

Balance Confidence and Function After Knee-Replacement Surgery

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This study examined the relationship between balance confidence and function in older adults after knee-replacement surgery. Thirty-six adults (20 men and 16 women age 58–84 years) completed measures of balance confidence, general self-efficacy, and function. Results showed that participants with greater balance confidence had better functional performance and reported fewer difficulties with activities of daily living. General self-efficacy and age were not related to any of the functional measures. Women scored lower than men for all balance-confidence and function measures. These findings highlight the potential value of studying balance-related self-efficacy beliefs in people with knee replacements. Longitudinal studies are now needed to determine whether a change in balance confidence is associated with a change in function and to further explore gender differences.

Key Words: efficacy, fear of falling, aging, joint replacement

Knee-joint replacement has become a frequently performed operation to provide relief of pain from an arthritic knee joint in older adults. Research into function after knee-replacement surgery has tended to focus on physical outcome measures including range of motion (Chiu, Ng, Tang, & Yau, 2002) and strength (Silva et al., 2003). Little attention has been paid to psychological factors such as whether individuals experience a loss of confidence in their ability to perform activities of daily living after surgery.

Measures of balance confidence have been developed to quantify the psychological component of balance-related behavior. Two measures that have been frequently used are the Falls Efficacy Scale (Tinetti, Richman, & Powell, 1990) and the Activities-specific Balance Confidence scale (Powell & Myers, 1995). These measures are based on Bandura's theory of self-efficacy, which is defined as the confidence a person has in his or her ability to successfully perform a specific behavior (Bandura, 1986). In this context, balance confidence refers to the degree of confidence a person has in keeping his or her balance while performing activities of daily living. Findings from a number of studies employing these measures have demonstrated strong links between balance confidence and physical and social functioning in elderly adults (Myers et al., 1996; Tinetti, Mendes de Leon, Doucette, & Baker, 1994). Low balance confidence has also been shown to be predictive of

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functional decline and activity avoidance (Cumming, Salkeld, Thomas, & Szonyi, 2000; Mendes de Leon, Seeman, Baker, Richardson, & Tinetti, 1996; Vellas, Wayne, Romero, Baumgartner, & Garry, 1997).

Balance confidence has not yet been investigated in people who have undergone knee-replacement surgery. It seems reasonable to hypothesize that balance confidence could be a factor that influences outcome in this population, because altered gait patterns and sensory deficits are often associated with this type of surgery (Skinner, Barrack, Cook, & Haddad, 1984). Furthermore, those who undergo knee replacement are most often elderly (Callahan, Drake, Heck, & Dittus, 1994).

The purpose of this study was therefore to examine the extent to which balance confidence was related to functional outcome in adults after knee-replacement surgery. It was hypothesized that lower balance confidence would be associated with greater functional limitations. Because gender differences between self-efficacy (although not balance-related self-efficacy) and performance have been reported in other studies (Gaines, Talbot, & Metter, 2002; Seeman, Unger, McAvay, & Mendes de Leon, 1999), we also sought to explore the relationship between balance confidence and function separately for men and women.

Method

Participants

Thirty-six community-dwelling adults between 58 and 84 years of age ($M = 72.4 \pm 6.7$; 20 men, 16 women) who had undergone knee-replacement surgery because of osteoarthritis participated in the study. All surgeries were performed by the same experienced knee surgeon. Participants were recruited into the study when they attended the clinic for annual review. To be included, participants had to have no symptomatic involvement of the contralateral knee and no impairment of the hip or ankle joints. Participants also had to have achieved a successful outcome based on the clinical criteria of no or minimal pain, good stability, and good range of motion. These variables were assessed using the American Knee Society (AKS) knee score (Insall, Dorr, Scott, & Scott, 1989). This score allocates 50 points for assessment of pain, 25 points for range of motion, and 25 points for stability. The maximum score in each category indicates normality. Thus, a well-aligned knee with no pain, 125° of movement, and negligible instability would score the maximum rating of 100 points. The scale has been shown to have adequate convergent construct validity (Lingard, Katz, Wright, Wright, & Sledge, 2001). For the purposes of this study, minimal pain was defined as a score of 40–50 or higher, good stability as 20–25 or higher, and good range of motion as 20–25 or higher. This assessment was made by the treating surgeon before enrollment. No one recruited declined to participate.

Measures

Falls History and Balance Confidence. The number of falls and fall-related injuries for the preceding 12 months was ascertained by self-report. Participants were also asked if they were afraid of falling and, if so, whether they avoided any activities because of this fear.

Two measures of balance confidence were used. The first was the Falls Efficacy Scale (FES; Tinetti et al., 1990), a 10-item scale that examines an individual's beliefs in his or her capabilities to carry out basic activities of daily living without falling. This measure has been widely used, and it appears to be both reliable (test-retest reliability correlation of .71) and valid (Tinetti et al., 1994). Confidence in accomplishing each activity without falling is scored on a 10-point continuum with low scores corresponding to lower confidence. The total FES score is the sum of each score across the 10 activities, ranging from 10 to 100.

The second measure was the Activities-specific Balance Confidence scale (ABC; Powell & Myers, 1995), a 16-item scale designed to measure an individual's confidence in performing activities such as walking up and down stairs and walking in crowded shopping centers without losing balance. In contrast to the FES, the ABC covers a wider continuum of item difficulty and, as such, has been suggested to be more suitable for detecting loss of balance confidence in more highly functioning adults (Powell & Myers). The ABC scale has been shown to have good test-retest reliability ($r = .92$) and adequate internal, divergent, and construct reliability (Powell & Myers). For each item, balance confidence is rated on a 0 (*no confidence*) to 100 (*complete confidence*) response continuum. The total ABC score is the mean of the 16 item scores (0–100 range). Further details regarding the reliability and validity of the FES and ABC scales can be found in Jorstad, Hauer, Becker, and Lamb (2005).

General Self-Efficacy. The General Self-Efficacy scale (GSE) was also employed (Schwarzer & Jerusalem, 1995). This 10-item scale is designed to assess the belief that one can perform a novel or difficult task or cope with adversity. Participants respond to items such as “I can always manage to solve difficult problems if I try hard enough” using a 4-point scale (1 = *not at all true* to 4 = *exactly true*). The total GSE score is the sum of all 10 items and ranges from 10 (low general self-efficacy) to 40 (high general self-efficacy). The scale has good internal consistency (Cronbach's alpha $> .75$ across 25 nations) and convergent validity (Scholz, Dona, Sud, & Schwarzer, 2002). The purpose of using this measure was to examine whether people who have lower self-confidence in general were also more likely to have lower balance-related confidence. To our knowledge no study has examined confidence that is balance specific and compared it with a more general self-confidence measure.

Functional Outcome. Three measures of functional outcome were employed. The first was the AKS-function score, which is a self-report measure of functional performance based on walking and stair-climbing ability (Insall et al., 1989). Walking ability is graded on a six-level scale, and the ability to negotiate stairs is graded on a five-level scale. Deductions are made for the use of walking aids. A maximum score of 100 points is awarded for the ability to walk an unlimited distance (50 points) and ascend and descend stairs without using a handrail (50 points). Good interrater reproducibility has been reported for this scale ($r = .78$; Bach et al., 2002).

The second measure was the Oxford-12 knee score (Dawson, Fitzpatrick, Murray, & Carr, 1998), which is a self-report measure of difficulties associated with performing activities of daily living. Each of the 12 items is scored on a 5-point scale from least to most difficult. The total score is the sum of all items and ranges

from 12 (*no difficulty*) to 60 (*maximum difficulty*). The scale has been shown to have high internal consistency and reliability (Dawson et al.).

The third functional outcome was walking speed, which was measured by use of an electronic mat (GAITRite, CIR Systems, PA) approximately 8 m in length. The sampling rate of the system is 80 Hz, and it has been shown to be a valid and reliable measure of temporospatial parameters of gait (Bilney, Morris, & Webster, 2003; Menz, Latt, Tiedemann, Mun San Kwan, & Lord, 2004; Webster, Wittwer, & Feller, 2005).

Procedures

The procedures were approved by La Trobe University's Ethics Committee. All participants were informed of the nature of the experiment, and written consent was obtained. All data were collected during a single session approximately 1.5 hr in duration. Participants were required to wear a comfortable pair of flat-soled walking shoes. The self-report functional-outcome measures (AKS-function and Oxford-12), balance confidence (FES and ABC scales), and GSE scale were completed first. Participants then performed a practice trial of walking down the electronic mat to familiarize themselves with the equipment. Each participant was then required to walk at self-selected comfortable (preferred) and fast speeds. Four trials were performed for each speed. Each walking trial began and ended approximately 2 m away from the mat so that a constant gait pattern was maintained and acceleration and deceleration occurred before and after the mat itself. The AKS knee score was readministered by the treating orthopedic surgeon before the laboratory session.

Data Analysis

For each participant, data from the four walking trials were averaged to give an individual mean and standard deviation for both preferred and maximum walking speeds. Descriptive statistics were then used to calculate means and standard deviations (for continuous variables) and percentages (for dichotomous variables) for the entire participant group and separately for men and women. Gender differences between balance confidence and function measures were examined using *t* tests and the Mann-Whitney U test. Correlation analyses were used to describe and examine relationships between balance confidence and function. Power calculations determined that 26 participants would provide sufficient power (.8) to detect large effect sizes ($r = .5$), indicating that the sample size of 36 was reasonable for these correlation analyses.

Results

Baseline Characteristics and Gender Differences

Table 1 shows descriptive information for demographics, falls, balance confidence, and functional-outcome variables for the study group as a whole and men and women separately. Men and women did not differ in terms of age, length of time

Table 1 Descriptive Statistics of the Study Sample

	Total sample (<i>N</i> = 36)	Women (<i>n</i> = 16)	Men (<i>n</i> = 20)
Demographic and Surgical			
Age (years)	72.2 ± 6.07	72.7 ± 6.6	71.9 ± 7.0
Time since surgery (years)	1.61 ± 0.8	1.60 ± 0.9	1.62 ± 0.8
AKS knee score (0–100)	93.3 ± 6.8	91.6 ± 7.6	94.6 ± 5.9
Fall Related			
Falls in preceding year, no. of participants			
0	23 (64%)	10 (62%)	13 (65%)
1	11 (30%)	6 (38%)	5 (25%)
2 or more	2 (6%)	0 (0%)	2 (10%)
Fear			
not afraid	26 (72%)	9 (56%)	17 (85%)
afraid, not decrease activity	5 (14%)	3 (19%)	2 (10%)
afraid, decrease activity	5 (14%)	4 (25%)	1 (5%)
Balance Confidence and General Efficacy			
FES score (0–100)	95.0 ± 7.2	90.1 ± 8.3	98.9 ± 1.9
ABC score (0–100)	89.4 ± 12.4	80.1 ± 12.6	96.9 ± 5.2
General self-efficacy (10–40)	32.7 ± 3.5	32.0 ± 3.6	33.1 ± 3.4
Function			
AKS-function score (0–100) ^a	88.8 ± 12.8	81.6 ± 13.6	94.5 ± 8.8
Oxford-12 (12–60) ^b	17.8 ± 4.7	20.7 ± 5.4	15.6 ± 2.7
Walking speed (m/s)			
preferred speed	1.36 ± 0.2	1.20 ± 0.2	1.46 ± 0.1
maximum speed	1.73 ± 0.3	1.52 ± 0.2	1.90 ± 0.2

Note. Summary data are $M \pm SD$. AKS = American Knee Society; FES = Falls Efficacy Scale; ABC = Activities-specific Balance Confidence scale.

^aHigher values indicate better functional ability. ^bHigher values indicate greater functional limitation.

since surgery, or clinical knee scores (AKS knee score). Only 2 participants, both of whom were men, had had multiple falls in the preceding year. Despite this, only 15% of male participants reported that they were afraid of falling, compared with 44% of female participants ($p = .07$). Although there was no difference in GSE scores between men and women, for both balance-confidence measures men scored significantly higher (greater confidence) than women ($p < .001$).

There were also significant gender differences for the three function measures. For both self-report measures men reported better function and had fewer difficulties than women did (AKS-function, $p < .01$; Oxford-12, $p = .001$). Men also walked

significantly faster than women at both preferred and maximum speeds—walking speed was normalized to height for this comparison ($p < .01$).

Correlation Analyses

Age was not found to be associated with balance confidence or the general self-efficacy measures. The FES and ABC scales were significantly associated with each other ($r = .81, p < .01$), but neither of these was related to the general self-efficacy measure. The AKS knee score was not correlated with balance-confidence or function measures.

The relationship between balance confidence, general self-efficacy, and functional measures is shown in Table 2. The bivariate correlation is shown first, but because there were baseline gender differences in both balance confidence and function, partial correlations were also conducted controlling for gender.

Results showed that the FES and ABC were significantly correlated with both the Oxford-12 and the AKS-function scores. The relationship was such that better function was correlated with greater confidence. For the Oxford-12, the relationship was significant after controlling for gender. For the AKS-function score, the relationship remained significant for the ABC scale but not the FES after controlling for gender.

For walking speed, the bivariate correlation was significant for both balance-confidence measures, but neither measure remained significant after controlling for gender. General self-efficacy and age were not related to any of the functional measures.

Table 3 shows the relationship between balance-confidence and function measures separately for men and women. The ABC correlated with measures of function for both men and women, whereas the FES correlated with a measure of function for women only.

Table 2 Bivariate Relations Among Age, Efficacy, and Function Measures, With Partial Correlations Controlling For Gender

Variable	Age	FES	ABC	GSE
Oxford-12	-.15	-.81*	-.75*	-.23
controlling for gender	-.17	-.71*	-.62*	-.17
AKS-function	.02	.52*	.62*	.28
controlling for gender	.07	.30	.43*	.22
Preferred walking speed	-.09	.52*	.59*	-.04
controlling for gender	-.03	.18	.25	-.21
Maximum walking speed	-.06	.57*	.63*	.02
controlling for gender	-.02	.23	.27	-.15

Note. FES = Falls Efficacy Scale; ABC = Activities-specific Balance Confidence scale; GSE = General Self Efficacy scale; AKS = American Knee Society.

* $p < .01$.

Table 3 Bivariate Relations Among Balance Confidence and Function Measures Shown Separately for Men and Women

	Men		Women	
	FES	ABC	FES	ABC
Oxford-12	-.22	-.19	-.82*	.62*
AKS-function	-.13	.58*	.36	.35
Preferred walking speed	.29	.20	.19	.31
Maximum walking speed	.32	.17	.32	.44

Note. FES = Falls Efficacy Scale; ABC = Activities-specific Balance Confidence scale; AKS = American Knee Society.

* $p < .01$.

Discussion

This study was an initial attempt to see whether psychological factors such as balance confidence are associated with function in individuals who have undergone knee-replacement surgery. The results showed that participants with higher balance-confidence scores reported better function and had fewer difficulties with activities of daily living. Although these results do not indicate causality, they highlight the potential value of studying balance-related self-efficacy beliefs in people who have had knee replacements.

This is the first study to include a general self-efficacy measure with the more specific balance-confidence measures. This measure was included to see whether people with lower general self-efficacy were also more likely to have lower balance self-efficacy. It was found that the general efficacy measure was unrelated to balance confidence, age, or function. These data therefore highlight the independence of balance confidence and reinforce the situation-specific nature of self-efficacy beliefs (Bandura, 1986).

This study also explored gender differences in balance confidence and function, and although some gender differences were noted there are two potential confounders that should be acknowledged when considering these data. First, women scored lower than men on all three functional measures and were therefore performing at a different functional level. Second, men are less likely to report functional difficulty than women are (McAuley, Mihalko, & Rosengren, 1997; Tinetti et al., 1994), and because two of the functional measures were self-report, there is a potential for reporting bias. Such bias could also be related to the disconnection we found between fear of falling and the number of falls between men and women. That is, although more men had fallen in the preceding 12 months, more women than men reported a fear of falling. Although it was beyond the scope of this study to explore this issue further, other possible explanations for this might include an overconfidence in men and a lower rate of falls in women because they respond to their increased fear of falling by adopting more cautious behavior (Hamel & Cavanagh, 2004). Despite these limitations, we are unaware of any previous research that has considered gender differences when comparing

outcomes of knee-replacement surgery, and the present results indicate that this might be a worthwhile area for future research.

Similar to Hatch, Gill-Body, and Portney (2003), we found that some participants needed reminders to distinguish between their level of balance confidence in performing each activity and their ability to perform the activity when administering the FES and ABC scales. Furthermore, many participants stated that although they felt confident in being able to perform the various tasks without falling or losing their balance, they now performed the activity more cautiously or differently. For example, they might have taken longer to complete the task or have negotiated steps with two feet per step instead of one. This raises an interesting issue—the current scales do not take into account whether participants perform the various tasks in a “normal” manner. It might be of interest for future research to distinguish between participants who are able to perform activities normally but choose not to and participants who are not able to perform activities normally. This might be particularly relevant for individuals with chronic medical conditions.

We included both the FES and ABC scales because neither scale had previously been used in people with knee replacements. Because there is a trend for knee-replacement surgery to be performed in younger and more active patients, we think that the ABC scale, with a wider continuum of activities, is perhaps more suitable (Myers et al., 1996). Because there was a potential for ceiling effects with both scales, though, particularly for male participants, other measures might need to be developed for higher functioning older adults. Although both scales have been validated for community-dwelling older adults, they have not been validated specifically for people with knee replacements. Nonetheless, a recent review of all fall-related psychological outcome measures has indicated that the ABC scale has satisfactory reliability, validity, and responsiveness in community-dwelling older adults (Jorstad et al., 2005). We have therefore now added some more challenging activities to this scale (for example, standing on a moving bus while carrying shopping) in an attempt to make it more appropriate for our higher functioning patients.

A limitation of the present study was that only one objective measure of function was used. Other clinical tests of balance and mobility, such as the timed up-and-go test and Berg's balance scale, might have shown stronger relationships with balance confidence (Li et al., 2002; Myers, Fletcher, Myers, & Sherk, 1998). Future studies should include more objective measures of function. Nonetheless, the present results are consistent with those of Rosengren, McAuley, and Mihalko (1998), who found a significant correlation of .43 between the Falls Efficacy Scale and walking speed in 55 healthy community-dwelling individuals, compared with .57 in this study. Unfortunately, Rosengren et al. did not examine gender.

Rejeski and colleagues (Rejeski, Craven, Ettinger, McFarlane, & Shumaker, 1996; Rejeski, Miller, Foy, Messier, & Rapp, 2001) previously found that self-efficacy beliefs were predictive of functional performance in participants with knee osteoarthritis (Rejeski et al., 1996) and knee pain (Rejeski et al., 2001). In contrast to the present study, those authors used task-specific efficacy measures (participants rated their level of certainty that they could complete stair-climbing and lifting tasks 2 to 10 times without stopping). In a later study (Rejeski et al., 2001), participants

were also followed for a 30-month period, and those who had low self-efficacy and poor function at baseline had the greatest decline in function. From those results, the authors concluded that self-efficacy beliefs appear to be most protective against functional decline in people who are challenged by deteriorating function. Although similar numbers of men and women participated, gender differences were not analyzed. Even so, such data reinforce the need to evaluate the influence that self-efficacy beliefs have on functional outcomes in people with chronic medical conditions, irrespective of whether the scales in the present study or more task-specific measures are used. It should, however, be noted that no causality can be inferred from the correlations reported in the present study. Longitudinal studies are needed to determine whether changes in balance confidence are associated with changes in function in people who have undergone knee-replacement surgery. It is also possible that lower efficacy is caused by decreasing function rather than decreasing function causing lower efficacy.

In summary, the results of the present study suggest that balance confidence is associated with function in people who have undergone knee-replacement surgery. As such, it might be worth including balance-confidence measures alongside physical outcome measures in this patient population. The gender differences found in both balance confidence and function warrant further exploration.

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