# Gender Differences in Range of Motion in Older Adults

Jean A. Kalscheur, MS, OTR/L
Patricia S. Costello, PhD
Lynnda J. Emery, EdD, OTR/L

**ABSTRACT.** This study had three purposes: to compare active neck and upper extremity range of motion (ROM) in women and men in context of expected values, to examine ROM decrease with age in women and men, and to predict age-related ROM in older women and men. Sixty-one women and 25 men who lived independently in the community were measured. ROM was less for older women and older men when compared to expected values. ROM declined with age for both women and men; however, women maintained greater range. The estimated regression coefficients can be used to predict ROM in older women and men. Clinical implications in evaluation are discussed. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress.com> Website: <http://www.HaworthPress.com>* 

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Jean A. Kalscheur is Associate Professor, Department of Occupational Therapy, Patricia S. Costello is Professor, Department of Mathematics and Statistics, and Lynnda J. Emery is Professor, Department of Occupational Therapy, all at Eastern Kentucky University.

Address correspondence to: Ms. Jean A. Kalscheur, Eastern Kentucky University, Lancaster 521/Dizney 103, Richmond, KY 40475 (E-mail: Jean.Kalscheur@eku.edu).

The authors would like to thank Jill Blandford Greenwell for her assistance with word processing.

Physical & Occupational Therapy in Geriatrics, Vol. 22(1) 2003
http://www.haworthpress.com/web/POTG

Digital Object Identifier: 10.1300/J148v22n01_05

**KEYWORDS.** Gerontology, aging, older women, older men, physiological aspects of aging

## INTRODUCTION

Range of motion (ROM) influences a person's occupational performance and function and is a primary neuromusculoskeletal performance component routinely evaluated by physical and occupational therapists. While it is generally assumed that ROM declines with age (Bonder & Goodman, 1995; Kauffmann, 1994; Levy, 1993), age-related changes in ROM have only been partially studied (Bassey, Morgan, Dallosso, & Ebrahim, 1989; Cunningham, Paterson, Himann, & Rechnitzer, 1993; Kalscheur, Emery, & Costello, 1999). The literature is sparse on gender differences in ROM for older persons.

Clinical observations suggest that as neuromusculoskeletal values decline, functional limitations are likely to follow (Jette, Branch, & Berlin, 1990; Levy, 1993). Research has documented that the disease process decreases upper and lower extremity range of motion and decreases performance in basic and instrumental activities of daily living (Holland, Tanaka, Shigematsu, & Nakagaichi, 2002). It is therefore important for therapists to recognize the typical aging process, and to distinguish the aging process from the disease process (Hasselkus, 1993; Kaye, Oken, Howieson, Howieson, Holm, & Dennison, 1994). To better document range of motion changes involved in the aging process, this study had three purposes:

1. to compare active neck and upper extremity ROM in women and men in context of expected values,
2. to examine ROM decrease with age in men and women, and
3. to predict age-related ROM changes in older women and men.

## METHODS

### Participants

Potential participants were contacted via local church and senior citizen groups in small, rural Midwest communities. The inclusion criteria were: (1) 62 years of age or older, (2) living independently in the community, (3) available on the day of testing for approximately one hour.

(4) willing to complete a personal history form, and (5) able to provide consent and submit voluntarily to the measurement protocol.

### *Measurement Instruments and Protocol*

Standard plastic goniometers were used to take measurements following the Neutral Zero Method. Data collectors were trained over four sessions to establish reliability. Practice in all sessions continued until all raters achieved two repeated measures within 4 degrees or less for all measures taken. Twenty-four measures were taken using a specified protocol (Norkin & White, 1985). Measurement was completed using recommended test position, stabilization, end-feel, and goniometric alignment.

### *Procedure for Data Collection*

Participants wore garments that exposed the regions for testing. Inquiries about painful conditions, palpation, and visual inspection were used to screen participants prior to measurement. Measurements were completed on each participant in one session using the established test protocol.

### *Procedure for Data Analysis*

Data were analyzed on the Alpha computer using SAS statistical analysis software (SAS Institute Inc., 1990). The comparison measures were those established by the American Academy of Orthopaedic Surgeons (AAOS) (1965). To compare women and men for expected range of motion, mean end range and standard deviations were calculated. To further compare range of motion between women and men, the Wilcoxon rank sum test was used. Finally, to predict age-related range of motion changes in older women and men, linear regression coefficients were calculated.

## *RESULTS*

### *Participants*

Participants included 61 women and 25 men who met the inclusion criteria; all were Caucasian. Their occupations were reported as main-

taining a household, volunteer work, and employed part-time as cashiers, cooks, clerks, and secretaries. The youngest woman was 63.0 years of age; the oldest was 85.3. The females had a median age of 72.75 years and the mean was 73.07 ± 6.16 years. Using five year intervals, the age distribution of the female participants across the age range was fairly even: 15 women were between 63.0 and 67.9 years; 16 were between 68.0 and 72.9 years; 16 were between 73.0 and 77.9 years; 10 were between 78.0 and 82.9 years; and 4 were between 83.0 and 85.3 years. The youngest man was 65.9 years of age; the oldest was 86.0. The males had a median age of 72.42 years and the mean was 73.32 ± 5.88 years. Using five year intervals, the age distribution of the male participants across the age range was also fairly even: 5 men were between 65.9 and 67.9 years; 9 were between 68.0 and 72.9 years; 5 were between 73.0 and 77.9 years; 4 were between 78.0 and 82.9 years; and 2 were between 83.0 and 86.0 years.

### *ROM Differences Between Men and Women*

Mean end range and standard deviation were calculated for each measure for the males and females separately, and are presented in Table 1. The expected end range of motion as published by the AAOS (1965) appears in the second column. This provided preliminary comparison of males and females in the context of expected end range values. The Wilcoxon rank sum test was applied to determine if statistically significant differences existed between the males and females (Table 1). A nonparametric test was used because there was evidence that some of the range of motion scores were not normally distributed. To maintain an experiment wise error rate of 5% given that twenty-four Wilcoxon rank sum tests were performed, Bonferroni's Inequality, which states that the results are only significant for p-values that are less than .0021, was used. Using this criterion, the average end range for females is statistically larger than that of males for neck extension ($Z = -3.10$, $p = .002$), right shoulder abduction ($Z = -3.27$, $p = .001$), and both right ($Z = -3.62$, $p = .000$) and left ($Z = -3.65$, $p = .000$) elbow flexion. If a comparison wise error rate of 5% is used, there is also evidence that the average end range for females is statistically larger than that of males for left neck lateral flexion ($Z = -2.44$, $p = .015$), both right ($Z = -2.43$, $p = .015$) and left ($Z = -2.07$, $p = .039$) shoulder flexion, both right ($Z = -2.84$, $p = .005$) and left ($Z = -2.83$, $p = .005$) shoulder internal rotation, both right ($Z = -2.69$, $p = .007$) and left ($Z = -2.00$, $p = .045$) shoulder external rotation, both right ($Z = -2.83$, $p = .005$) and left ($Z = -2.81$, $p = .005$) forearm pronation, right wrist flexion ($Z = -2.06$, $p = .040$), and left wrist extension ($Z = -2.18$, $p = .029$).

TABLE 1. Range of Motion Measures for Expected End Range, Mean, and Standard Deviation and for Women and Men

| Measurement | Expected End Range (degrees) | Mean End Range (degrees) (Women) | Mean End Range (degrees) (Men) | Standard Deviation (Women) | Standard Deviation (Men) |
|---|---|---|---|---|---|
| Neck Flexion | 45 | 42.15 | 40.92 | 11.38 | 11.96 |
| Neck Extension** | 45 | 40.67 | 29.72 | 13.23 | 14.31 |
| Neck Lateral Flexion | | | | | |
| Right | 45 | 26.00 | 22.48 | 8.72 | 6.29 |
| Left* | 45 | 26.41 | 21.68 | 7.67 | 7.70 |
| Neck Rotation | | | | | |
| Right | 60 | 61.82 | 58.84 | 11.88 | 10.16 |
| Left | 60 | 56.87 | 56.92 | 10.33 | 10.79 |
| Shoulder Abduction | | | | | |
| Right** | 180 | 154.62 | 130.52 | 21.37 | 35.26 |
| Left | 180 | 150.25 | 141.12 | 21.65 | 22.95 |
| Shoulder Flexion | | | | | |
| Right* | 180 | 158.23 | 151.76 | 19.55 | 16.53 |
| Left* | 180 | 159.20 | 152.68 | 8.73 | 16.42 |
| Shoulder Internal Rotation | | | | | |
| Right* | 70 | 52.92 | 45.60 | 8.99 | 9.47 |
| Left* | 70 | 53.74 | 47.32 | 9.94 | 8.63 |
| Shoulder External Rotation | | | | | |
| Right* | 90 | 76.05 | 66.36 | 16.31 | 12.55 |
| Left* | 90 | 72.44 | 65.48 | 15.37 | 14.16 |
| Elbow Flexion | | | | | |
| Right** | 150 | 148.61 | 142.48 | 4.72 | 7.22 |
| Left** | 150 | 149.39 | 143.20 | 5.77 | 6.37 |
| Forearm Supination | | | | | |
| Right | 80 | 86.89 | 84.68 | 8.49 | 8.61 |
| Left | 80 | 89.84 | 90.08 | 4.29 | 15.65 |
| Forearm Pronation | | | | | |
| Right* | 80 | 87.16 | 81.68 | 7.81 | 7.41 |
| Left* | 80 | 88.48 | 84.20 | 5.58 | 11.08 |
| Wrist Flexion | | | | | |
| Right* | 80 | 71.03 | 66.04 | 8.78 | 9.34 |
| Left | 80 | 68.10 | 63.84 | 8.40 | 8.03 |
| Wrist Extension | | | | | |
| Right | 70 | 59.02 | 57.36 | 8.57 | 10.90 |
| Left* | 70 | 64.23 | 58.96 | 8.80 | 10.92 |

Note: Data for Expected End Range from *Joint Motion: Method of Measuring and Recording*, by American Academy of Orthopaedic Surgeons, 1965. Women participants N = 61; male participants N = 25. *$p < .05$ (comparison wise error rate of 5%) **$p < .0021$ (experiment wise error rate of 5%). All statistically significant differences show females ROM greater than males.

### *ROM Decrease with Age in Men and Women*

To determine if active ROM decreased with age and if this change differed for males and females, multiple linear regression analyses were performed with age, gender, and age-gender interaction as the independent variables and ROM as the dependent variable. First, a t-test was performed to determine if there was an interaction between age and gender. There was a significant interaction between age and gender for both left forearm supination ($t = -2.90$, $p = 0.005$) and for right wrist flexion ($t = 2.26$, $p = 0.026$). This was unfortunate because a significant interaction makes it more difficult to determine if there is a significant relationship between ROM and age for males and females.

For the remaining ROM, multiple linear regression analyses were performed with age and gender as the independent variables and ROM as the dependent variable. The estimated regression coefficients (both intercept and slope), t-values (for age and gender), and p-values (for age and gender) are presented in Table 2. Of the 22 measurements used (not including left forearm supination and right wrist flexion which had significant age-gender interaction), 10 changed with age to a statistically significant degree. These were: neck extension, left neck lateral flexion, right neck rotation, right shoulder abduction, right shoulder flexion, right and left shoulder external rotation, right forearm supination and pronation, and right wrist extension. For these 10 ranges, the amount of statistically significant ROM decline that occurs each year as age progresses varies from an average of 0.31 degrees per year of age for both right forearm pronation and right forearm supination to an average of 1.09 degrees per year of age for right shoulder external rotation.

In addition, of the 22 measurements used (not including left forearm supination and right wrist flexion which had significant age-gender interaction), 14 differed for gender to a statistically significant degree. These were: neck extension; left neck lateral flexion; right shoulder abduction; left shoulder flexion; right and left shoulder internal rotation; right and left shoulder external rotation; right and left elbow flexion; right and left forearm pronation; left wrist flexion; and left wrist extension. These findings are essentially the same as those obtained using the Wilcoxon rank sum test with a comparison wise error rate of 5%. The only differences are that right shoulder flexion was determined to be significant using the Wilcoxon rank sum test but was not significant in the regression analysis; right wrist flexion was also significant using the Wilcoxon rank sum test but could not be tested using the regression analysis because age and gender had a significant interaction; and left

TABLE 2. Linear Regression Coefficients of Motions by Age or Gender

| Movement | *Estimated Regression Coefficient* | | Age | | Gender | |
|---|---|---|---|---|---|---|
| | Intercept | Slope | t-value | p-value | t-value | p-value |
| Neck Flexion | | | −0.12 | 0.904 | −0.44 | 0.659 |
| Male | 42.769 | −0.025 | | | | |
| Female | 43.990 | −0.025 | | | | |
| Neck Extension | | | −2.34 | 0.022* | −3.45 | 0.001* |
| Male | 70.259 | −0.553 | | | | |
| Female | 81.073 | −0.553 | | | | |
| Neck Lateral Flexion | | | | | | |
| Right | | | −1.16 | 0.248 | −1.81 | 0.074 |
| Male | 34.859 | −0.169 | | | | |
| Female | 38.337 | −0.169 | | | | |
| Left | | | −2.62 | 0.011* | −2.63 | 0.010* |
| Male | 47.217 | −0.348 | | | | |
| Female | 51.860 | −0.348 | | | | |
| Neck Rotation | | | | | | |
| Right | | | −2.78 | 0.007* | −1.09 | 0.279 |
| Male | 99.036 | −0.548 | | | | |
| Female | 101.879 | −0.548 | | | | |
| Left | | | −1.49 | 0.141 | 0.05 | 0.961 |
| Male | 77.240 | −0.277 | | | | |
| Female | 77.120 | −0.277 | | | | |
| Shoulder Abduction | | | | | | |
| Right | | | −2.35 | 0.021* | −3.95 | 0.000* |
| Male | 209.103 | −1.072 | | | | |
| Female | 232.939 | −1.072 | | | | |
| Left | | | −1.83 | 0.071 | −.173 | 0.087 |
| Male | 193.291 | −0.712 | | | | |
| Female | 202.240 | −0.712 | | | | |
| Shoulder Flexion | | | | | | |
| Right | | | −2.36 | 0.021* | −1.45 | 0.151 |
| Male | 208.438 | −0.773 | | | | |
| Female | 214.715 | −0.773 | | | | |
| Left | | | −1.56 | 0.122 | −2.38 | 0.019* |
| Male | 176.021 | −0.318 | | | | |
| Female | 182.458 | −0.318 | | | | |

TABLE 2 (continued)

| Movement | *Estimated Regression Coefficient* | | Age | | Gender | |
|---|---|---|---|---|---|---|
| | Intercept | Slope | t-value | p-value | t-value | p-value |
| Shoulder Internal Rotation | | | | | | |
| Right | | | −1.12 | 0.264 | −3.36 | 0.001* |
| Male | 59.074 | −0.184 | | | | |
| Female | 66.346 | −0.184 | | | | |
| Left | | | 0.90 | 0.369 | −2.83 | 0.006* |
| Male | 35.913 | 0.156 | | | | |
| Female | 42.369 | 0.156 | | | | |
| Shoulder External Rotation | | | | | | |
| Right | | | −4.37 | 0.000* | −2.85 | 0.006* |
| Male | 146.262 | −1.090 | | | | |
| Female | 155.679 | −1.090 | | | | |
| Left | | | −3.11 | 0.003* | −1.99 | 0.050* |
| Male | 124.046 | −0.799 | | | | |
| Female | 130.810 | −0.799 | | | | |
| Elbow Flexion | | | | | | |
| Right | | | −1.65 | 0.103 | −4.66 | 0.000* |
| Male | 154.415 | −0.163 | | | | |
| Female | 160.501 | −0.163 | | | | |
| Left | | | −1.57 | 0.119 | −4.39 | 0.000* |
| Male | 155.400 | −0.166 | | | | |
| Female | 161.552 | −0.166 | | | | |
| Forearm Supination | | | | | | |
| Right | | | −2.09 | 0.040* | −1.07 | 0.287 |
| Male | 107.626 | −0.313 | | | | |
| Female | 109.753 | −0.313 | | | | |
| Left | | | ** | | ** | |
| Male | 165.619 | −1.030 | | | | |
| Female | 90.919 | −0.015 | | | | |
| Forearm Pronation | | | | | | |
| Right | | | −2.32 | 0.023* | −3.03 | 0.003* |
| Male | 104.585 | −0.312 | | | | |
| Female | 109.991 | −0.312 | | | | |
| Left | | | −1.33 | 0.187 | −2.36 | 0.020* |
| Male | 97.400 | −0.180 | | | | |
| Female | 101.631 | −0.180 | | | | |

TABLE 2 (continued)

| Movement | Estimated Regression Coefficient | | Age | | Gender | |
|---|---|---|---|---|---|---|
| | Intercept | Slope | t-value | p-value | t-value | p-value |
| Wrist Flexion | | | | | | |
| Right | | | *** | | *** | |
| Male | 42.723 | 0.318 | | | | |
| Female | 105.740 | −0.475 | | | | |
| Left | | | −1.14 | 0.260 | −2.15 | 0.035* |
| Male | 78.959 | −0.206 | | | | |
| Female | 83.166 | −0.206 | | | | |
| Wrist Extension | | | | | | |
| Right | | | −2.16 | 0.034* | −0.73 | 0.470 |
| Male | 83.191 | −0.352 | | | | |
| Female | 84.760 | −0.352 | | | | |
| Left | | | −1.14 | 0.260 | −2.33 | 0.022* |
| Male | 73.052 | −0.192 | | | | |
| Female | 78.273 | −0.192 | | | | |

*Note:* $^*p < .05$

wrist flexion was determined to be significant using the regression analysis but was not significant when the Wilcoxon rank sum test was used. The results from the Wilcoxon rank sum test are more reliable because there was evidence that some of the ranges were not normally distributed and the Wilcoxon rank sum test does not assume that the data are normally distributed.

### *Predicting ROM in Older Men and Women*

The estimated regression coefficients can be used to predict the ROM for any woman between the ages of 63 and 85 and any man between the ages of 66 and 86. However, there can be much variability among the actual ROM that is observed for individual women and men. For example, neck extension for a woman of 70 years, using the regression equation, is predicted to be 42.37 degrees because 81.073 - 0.553 (70) = 42.37. Yet, the two women in this study who were aged 70 had actual neck extension measurements of 27 degrees and 40 degrees. The predicted range of motions for males and females aged 65, 70, 75, 80, and 85 was calculated using the estimated regression coefficients and the results are given in Table 3.

TABLE 3. Predicted Range of Motion at Various Ages

| Movement | Age | | | | |
|---|---|---|---|---|---|
| | 65 | 70 | 75 | 80 | 85 |
| Neck Flexion | | | | | |
| Male | 41.13 | 41.00 | 40.88 | 40.75 | 40.63 |
| Female | 42.35 | 42.23 | 42.10 | 41.97 | 41.85 |
| Neck Extension | | | | | |
| Male | 34.32 | 31.56 | 28.79 | 26.03 | 23.26 |
| Female | 45.14 | 42.37 | 39.61 | 36.84 | 34.08 |
| Neck Lateral Flexion | | | | | |
| Right | | | | | |
| Male | 23.89 | 23.04 | 22.20 | 21.35 | 20.51 |
| Female | 27.36 | 26.52 | 25.67 | 24.83 | 23.99 |
| Left | | | | | |
| Male | 24.58 | 22.84 | 21.10 | 19.35 | 17.61 |
| Female | 29.22 | 27.48 | 25.74 | 24.00 | 22.26 |
| Neck Rotation | | | | | |
| Right | | | | | |
| Male | 63.40 | 60.66 | 57.92 | 55.18 | 52.44 |
| Female | 66.24 | 63.50 | 60.76 | 58.02 | 55.28 |
| Left | | | | | |
| Male | 59.22 | 57.84 | 56.46 | 55.07 | 53.68 |
| Female | 59.11 | 57.72 | 56.33 | 54.95 | 53.56 |
| Shoulder Abduction | | | | | |
| Right | | | | | |
| Male | 139.44 | 134.08 | 128.72 | 123.36 | 118.00 |
| Female | 163.28 | 157.91 | 152.56 | 147.20 | 141.84 |
| Left | | | | | |
| Male | 147.04 | 143.48 | 139.93 | 136.37 | 132.81 |
| Female | 155.99 | 152.43 | 148.87 | 145.32 | 141.76 |
| Shoulder Flexion | | | | | |
| Right | | | | | |
| Male | 158.19 | 154.33 | 150.46 | 146.60 | 142.73 |
| Female | 164.47 | 160.60 | 156.74 | 152.87 | 149.01 |
| Left | | | | | |
| Male | 155.33 | 153.74 | 152.15 | 150.55 | 148.96 |
| Female | 161.77 | 160.17 | 158.58 | 156.99 | 155.40 |
| Shoulder Internal Rotation | | | | | |
| Right | | | | | |
| Male | 47.13 | 46.21 | 45.29 | 44.37 | 43.45 |
| Female | 54.40 | 53.48 | 52.56 | 51.65 | 50.73 |
| Left | | | | | |
| Male | 46.03 | 46.80 | 47.58 | 48.36 | 49.14 |
| Female | 52.48 | 53.26 | 54.04 | 54.82 | 55.59 |

TABLE 3 (continued)

| Movement | Age 65 | 70 | 75 | 80 | 85 |
|---|---|---|---|---|---|
| Shoulder External Rotation | | | | | |
| Right | | | | | |
| Male | 75.43 | 69.98 | 64.53 | 59.08 | 53.63 |
| Female | 84.85 | 79.40 | 73.95 | 68.50 | 63.05 |
| Left | | | | | |
| Male | 72.13 | 68.13 | 64.14 | 60.15 | 56.15 |
| Female | 78.89 | 74.90 | 70.90 | 66.91 | 62.91 |
| Elbow Flexion | | | | | |
| Right | | | | | |
| Male | 143.83 | 143.02 | 142.21 | 141.39 | 140.58 |
| Female | 149.92 | 149.11 | 148.29 | 147.48 | 146.67 |
| Left | | | | | |
| Male | 144.58 | 143.75 | 142.92 | 142.09 | 121.26 |
| Female | 150.74 | 149.90 | 149.07 | 148.24 | 147.41 |
| Forearm Supination | | | | | |
| Right | | | | | |
| Male | 87.28 | 85.72 | 84.15 | 82.59 | 81.03 |
| Female | 89.41 | 87.85 | 86.28 | 84.72 | 83.15 |
| Left | | | | | |
| Male | 98.65 | 93.50 | 88.35 | 83.20 | 78.05 |
| Female | 89.96 | 89.88 | 89.81 | 89.73 | 89.66 |
| Forearm Pronation | | | | | |
| Right | | | | | |
| Male | 84.28 | 82.72 | 81.16 | 79.59 | 78.03 |
| Female | 89.69 | 88.12 | 86.56 | 85.00 | 83.44 |
| Left | | | | | |
| Male | 85.70 | 84.80 | 83.90 | 83.00 | 82.10 |
| Female | 89.93 | 89.03 | 88.13 | 87.23 | 86.33 |
| Wrist Flexion | | | | | |
| Right | | | | | |
| Male | 63.39 | 64.98 | 66.57 | 68.16 | 69.75 |
| Female | 74.87 | 72.49 | 70.12 | 67.74 | 65.37 |
| Left | | | | | |
| Male | 65.56 | 64.53 | 63.49 | 62.46 | 61.43 |
| Female | 69.76 | 68.73 | 67.70 | 66.67 | 65.64 |
| Wrist Extension | | | | | |
| Right | | | | | |
| Male | 60.29 | 58.53 | 56.77 | 55.01 | 53.25 |
| Female | 61.86 | 60.10 | 58.34 | 56.58 | 54.81 |
| Left | | | | | |
| Male | 60.56 | 59.60 | 58.64 | 57.68 | 56.72 |
| Female | 65.78 | 64.82 | 63.86 | 62.90 | 61.94 |

## DISCUSSION

This study provides results that range of motion decreases as part of the typical aging process (Bassey, Morgan, Dallosso, & Ebrahim, 1989; Cunningham, Paterson, Himann, & Rechnitzer, 1993; Kalscheur, Emery, & Costello, 1999). Therapists can expect range of motion decline with age as well as gender differences, with women having greater range than men, on average. The regression coefficients can be used to predict ROM for any woman between 63-85 and any man between 66-86 years of age.

These measurements are for individual joint motions thought to contribute to functional performance in upper extremity activities. Participants lived independently in the community and were without reported impairment and disease process. This expected baseline information is important for therapists because it establishes a comparison from which more in-depth evaluations of clients with impairment and disease process can be done.

In addition to typical client evaluation, established measurements of expected ROM on older women and men may assist therapists in other ways. Outcomes research on the efficacy of treatment for improved functional ROM with use of comparison groups may be enhanced (Knebl, Shores, Gamber, Gray, & Herron, 2002). Additionally, these upper extremity and neck measures can be examined in combination using flexible electrogoniometry to examine composite range needs for functional performance (Rowe, Myles, Walker, & Nutton, 2000).

In summary, the expected decline in range of motion in women and men as they age is reported. While these values should not be used to limit an individual client, these typical measurements can assist therapists in making decisions about intervention to improve functional performance. Replication of this study may provide for stronger establishment of norms by age and gender that are needed to distinguish the aging process from the disease process (Hasselkus, 1993; Kaye et al., 1994).

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