Brief Report

Characteristics of Older Adults With Self-Reported Stooping, Crouching, or Kneeling Difficulty

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Background. Stooping, crouching, and kneeling (SCK) are fundamental components of daily living tasks, and nearly a quarter of older adults report a lot of difficulty or inability to perform these movements. This study examined characteristics associated with SCK difficulty to explore underlying mechanisms and remediation strategies.

Methods. One hundred eighty-four older adults with no, low, or high SCK difficulty underwent a comprehensive laboratory visit at the University of Michigan.

Results. Twenty-one percent of participants (n = 39) reported a lot of difficulty or inability to stoop, crouch, or kneel. Characteristics independently associated with increasing SCK difficulty were self-reported leg joint limitations (OR = 3.84; 95% CI, 1.64–9.01), Activities-specific Balance Confidence Scale score (OR = 0.97; 95% CI, 0.95–0.99), and knee extension strength (OR = 0.72; 95% CI, 0.55–0.94).

Conclusions. Increasing SCK difficulty is associated with balance confidence as well as leg limitations. Remediation of SCK difficulty will likely require a program that encompasses both behavioral and physical issues.

Key Words: Stooping difficulty—Crouching difficulty—Kneeling difficulty.

Based on the Established Populations for Epidemiologic Studies of the Elderly (EPESE) baseline data, almost one quarter of community-dwelling older adults (24%) have a lot of difficulty or are unable to stoop, crouch, or kneel (1). Stooping, crouching, or kneeling (SCK) movements are an integral component of many daily living tasks, including picking up an object from the floor, reaching to low-lying shelves, and gardening. Limitations in stooping, crouching, or kneeling are associated with the increased likelihood of limitations in other lower-body functional tasks such as lifting and prolonged standing (2) and are associated with fall risk (3). Although SCK difficulty may significantly impact the overall mobility and independence of older adults, few data explore the mechanisms underlying SCK difficulty.

SCK movements require coordination of the whole body over a wide range of postures while maintaining balance. SCK movements in older adults may be limited by obesity as well as musculoskeletal impairments such as decreased lower extremity strength, and pain or stiffness-induced leg joint limitations (4–6). These movements may also be more difficult for older adults with decreased sensation and who have low balance confidence (i.e., confidence in the ability to maintain balance and avoid a fall) as both of these factors are associated with fall risk (7). Tasks requiring stooping, crouching, or kneeling can constitute a substantial postural threat, particularly for persons who have physical impairments.

Although SCK difficulty is prevalent and affects daily function, factors contributing to SCK difficulty have not been studied in a comprehensive manner. The goal of this cross-sectional study is to identify these factors and thus inform specific interventions that might impact SCK difficulty. We hypothesized that, compared to persons without SCK difficulty, those with increasing SCK difficulty would have greater impairments in musculoskeletal, sensory, and balance function, as well as in balance confidence.

Methods

Participants

The present study used baseline data from older adults enrolled in a 10-week balance training study (n = 184) (8). In that study, participants were recruited at local senior housing facilities and senior centers in Southeastern Michigan. Inclusion criteria were: (a) age 65 years or older; (b) at least mild balance impairment, as defined by a unipedal stance time (UST) of < 25 seconds or more than one error during a tandem walk; and (c) ability to stand and take at least one step unsupported by a device or person. Potential participants were screened by a nurse practitioner to exclude those with significant cognitive impairment (<24 on the Mini-Mental State Examination [MMSE]), unstable medical conditions, or severe pain upon weight bearing precluding participation. For the present study, enrollees were...
categorized based on their response to a single question on the EPESE questionnaire (9) in which they rated their ability to stoop, crouch, or kneel according to a five point difficulty scale: no difficulty \( n = 45 \), a little \( n = 50 \), some \( n = 50 \), a lot \( n = 22 \), or unable to do \( n = 17 \). For analysis, participants were categorized into three groups: (i) no SCK difficulty (if they reported no difficulty), (ii) low SCK difficulty (if they reported a little, or some difficulty), or (iii) high SCK difficulty (if they reported having a lot of difficulty or were unable to perform SCK tasks).

**Data Collection**

Factors contributing to increased SCK difficulty were determined from general descriptors (such as age, gender, and obesity), and both self-reported health and performance-based physical function. Obesity was operationalized as a body mass index (BMI) > 30 kg/m². Self-report (interview-based) measures were taken from the medical screening administered by a nurse practitioner. The total number of chronic medical conditions was ascertained by asking participants if they had a previous history of osteoarthritis, rheumatoid arthritis, osteoporosis, myocardial infarction, stroke, joint replacement, Parkinson’s disease, or peripheral neuropathy. The presence of dizziness was determined by asking participants if they had a current episode of light-headedness or vertigo, which would affect their balance, and the total number of prescribed medications was recorded from their medical screening. Depression was assessed by the short version of the Geriatric Depression Scale (GDS; range 0–15), and cognitive function was assessed by the Folstein MMSE (range 0–30) (10). Self-reported balance confidence was determined by the Activities-specific Balance Confidence Scale (ABC Scale; range 0–100) (11), and self-reported joint movement limitations were determined by the report of pain or stiffness in the back or leg (i.e., hip, knee, or ankle). Physical function measures included maximum isokinetic knee extension strength (hereafter referred to as knee extension strength), using an isokinetic dynamometer, at a velocity of 120 degrees per second (8), and two common functional tests of balance and mobility; the UST (12) and the Timed Up and Go (TUG) test (13). To normalize for body size, knee extension peak torque values were expressed as a percentage of the product of body weight (Newtons) and body height (meters). Participants who were unable to perform the UST \( n = 63/184 \), 34\% were coded as having a UST of 0 seconds. Impaired position sense was reported if participants had an abnormal position sense in the big toe of either one or both legs, as defined by having one or more repositioning errors within five trials (14). Fall-related variables were obtained by asking participants whether they had fallen within the past year, if yes) the number of falls incurred, and if medical treatment was sought for their injuries (i.e., injurious falls).

**Data Analysis**

All analyses were carried out in SPSS (version 15.0; SPSS Inc., Chicago, IL). The Kolmogorov–Smirnov test was used to test for normality when variables were continuous. Group differences were evaluated in continuous variables by either using a one-way analysis of variance when normally distributed (e.g., age and knee extension strength) or the nonparametric Kruskal–Wallis rank test when abnormally distributed. To determine group differences in dichotomous variables, the chi-square test for independence was performed. To examine statistical significance, both SCK Difficulty groups (e.g., low and high difficulty) were individually compared to the no SCK Difficulty group using Hochberg’s step-up method. To identify characteristics independently associated with self-reported SCK difficulty among older adults, an age-adjusted proportional odds model was used with a forward selection procedure, so as to capture the ordinal nature of self-reported SCK difficulty. The model included covariates that were statistically significant at \( p \leq .1 \) and included only participants with complete data on all measures \( n = 142/184, 77\% \). In a preliminary analysis, we found that none of the predictor variables were highly correlated (> .5), thus, indicating a low chance of colinearity in the model.

To determine whether the inclusion of the 42 participants with missing data biased the primary analysis of characteristics associated with SCK difficulty, a secondary analysis was conducted using t tests and chi-square tests, comparing participants included and those excluded in the proportional odds model. We found no significant increases in the percentage of missing data in the participants who reported a lot of difficulty or were unable to carry out SCK tasks (20\%), in comparison to the mean for the entire sample (23\%). No statistically significant differences were found between participants included and those excluded from the proportional odds model in all but one variable: age. Participants who were excluded from the final proportional odds model were older (80.3 ± 7.2 vs 77.5 ± 6.9, \( p = .021 \)). Given a lack of systematic differences between groups, results from the reduced sample are presented in this article.

**RESULTS**

Participants \( n = 184 \) had a mean age ± standard deviation of 78.5 ± 6.9 (range 65–92) and were predominantly female (78.3 \%). Twenty-one percent of all study participants reported a lot of SCK difficulty or were unable to stoop, crouch, or kneel; 23\% were obese; and 32\% had two or more chronic conditions.

Characteristics of participants with no SCK difficulty, low SCK difficulty, and high SCK difficulty are shown in Table 1. Comparison of the three groups revealed differences in gender, the number of chronic medical conditions, dizziness, GDS-short version score, ABC Scale score, self-reported back and leg joint limitations, knee extension strength, UST, TUG time, and incidence of more than two falls in the past year. There was a trend toward a group difference in the number of medications. There were no significant SCK group differences in age, obesity, MMSE score, impaired position sense, and incidence of injurious falls. Hochberg’s step-up post hoc analyses revealed that, in comparison to participants with no SCK difficulty, participants with low or high SCK difficulty had significantly lower ABC Scale score, more self-reported leg joint limitation, and decreased knee extension strength.

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Based on the findings from the primary analyses, the following predictor variables were included in the age-adjusted proportional odds model: gender, chronic medical conditions, dizziness, number of medications, GDS-short version, ABC Scale score, self-reported back and leg joint limitations, knee extension strength, UST, TUG time, and more. The proportional odds model demonstrated that participants who report leg joint limitations have 3.84 times the odds of reporting increased SCK difficulty, and that a unit increase in the ABC Scale score (i.e., 1.15 Nm for the average participant in this study) led to a 3% and 28% decrease in the odds of reporting increased SCK difficulty, respectively.

**DISCUSSION**

To the authors’ knowledge, no studies have comprehensively evaluated the mechanisms underlying self-reported SCK difficulty, despite the high prevalence of SCK difficulty in older adults. We hypothesized that, compared to persons without SCK difficulty, those with increased SCK difficulty would have greater impairments in musculoskeletal, sensory, balance function, as well as balance confidence. Results from the primary analyses are mostly in agreement with our hypothesis. However, obesity and impaired position sense did not differ between the groups.

Self-reported leg joint limitations, ABC Scale score, and knee extension strength were found to be independently associated with increased self-reported SCK difficulty in the age-adjusted proportional odds model. Most of these factors have been noted elsewhere to be associated with SCK difficulty as well as limitations in physical function. Leg joint limitations in older adults, as a result of knee and hip osteoarthritis, have been associated with greater limitations.
in physical function, including bending, kneeling, and stooping (15). Balance confidence is strongly associated with self-reported physical function (16) and physical performance (e.g., gait speed, timed hand function) measures (17). Reduced knee extension strength has been associated with limited function in daily activities such as rising from a chair or walking (18,19). More specifically, the generation of both increased momentum and stable and controlled movements while rising from a chair, may be limited by knee extension strength (18).

These findings may have implications for refining clinical interventions for older adults with SCK difficulty. Physical capabilities, such as knee extension strength, are often a focus of rehabilitation treatment to help people perform daily living tasks. This study suggests that interventions that address leg joint limitations and balance confidence may be especially important. Leg joint limitations can be addressed by teaching task-specific strategies such as using support surfaces for assistance in SCK movements or customized whole-body movement strategies. Practice of task-specific strategies is an important component of improving self-efficacy and thus could also positively impact low balance confidence (20). Analogously, older adult congregate housing residents with observed performance difficulties in bath transfers were also more likely to have leg range-of-motion limitations and low balance confidence (21). Finally, given the shared characteristics between older adults with increased SCK difficulty and older adults with a history of falls (including range-of-motion limitations in the back, and lower extremity strength) (22–24), reducing SCK difficulty may also reduce fall risk. Thus, the present study suggests that increasing SCK difficulty is associated with behavioral as well as physical limitations, and that interventions to reduce SCK difficulty will require a broader program that goes beyond enhancing physical function, to include behavioral and strategy training (21). We believe that interventions should be designed specifically for SCK difficulty, just as we designed interventions for rising from a bed or chair or from the floor (25,26). SCK are key functional tasks that may be amenable to training. SCK is a very high level, complex, balance task that requires sufficient joint motion and strength, similar to sit-to-stand tasks.

This study had limitations. Participants were predominately female, did not have cognitive impairments, were selected for having functional balance impairments, and did not have objective measures of active joint ranges of motion. Because of the selection criteria for the balance training program, the fittest older adults who were participating in a regular exercise program and the frailest older adults with severe lower extremity pain or assistive device dependency were excluded. Despite limitations in generalizability, the recruited sample represents persons who are an ideal target group for strategy training, as they are at fall risk and have little cognitive impairment that would preclude learning and using new strategies. Future research should examine older adults with a broader range of physical function.

Finally, the importance of SCK is already evident in batteries of mobility and balance performance such as the Physical Performance Test (27) and the Berg Balance Scale (28), which include bending over to pick up objects from the ground. Nevertheless, an objective measure of difficulty in bending over to pick up objects is still lacking, as these batteries consider only time or ability. A biomechanical assessment of stability while bending over to pick up objects may elucidate the mechanism underlying increased fall risk in older adults with SCK difficulty.

This study had several strengths. It provided a comprehensive examination of characteristics associated with increasing SCK difficulty among older adults, whereas previous studies had examined the role of specific deficits such as muscle loss or back pain or stiffness. Thus, a wider series of factors appear to be associated with increasing SCK difficulty among older adults and suggest the need for a broader intervention program to reduce SCK difficulty.

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All authors participated in study concept and design. Manuel Hernandez was responsible for data acquisition and worked with Susan Murphy on data analysis. All authors assisted with data interpretation and manuscript preparation.

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