Brief Report

Self-Efficacy Mediates Walking Performance in Older Adults with Knee Osteoarthritis

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Background. Self-efficacy is a determinant of walking performance in older adults with knee osteoarthritis. We examined whether self-efficacy mediated the effect of age, psychosocial, impairment, and mechanical factors on walking performance.

Methods. Fifty-four participants with knee osteoarthritis completed the Six Minute Walk test and Arthritis Self-Efficacy Scale. Independent variables reflected age, psychosocial (depressive symptoms), impairment (pain, stiffness), and mechanical (strength, obesity) factors.

Results. Self-efficacy fully mediated the effect of age and impairments on walking. The effects of strength were only partially mediated by self-efficacy. Depressive symptoms and obesity were not mediated by self-efficacy.

Conclusions. These findings are consistent with Social Cognitive Theory, according to which age may alter outcome expectations, and impairments like pain and stiffness provide negative physiological feedback to influence performance. Mechanical factors like strength and obesity may better represent a person’s capabilities and interact with other variables to influence physical performance in older adults with knee osteoarthritis.

Walking is the most common limitation leading to chronic disability in community-dwelling older adults with knee osteoarthritis (OA) (1). Biomedical factors alone do not explain all of the variance in mobility performance (2); for example, factors like self-efficacy are important to balance (3) and walking performance in seniors (4,5). Self-efficacy is the belief that one has the capabilities to execute the actions required to satisfy specific situational demands (6). Self-efficacy is at the heart of Social Cognitive Theory, which suggests that people’s performance is better predicted by their beliefs about their capabilities than by their actual capabilities (6). Consistent with this theory, self-efficacy explains a large portion of the variance in performance of physical activities like walking in people with knee OA (4,5). Furthermore, the effect of exercise or dietary interventions is mediated by self-efficacy in improving performance in this group (7,8). However, knowledge of the determinants of self-efficacy, and how self-efficacy interacts with these determinants, remains limited. Because self-efficacy has been shown to relate to knee stiffness, strength, age, and depressive symptoms in this population (9), it may interact with similar variables including age, impairment, psychosocial, and mechanical factors to act as a mediator of performance.

The purpose of this study was to determine whether self-efficacy mediated the effect of age, impairment (pain, stiffness), psychosocial (depressive symptoms), and mechanical factors (strength, obesity) on walking performance in a small sample of people with knee OA. We hypothesized that self-efficacy fully mediated the effect of these factors on walking.

Methods

Participants

Fifty-seven participants, recruited using newspaper advertisements, completed the study (Figure 1). Data from three participants were excluded because of the presence of predominantly lateral knee OA on radiographs. Lateral OA may involve different dynamics from that of medial OA (10). The remaining 54 adults were older than 50 years and had physician-diagnosed knee OA consistent with the American College of Rheumatology criteria (11).

Participants were 68.3 ± 8.7 years old, ranging between 50 and 87 years. Body mass index (BMI; 28.6 ± 5.1 kg/m²) indicated that the group was overweight. Pain (30.3 ± 18.6), stiffness (43.3 ± 25.0), and function (34.4 ± 19.6) scores from the Western Ontario McMaster Universities Osteoarthritis Index (WOMAC) showed that participants had mild-to-moderate knee OA. Thirty-two participants were women. No participant had undergone corrective surgery or had had an ipsilateral hip or ankle condition. All were screened for medical conditions that could be exacerbated by the protocol, such as unstable heart disease. The most common comorbidities were hand OA, heart
disease, and low back pain. All provided written informed consent.

**Dependent Variable: Performance**

The Six Minute Walk test (SMW; m), which yields reliable, valid data (12), was used to quantify walking performance. Participants walk at a self-selected pace and may stop or use a mobility aid. The SMW was recorded indoors in a well-lit, 25 m, tiled hallway, and the score recorded was the total distance covered in 6 minutes. Participants were instructed to walk as far as possible for 6 minutes and were given time cues every 30 seconds to monitor progress.

**Proposed Mediator: Self-Efficacy**

The Functional Self-Efficacy subscale (FSE) of the Arthritis Self-Efficacy Scale quantified self-efficacy for physical tasks (13). The FSE includes nine questions, in a visual analog format, and a higher score indicates greater self-efficacy (a positive result). An example question is, “How certain are you that you can walk 100 feet on flat ground in 20 seconds?” A test–retest reliability coefficient \( r \) of 0.89 and an alpha coefficient of 0.93 were reported for the FSE (13).

**Independent Variables**

**Age.**—The age (AGE; years) of the participants was recorded.

**Impairments.**—The Pain (PAIN) and Stiffness (STIFF) subscales of the WOMAC were included. This self-administered questionnaire for hip or knee OA uses a visual analog format. Items can range between 0 and 100 mm, best to worst. The reliability and validity of WOMAC data have been well established, including the use of the subscales separately (14).

**Psychosocial.**—The Center for Epidemiologic Studies-Depression (CES-D) scale is a 20-item Likert scale with emphasis on mood, guilt, worthlessness, helplessness, loss of appetite, and sleep disorders (15). Correlation coefficients \( r \) between 0.85 and 0.90 have been reported in general and patient populations (15). The scale yields valid data in arthritic populations (16). A score of \( \geq 16 \) indicates some depressive symptoms over the past week (15).

**Mechanical.**—Quadriceps (QUAD; Nm) and hamstring strength (HAMS; Nm) were measured using a Biodex isokinetic dynamometer (Biodex Medical Systems, Shirley, NY). Participants completed five submaximal practices followed by five maximum-effort trials of concentric knee flexion and extension. Five peak extension and flexion torques within a 0.1°/s of 60°/s were averaged. The reliability of windowed knee data is 0.90–0.96 on Biodex systems (17). BMI (kg/m²) was calculated from measured height and weight while the participants were barefoot and wearing shorts and a shirt.

**Analysis**

We elaborated on the criteria by Baron and Kenny (18) to identify whether FSE acted as a mediator. Separate linear regressions were performed to identify whether each independent variable was related to FSE. An F value of \( \geq 0.05 \) was necessary for inclusion. A linear regression was performed to determine the relationship between the proposed mediator, FSE, and the dependent variable, SMW. We used separate linear regressions to examine the relationship between the independent variables and SMW. We evaluated the relationship between the independent and dependent variables controlling for the proposed mediator, FSE. If an independent variable met the first three criteria, but not the fourth, the Sobel equation tested for partial mediation (19):

\[
\begin{align*}
  z &= \frac{\alpha \beta}{\alpha^2 \sigma_\alpha^2 + \beta^2 \sigma_\beta^2} \\
  \alpha &= \text{unstandardized beta (independent variable)} \\
  \beta &= \text{unstandardized beta (mediator)} \\
  \sigma_\alpha &= \text{standard error (independent variable)} \\
  \sigma_\beta &= \text{standard error (mediator)}
\end{align*}
\]

\( z > 1.96 = \text{partial mediation (} p < .05 \text{)} \)

Consistent with this approach, no variables were used as covariates.

**RESULTS**

The FSE scores (80.7 \( \pm \) 13.4) were high compared to those in other knee OA studies (4,20). Quadriceps (63.8 \( \pm \) 29.0 Nm) and hamstrings (34.0 \( \pm \) 20.5 Nm) strength demonstrated that the sample was strong. One participant did not complete the strength testing due to an episode of asthma. A repeated-measures analysis of variance revealed...
that fatigue did not affect strength scores \((p = .61, .76\) for quadriceps, hamstrings).

Table 1 presents regression models corresponding to the mediation criteria illustrated in Figure 2. For 1, all independent variables except BMI were significantly related to FSE. Thus, BMI was removed from subsequent analyses. For 2, FSE explained 50.6% of the variance in SMW. Next (3), the CES-D scale score was the only independent variable not significantly related to SMW.

Using regressions, we explored the effect of independent variables on the SMW, while controlling for FSE. The unstandardized coefficients were reduced compared to models of independent variables on SMW, suggesting that controlling for FSE minimized the impact of the independent variables on walking. In fact, coefficients for the AGE, PAIN, and STIFF equations were insignificant, suggesting full mediation.

Controlling for FSE did not remove a significant effect of QUAD or HAMS on SMW, suggesting that the effect of strength on SMW was not fully mediated by FSE. Partial mediation was explored for QUADS and HAMS. Using the Sobel equation, we calculated \(z\) values of 2.46 and 2.81 for the tests of partial mediation by QUADS and HAMS, respectively, suggesting that strength was partially mediated by FSE.

### Discussion

Social Cognitive Theory hypothesizes that a person’s self-efficacy will influence his or her choice of activity, effort, persistence, and achievement (6). Compared to persons who doubt their capabilities, those with high self-efficacy will work harder and persist longer to achieve superior performance. Sources of self-efficacy are varied: past successful or “mastery” performance, persuasion, vicarious experience, and physiological feedback. Other variables, such as affect and outcome expectations, are closely linked with self-efficacy (6). Our data support the hypothesis that the effect of age on walking is fully mediated by self-efficacy. Work regarding efficacy and perceived control in aging provide support for this finding (21). Although not a proposed source of self-efficacy (6), age is likely relevant to outcome expectations. Outcome expectations and self-efficacy are not the same, but these constructs are often related (6). Perhaps as people age, their expectations for physical capabilities diminish, leading to an alteration in self-efficacy and subsequent performance.

Self-efficacy fully mediated the effect of pain and stiffness on walking. It has been recently contended that self-efficacy mediates the effect of impairments on mobility in people with knee OA (22). We propose that pain and stiffness provided negative physiological feedback, which was either consciously or unconsciously considered when each participant decided how much effort and persistence should be invested in walking. Pain management programs could be explored as means of improving physical performance. There exists a need to target mobility-related efficacy beliefs in refining intervention strategies. Lastly, because stiffness may be modifiable, identification of effective strategies to minimize stiffness (such as hydrotherapy, thermal modalities, and non-weight-bearing exercise) should be explored.

The effect of strength on performance was partially mediated by self-efficacy, which is consistent with Social

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Predicted</th>
<th>Predictor</th>
<th>Mediator</th>
<th>Unstandardized Coefficient</th>
<th>Standardized Coefficient</th>
<th>(p)</th>
<th>Adjusted (R^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Independent and mediator</td>
<td>FSE</td>
<td>Age</td>
<td>Mediator</td>
<td>(-0.50 \pm 0.20)</td>
<td>(-0.33)</td>
<td>.016</td>
<td>.09</td>
</tr>
<tr>
<td>1 Independent and mediator</td>
<td>FSE</td>
<td>Pain*</td>
<td>Mediator</td>
<td>(-0.06 \pm 0.02)</td>
<td>(-0.44)</td>
<td>.001</td>
<td>.18</td>
</tr>
<tr>
<td>1 Independent and mediator</td>
<td>FSE</td>
<td>Stiffness*</td>
<td>Mediator</td>
<td>(-0.16 \pm 0.03)</td>
<td>(-0.60)</td>
<td>.001</td>
<td>.35</td>
</tr>
<tr>
<td>1 Independent and mediator</td>
<td>FSE</td>
<td>CES-D</td>
<td>Mediator</td>
<td>(-0.67 \pm 0.20)</td>
<td>(-0.43)</td>
<td>.001</td>
<td>.17</td>
</tr>
<tr>
<td>1 Independent and mediator</td>
<td>FSE</td>
<td>Quadriceps strength*</td>
<td>Mediator</td>
<td>(0.16 \pm 0.06)</td>
<td>0.35</td>
<td>.011</td>
<td>.10</td>
</tr>
<tr>
<td>1 Independent and mediator</td>
<td>FSE</td>
<td>Hamstrings strength*</td>
<td>Mediator</td>
<td>(0.26 \pm 0.09)</td>
<td>0.39</td>
<td>.004</td>
<td>.14</td>
</tr>
<tr>
<td>1 Independent and mediator</td>
<td>FSE</td>
<td>Body mass index</td>
<td>Mediator</td>
<td>(-0.67 \pm 0.35)</td>
<td>(-0.26)</td>
<td>.063</td>
<td>.05</td>
</tr>
<tr>
<td>2 Mediator and dependent</td>
<td>SMW</td>
<td>FSE</td>
<td>Mediator</td>
<td>(6.67 \pm 0.90)</td>
<td>0.72</td>
<td>.000</td>
<td>.50</td>
</tr>
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<td>3 Independent and dependent</td>
<td>SMW</td>
<td>Age</td>
<td>Predicted</td>
<td>(-5.46 \pm 1.84)</td>
<td>(-0.38)</td>
<td>.005</td>
<td>.13</td>
</tr>
<tr>
<td>3 Independent and dependent</td>
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<td>Pain*</td>
<td>Predicted</td>
<td>(-0.52 \pm 0.17)</td>
<td>(-0.39)</td>
<td>.004</td>
<td>.14</td>
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<tr>
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<td>Stiffness*</td>
<td>Predicted</td>
<td>(-1.21 \pm 0.31)</td>
<td>(-0.48)</td>
<td>.001</td>
<td>.22</td>
</tr>
<tr>
<td>3 Independent and dependent</td>
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<td>CES-D</td>
<td>Predicted</td>
<td>(-4.76 \pm 1.91)</td>
<td>(-0.33)</td>
<td>.061</td>
<td>.09</td>
</tr>
<tr>
<td>3 Independent and dependent</td>
<td>SMW</td>
<td>Quadriceps strength*</td>
<td>Predicted</td>
<td>(2.07 \pm 0.54)</td>
<td>0.47</td>
<td>.001</td>
<td>.21</td>
</tr>
<tr>
<td>3 Independent and dependent</td>
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<td>Hamstrings strength*</td>
<td>Predicted</td>
<td>(2.93 \pm 0.76)</td>
<td>0.47</td>
<td>.001</td>
<td>.21</td>
</tr>
<tr>
<td>4 Controlling for mediator</td>
<td>SMW</td>
<td>Age</td>
<td>FSE</td>
<td>(-2.34 \pm 1.45)</td>
<td>(-0.16)</td>
<td>.110</td>
<td>.52</td>
</tr>
<tr>
<td>4 Controlling for mediator</td>
<td>SMW</td>
<td>Pain*</td>
<td>FSE</td>
<td>(-0.13 \pm 0.15)</td>
<td>(-0.10)</td>
<td>.384</td>
<td>.50</td>
</tr>
<tr>
<td>4 Controlling for mediator</td>
<td>SMW</td>
<td>Stiffness*</td>
<td>FSE</td>
<td>(-0.19 \pm 0.31)</td>
<td>(-0.08)</td>
<td>.538</td>
<td>.49</td>
</tr>
<tr>
<td>4 Controlling for mediator</td>
<td>SMW</td>
<td>CES-D</td>
<td>FSE</td>
<td>Not completed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Controlling for mediator</td>
<td>SMW</td>
<td>Quadriceps strength*</td>
<td>FSE</td>
<td>(1.12 \pm 0.43)</td>
<td>0.26</td>
<td>.013</td>
<td>.56</td>
</tr>
<tr>
<td>4 Controlling for mediator</td>
<td>SMW</td>
<td>Hamstrings strength*</td>
<td>FSE</td>
<td>(1.41 \pm 0.63)</td>
<td>0.23</td>
<td>.030</td>
<td>.54</td>
</tr>
</tbody>
</table>

Notes: *Subscale of the Western Ontario McMaster Universities Osteoarthritis Index.

1 One participant did not complete the strength testing due to a medical event related to asthma (\(n = 53\)).

FSE = Functional Self-Efficacy subscale; SMW = Six Minute Walk test; CES-D = Center for Epidemiologic Studies-Depression.
Cognitive Theory: Capabilities (e.g., strength) are not as influential as the perception of capabilities on performance (6). However, the sample involved was strong. Self-efficacy is most influential in persons challenged by muscular weakness (23), and a task requiring greater strength, like stair-climbing, may have yielded different findings. The poor relationship between strength and self-efficacy noted here may have also reflected that strength assessment was a unique and nonfunctional experience. It would have been difficult for participants to perceive whether they had achieved mastery performance, suggesting that a poor relationship should have been expected. Another method of strength measurement using functional tasks may have been easier for participants to assess and therefore may have resulted in a stronger relationship between strength and self-efficacy. Because the effect of strength on walking scores was greater than on self-efficacy, the relationship between strength and physical performance may simply be direct. Another possibility is that there is a complex interaction between strength and other as yet unidentified variables that affect performance.

Our hypothesis that depressive symptoms would be mediated by self-efficacy was unsupported. First, because depressive symptoms contribute to slow gait speed in older adults (24), we must acknowledge the possibility that depression may interact with performance directly. Self-efficacy may not influence this relationship. Second, we must consider that depression may be more important to self-reported function than performance, because self-reported and performance measures are distinct (25). Finally, participants here did not demonstrate CES-D scale scores (10 ± 9) appreciably different from those of the general population (score of 7) but substantially lower than those with depressive symptoms (score of 16) (15); thus, the CES-D scale score may have been insensitive in this sample.

Similarly, our hypothesis that obesity would be mediated by FSE was not supported. The participants were overweight based on BMI, however, to a lesser degree compared to other studies (22). Different results may be found in studies featuring samples with greater BMI or more variability in this mechanical factor.

The small sample and cross-sectional nature of this study are limitations. Future research could prospectively examine modifying pain and stiffness and note whether these factors influence self-efficacy or performance. Gender was not considered in the analyses due to the small sample size.

Conclusion

We examined whether self-efficacy mediated the effect of age, impairment, psychosocial, and mechanical factors on performance in people with knee OA. Self-efficacy fully mediated the effect of pain, stiffness, and age on walking performance. Pain and stiffness likely provide negative physiological feedback, and getting older may alter a person’s outcome expectations. Self-efficacy partially mediated the effect of strength on performance. These findings highlight the importance of a psychosocial variable, self-efficacy, on performance in people with knee OA.
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