate to outdoor performance. Since balance confidence cannot be used to predict performance, other mobility predictors must be incorporated as part of the PT plan of care such as strength, balance measures, and coordination.

Bibliography

1. Nosova EV, Yen P, Chong KC, et al. Short-term physical inactivity impairs vascular function. *J Surg Res* 2014;190(2):672-682. doi:10.1016/j.jss.2014.02.001.

2. Hilberink SR, van der Slot WMA, Klem M. Health and participation problems in older adults with long-term disability. *Disabil Health J* 2017;10(2):361-366. doi:10.1016/j.dhjo.2016.12.004.

3. Sebastião E, Learmonth YC, Motl RW. Mobility measures differentiate falls risk status in persons with multiple sclerosis: An exploratory study. *NeuroRehabilitation* 2017;40(1):153-161. doi:10.3233/NRE-161401.

4. MacLellan MJ, Patla AE. Adaptations of walking pattern on a compliant surface to regulate dynamic stability. *Exp Brain Res* 2006;173(3):521-530. doi:10.1007/s00221-006-0399-5.

5. Barnett C, Vanicek N, Polman R, et al. Kinematic gait adaptations in unilateral transtibial amputees during rehabilitation. *Prosthet Orthot Int* 2009;33(2):135-147. doi:10.1080/03093640902751762.

6. Silverman AK, Wilken JM, Sinitski EH, Neptune RR. Whole-body angular momentum in incline and decline walking. *J Biomech* 2012;45(6):965-971. doi:10.1016/j.jbiomech.2012.01.012.

7. Alexander N, Schwameder H. Lower limb joint forces during walking on the level and slopes at different inclinations. *Gait Posture* 2016;45:137-142. doi:10.1016/j.gaitpost.2016.01.022.

8. Medley A, Thompson M. Contribution of age and balance confidence to functional mobility test performance: diagnostic accuracy of L test and normal-paced timed up and go. *J Geriatr Phys Ther* 2015;38(1):8-16. doi:10.1519/JPT.0000000000000015.

9. Friedman SM, Munoz B, West SK, Rubin GS, Fried LP. Falls and fear of falling: which comes first? A longitudinal prediction model suggests strategies for primary and secondary prevention. *J Am Geriatr Soc* 2002;50(8):1329-1335. doi:10.1046/j.1532-5415.2002.50352.x.

10. Salbach NM, Mayo NE, Robichaud-Ekstrand S, Hanley JA, Richards CL, Wood-Dauphinee S. Balance self-efficacy and its relevance to physical function and perceived health status after stroke. *Arch Phys Med Rehabil* 2006;87(3):364-370. doi:10.1016/j.apmr.2005.11.017.

11. Myers AM, Powell LE, Maki BE, Holliday PJ, Brawley LR, Sherk W. Psychological indicators of balance confidence: relationship to actual and perceived abilities. *J Gerontol A Biol Sci Med Sci* 1996;51(1):M37-43.

12. Liphart J, Gallichio J, Tilson JK, Pei Q, Wu SS, Duncan PW. Concordance and discordance between measured and perceived balance and the effect on gait speed and falls following stroke. *Clin Rehabil* 2016;30(3):294-302. doi:10.1177/0269215515578294.