Age-related Deterioration in Flexibility is Associated with Health-related Quality of Life in Nonagenarians

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ABSTRACT

Background and Purpose: Studies indicate that age is associated with deterioration in physical function and a concomitant decrease in health-related quality of life (HRQL). The contribution of physical function to HRQL in nonagenarians (ages 90-99) is unknown. The purposes of this study were to examine age-related changes in physical function and HRQL among community-dwelling nonagenarians and to determine the relationship between their physical function and HRQL. **Methods:** Seventy-four community-dwelling nonagenarians participated. The Continuous Scale Physical Function Performance Test-10 (CS-PFP10) was used to measure their physical function and the Short Form (SF)-36 was used to measure their HRQL. Pearson correlations were used to assess associations among age, physical function, and HRQL scores. **Results:** Age was inversely associated with the upper body flexibility ($r = -.365$, $p = .001$) subscale of the CS-PFP10, but not significantly associated with any other physical function or HRQL score. Significant associations between physical function and HRQL were limited to those between upper body flexibility and the physical function subscale ($r = .424$, $p < .001$) and physical function component summary score ($r = .376$, $p = .001$) of the SF-36. **Conclusion**: These data suggest that upper body flexibility continues to decline during the 10th decade of life and has implications for influence on aspects of HRQL in this segment of the population.

Key Words: physical function, physical fitness, well-being

INTRODUCTION

Physical function is important as it relates to a person's ability to perform basic and instrumental activities of daily living (ADLs). Basic ADLs can be defined by tasks such as dressing, walking, standing up from a chair, going up and down stairs, bending, lifting, eating, stooping, carrying objects, grooming, and running. Moreover, people's ability to execute these basic tasks without assistance is likely to influence performance of discretionary or instrumental ADLs, such as housekeeping, reaching into a high cabinet for cooking, gardening, traveling, and doing errands. Thus, optimizing physical function throughout the lifespan is clearly important for maintaining independence and optimizing quality of life.[1-3]

Regardless of the manner in which function is measured, evidence consistently demonstrates a strong association between physical function and health-related quality of life (HRQL) in older adults.[4,5] Health-related quality of life can be defined as an evaluation of one's health as related to function and well-being and within contexts of physical, psychological, social, and somatic areas.[6,7] Evidence suggests that HRQL worsens with age,[8,9] and is associated with functional level and the ability to remain independent with daily activities. This association appears regardless of the presence of co-morbidities.[10]

Unfortunately, information regarding age-related deteriorations in physical function and HRQL is limited, for the most part, to data from individuals in the seventh and eighth decades of life.[5,11-15] Few studies describe age-related changes in physical function and HRQL among individuals 90 years or older. Demura et al reported that the oldest-old (age ≥ 85 years) who were high functioning attributed their relatively high HRQL to the maintenance of social involvement.[14] Blazer et al indicated that depressive symptoms among the oldest-old are associated with physical disability, cognitive impairment, and lack of social support.[16] However, little else is known about the association between specific measures of physical function and HRQL in nonagenarians.

As the oldest-old represent the fastest growing segment of society within the United States,[17-19] further understanding is needed of the association between physical function and HRQL in this under-investigated subgroup of the older adult population. Therefore, the purposes of this investigation were to examine age-related changes in physical function and HRQL among a random sample of community-dwelling nonagenarians and to determine the relationship between their physical function and HRQL. For this older population, we hypothesized further age-related decrements in physical function and HRQL and a close association between physical function and HRQL.

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METHODS

The procedures described herein were approved by the institutional review boards of Louisiana State University, the Louisiana State University Health Sciences Center, and Pennington Biomedical Research Center.

Participants

The data presented in this study are from the nonagenarian participants of the population-based Louisiana Healthy Aging Study. The Louisiana Healthy Aging Study included adults 60 years of age and older who were sampled at random by way of the Medicare Beneficiary Enrollment Data file 2002 and Louisiana Voters Registration file 2000. For all sampled individuals in the Louisiana Health Aging Study, an introductory letter with a pre-paid postcard was mailed to the potential participants by the sampling core. If there was no response from the initial attempt, a follow-up letter was sent after 2 weeks. Potential subjects who did not respond to the mailing were contacted by phone to determine their interest in study participation. For the entire study, participation rate declined with age ($p < .001$). There was a participation rate of 41.83 % in 60 to 89 years olds as compared to 27.76 % in age group 90 years and older.

Inclusion criteria for this study were an age of 90 years and older, residence within a 40-mile radius of Baton Rouge, LA, and achievement of a score of 25 or more on the Mini Mental State Examination. Participants were excluded if they were blind, wheelchair bound, categorized as American Heart Association Class D or unstable Class C, or if they were otherwise deemed to be at high risk for adverse responses during exercise in accordance with the American College of Sports Medicine guidelines.[20]

Eighty-nine nonagenarians volunteered for the study. Among those who volunteered, 10 failed to meet all of the inclusion/exclusion criteria; 3 were wheelchair bound, and 2 were American Heart Association Class D. Additionally, 5 of the volunteers withdrew consent before completion of testing. Therefore, complete data are available for 74 participants.

A nurse practitioner obtained participant medical histories by interview and performed a thorough physical examination. The histories were reviewed for prevalence of disabling diseases and conditions, and current medication use. Diseases were classified as being cardiovascular (eg, atherosclerosis), neurological (eg, Parkinsonism), orthopaedic (eg, osteoarthritis), metabolic (eg, hypertension, diabetes), or other (eg, cancer). Therefore, participants reported a prevalence of between 0 and 5 categories of diseases/conditions.

Instruments

The Short Form (SF)-36 (version 2.0) was used to assess HRQL in the study sample.[21, 22] This measure has been validated for assessing HRQL in persons over 65 years of age. The SF-36 version 2.0 contains 8 subscales including physical function, role physical, bodily pain, general health, vitality, social function, mental health, and role emotional, as well as physical and mental component summary scores (Figure 1). The test provides scale scores for each domain that range from 0 to 100, with a higher score indicating better perceptions of functioning.

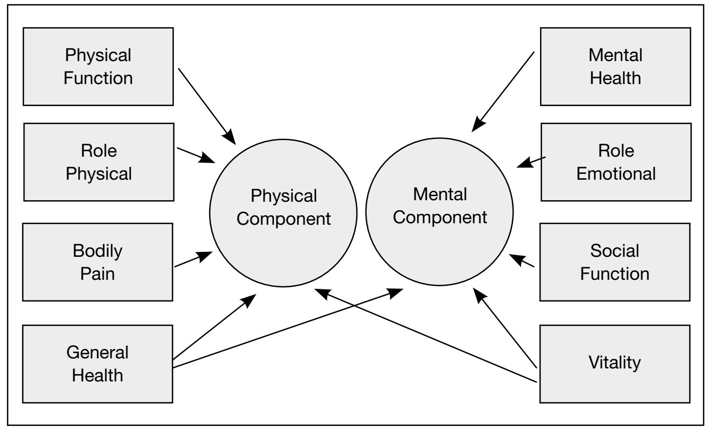

Figure 1. SF-36 version 2.0 Subscales.

A reduced version of the Continuous-Scale Physical Function Performance Test (CS-PFP10)[4, 23] was used to assess performance-based physical function. The CS-PFP10 required the participant to perform a series of ADL based activities ordered from easiest to most difficult in a standard fashion. The time taken to complete the tasks, distance covered, and/or weight carried was recorded and converted to a set of continuous-scale function scores. The test battery provided scores in 5 physical function domains: upper body strength, lower body strength, upper body flexibility, balance and coordination, endurance, and a total CS-PFP10 score. The reproducibility of the CS-PFP10 scores and subscales have demonstrated intraclass correlation coefficients in the range of $r = .79$ to .94.[4] In addition, the test has been validated for use in this population.[24] Participants were given specific directions for each task and they were instructed to perform each task safely, but to work at maximal effort. Scores ranged from 0 to 100, with higher scores reflecting a higher functional level. More detailed information regarding administration of the CS-PFP is available in Cress et al[4] or the World Wide Web at: http://www.coe.uga.edu/cs-pfp/cspfp_test.html (date of last access: February 9, 2006).

Procedures

Participants reported to the laboratory on 2 occasions separated by approximately 1 week. The first session included obtaining written informed consent, a review of medical history, and the SF-36 version 2.0. The second session involved the CS-PFP10. Each session lasted between 60 and 90 minutes.

Statistical Analysis

All data were analyzed using SPSS 11.0 system for Windows. Log transformations of the SF-36 subscales and summary scores were performed prior to statistical analyses as a result of a non-normal distribution of these data. Pearson correlations were employed to assess associations among age, SF-36 version 2.0 subscales and summary scores, and CS-PFP10 subscales and total score. Alpha levels were adjusted using

Bonferroni's technique in a manner specific to the hypotheses being tested, as follows: age versus function. In this case, the 6 physical function indices were considered potentially overlapping constructs. Therefore, alpha was adjusted to $p < .0083$ (ie, .05/6); age versus HRQL. For the purpose of this analysis the 10 SF-36 subscales and summary scores were considered to be potentially overlapping with respect to age. Therefore, alpha was adjusted to $p < .005$ (ie, .05/10), physical function versus HRQL. For the purpose of this analysis, we considered the 6 physical function scores to be potentially overlapping; however, within each function construct we considered the relationship between function and SF-36 scores to be unique. Therefore, we adjusted the alpha to $p < .0083$ (ie, .05/6).

RESULTS

Study Sample Characteristics

The 74 participants were comprised of 38 females (51.3%) and 36 males (48.7%) 90 years of age and older. The racial makeup of the participants was 71 Caucasian (95.9%) and 3 African American (4.1%). Table 1 provides descriptive statistics regarding age and anthropometric characteristics of the study sample. Table 2 provides the prevalence of chronic disease type and number of chronic diseases, respectively. The mean CS-PFP10 and SF-36 version 2.0 scores are found in Table 3.

Associations Among Variables

Associations among age, physical function, and HRQL in nonagenarians are presented in Table 4. Of interest was the appearance of associations among age, physical function (CS-PFP10 scores), and HRQL (SF-36 version 2.0 subscales and summary component scores).

Age was inversely associated with the upper body flexibility ($r = -.365$, $p = .001$) subscale of the CS-PFP10, indicating that increased age was associated with a decrease in flexibility within the study sample. Surprisingly, age was not significantly associated with any other physical function or HRQL subscale.

There were several significant associations between performance-based physical function and HRQL indices ($p < .0083$). The correlation coefficients for each of the comparisons are located in Table 4. Of note is the consistent appearance of associations between CS-PFP10 scores and domains and the physical function and vitality subscales and the physical component summary score of the SF-36 .

Table 1. Characteristics of Participants

Variable	*Total* n=74	*Female* n=38	*Male* n=36
Age (yr)	92.4 ± 2.3	92.3 ± 2.4	92.5 ± 2.2
Height (cm)	162.5 ± 9.4	155. 4 ± 6.5	170.0 ± 5.1
Weight (kg)	66.4 ± 13.4	61.9 ± 16.3	71.1 ± 7.0
Waist-Hip Ratio	0.9 ± 0.1	0.9 ± 0.1	0.9 ± 0.1

Table 2. Classification and Number of Major Disease Categories Demonstrated By Participants

Classification Category	**Study Sample (%)**
Cardiovascular diseases	14.9
Neurological diseases	9.5
Orthopedic conditions	44.6
Metabolic disorders	5.4
Other	43.2
Number of Major Disease Categories	**Study Sample (%)**
0	24.3
1	43.2
2	23.0
3	9.5
4 +	0

DISCUSSION

The purposes of this investigation of community-dwelling nonagenarians were to describe age-related changes in physical function and HRQL and to examine the relationship between physical function and HRQL in this study sample. Physical function was operationally defined as performance on the CS-PFP10, and HRQL was operationally defined as perceived functioning according to the SF-36.

In spite of the population-based study design, the response rate and pattern introduced some degree of bias. The overall response rate of approximately 28% is less than desirable. Some of the poor response was likely related to a high occurrence of undeliverable mail outs and low telephone ownership rates (as low as 62% in economically disadvantaged rural parishes). Given these difficulties the response rate, while somewhat low, is not surprising.

With respect to the response pattern, it is notable that the study sample was comprised of 96% Caucasian and only 4% African American participants, whereas the racial makeup of the general population of Louisianans 85 years of age and older is 64.8% Caucasian and 29.7% African American. The low percentage of African American participants is, unfortunately not unusual. With respect to the low response rate seen among the African Americans population, the result is likely due to many factors. To some extent, this may be due to difficulties in recruiting economically disadvantaged elders in general. However, to the extent that education and economics play a role in the low response rate among African Americans, there is certainly a racial bias in Louisiana. Furthermore, the African American population of Louisiana may also have a general distrust of scientific research as a result of the Tuskegee Syphilis Study.[25] Regardless of the reasons for the low represen-

Table 3. Descriptive Statistics for CS-PFP10 and SF-36 Version 2.0 Scores (n = 74)

CS-PFP 10 Scores	Minimum	Maximum	Mean	SD
Upper Body Strength	0.2	80.4	21.5	16.4
Upper Body Flexibility	0.5	83.6	44.3	20.9
Lower Body Strength	0.0	61.6	20.1	15.7
Balance and Coordination	0.2	65.9	27.7	19.0
Endurance	0.2	68.1	27.4	18.3
Total CS-PFP10	0.2	67.4	26.0	16.8
SF-36 Scores				
Physical Function	0.0	100.0	54.5	29.3
Role Physical	0.0	100.0	62.2	38.4
Bodily Pain	20.0	100.0	72.5	22.4
General Health	10.0	100.0	67.2	19.5
Vitality	5.0	100.0	55.0	22.8
Social Function	12.5	100.0	86.7	21.1
Role Emotional	0.0	100.0	84.2	28.8
Mental Health	56.0	100.0	83.3	11.4
Physical Component Summary	16.1	58.7	39.9	10.5
Mental Component Summary	36.7	70.5	56.3	6.5

Table 4. Relationships (r) among Age, Physical Function, and Health Related Quality of Life

	Age	Upper Body Strength	Upper Body Flexibility	Lower Body Strength	Balance and Coordination	Endurance	Total CS-PFP10
Age	1	-0.178	*-0.365	-0.169	-0.205	-0.231	-0.229
Physical Function	-0.121	**0.559	**0.424	**0.629	**0.651	**0.661	**0.657
Role Physical	0.051	0.236	0.212	0.214	0.134	0.184	0.202
Bodily Pain	0.020	0.173	0.127	0.214	0.211	0.237	0.225
General Health	0.034	0.264	0.171	0.256	0.241	0.241	0.252
Vitality	0.005	**0.407	0.252	**0.430	**0.418	**0.427	**0.434
Social Function	0.134	0.258	0.229	0.224	0.128	0.190	0.211
Role Emotional	0.005	0.210	0.053	0.173	0.076	0.124	0.136
Mental Health	-0.122	0.136	-0.002	0.057	0.032	0.053	0.056
Physical Component Summary	-0.042	**0.451	*0.376	**0.479	**0.469	**0.490	**0.498
Mental Component Summary	0.052	0.110	-0.044	0.037	-0.061	-0.014	0.000

** Denotes significance p < .001 * Denotes significance p < .008

tation of African Americans, under-representation of minorities is certainly a limitation of the present study.

In addition, the distribution of 51% female and 49% male in the study group is markedly different than the 70.9% female and 29.1% male distribution within the population of Louisianans over the age of 85. The reason for this is unclear. However, it is tempting to speculate that, within the general population, a smaller percentage of 90+ year old males may be living with chronic disabling conditions as compared to female counterparts.

For the purpose of this study it was important to investigate the presence of chronic diseases that might influence function, and the extent to which our study sample was representative of the general population. According to data collected by the National Center for Health Statistics on 85+ year olds in 2001-2002, 40.1% of individuals revealed history of heart disease and 13.6% revealed history of stroke.[26] It is difficult to perform an adequate comparison to national data because of disease descriptive and coding regulation issues for data input. Nevertheless, according to the American Geriatric Society Foundation for Health in Aging, adults have between 2 to 3 chronic medical conditions on average by age 75.[27] Therefore, it appears that the prevalence of chronic diseases in the study sample is reasonably representative of the general population.

The distributions of scores for the CS-PFP10 and SF-36 are within the range of expected values. While normative values for HRQL or physical function performance scores are not available for this specific age group, the present data suggest lower mean physical function and HRQL scores in these nonagenarians than in elders of a greater age range of older adults.[4,5]

Disability statistics provide a context within which the physical function scores can be rectified. According to a Centers for Disease Control News Release by the National Center for Health Statistics, nearly 22% of persons 85 years of age or older were unable to perform one or more activities.[26] Cress and Meyer recently reported that the risk of loss of independence begins to increase dramatically as CS-PFP scores fall below 57.[24] The low mean score for CS-PFP10 overall performance in the present study was 26.0, suggesting that a high percentage of the community-dwelling older adults in our sample are low in ADL competency and at high risk for loss of independence.

The present data provide little evidence of age-related declines in physical function and HRQL within this group of nonagenarians. This study revealed an inverse association between age and the CS-PFP10 upper body flexibility score ($r = -.365$, $p = .001$). There were no significant associations of age with any other physical function or HRQL subscale. However, the flexibility data are consistent with results from other studies[28-34] underscoring the suggestion that functional flexibility deteriorates during the oldest-old years.

Higher levels of flexibility are found to be associated with a greater mobility, ADL competency, and level of functional independence.[35] In the context of the physical function test used in this study, the CS-PFP10, the functional flexibility score is largely limited to shoulder and upper body flexibility as measured by both an overhead reach test and donning and doffing a jacket. Contributing to this decrease in functional flexibility among older adults are deteriorations in joint properties such as chemical composition, hydration, and compliance.[36-38] In addition, elderly individuals demonstrate age-related declines in shoulder range of motion[39] and may exhibit limits in mobility due to shortened muscles or alterations in connective tissue.[40-43] These changes could be caused by repetitive use of specific joint movements or postures[37] such as the characteristic geriatric posture of a forward head, increased thoracic kyphosis, and internally rotated shoulders.[44]

The low mean score for CS-PFP10 overall physical function performance in the present study suggests that a high percentage of the study sample was already at an overall low level of ADL competency as measured by all components of upper body flexibility, upper body strength, lower body strength, balance and coordination, and endurance. We conclude that for nonagenarians functional fitness elements (specifically upper body flexibility) along with proposed age-related joint and tissue properties may contribute to abnormal movement patterns[40] which can in turn limit the ability[45-47] to perform necessary basic and instrumental tasks reflected by overall PFP scores.

Without the ability to perform even basic tasks, overall mobility can decrease causing more harmful consequences. A decrease in mobility could limit not only self-care ability, but social activities, recreational involvement, and progressive physical function activity as well. Therefore, a decline in HRQL may be expected due to diminished self-worth and capability because of the limitations or inability to perform necessary activities. In this study, several associations between physical function and HRQL indices were revealed. With a decrease in upper body flexibility, certain aspects of quality of life decline, specifically the physical function subscale ($r = .424$, $p < .001$) and physical health summary component ($r = .376$, $p = .001$) scores of the SF-36.[22]

The SF-36 physical function measures the perception of limitation to performing all physical activity due to health, and physical health summary measures the perception of physical limitations, disabilities, decrements in well-being, energy level, and health. Similarly, in studies performed by Cress et al[4] involving 70+ year old individuals of various levels of mobility (community dwellers, and long-term care facility independent and dependent living residents) and Wood et al[5] involving 60+ year old independent-living individuals, there were also significant correlations between upper body flexibility and physical function. The findings by Cress et al,[4] in addition to the findings of the current study suggest that upper body flexibility declines and limits physical function as early as 70 years of age and continues to decline through the 10th decade. Thus, it appears to be a strong determinant of physical function as it relates to HRQL.

CONCLUSIONS

These data suggest that upper body flexibility continues to decline during the 10th decade of life and that this has implications for decreased HRQL. Such findings are relevant to scientists, clinicians, and other health professionals, particularly with regard to rehabilitation, exercise, and preventative wellness programs designed to optimize physical function and HRQL in the growing population of oldest-old individuals. Future studies should assess underlying age-related impairments in other measures of physical function, and should examine appropriate dose-response for physical activity and flexibility training with respect to HRQL in this subset of the older adult population. It is also recommended for further study to differentiate losses in flexibility that are attributed to aging from those associated with physical inactivity.

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