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Association between lung function and disability in African–Americans

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Abstract

Background—Impaired lung function is independently associated with higher rates of disability; however, few studies have examined the extent to which this relationship varies by sex. Because men are less likely to have disability, it is expected that the relationship between lung function and disability will be greater among women.

Methods—Logistic regression models were specified to examine the relationship between lung function and disability in 689 African–American men and women participating in the Carolina African American Twin Study of Aging. Disability was defined as difficulty in performing at least one of seven basic activities of daily living. Impaired lung function was defined as per cent of predicted peak expiratory flow (PEF) <80.

Results—Accounting for demographic and health-related characteristics, women who had impaired lung function had a higher odds (OR 1.77; 95% CI 1.02 to 3.06) of being disabled than those with normal lung function. Impaired lung function was unrelated to disability in men.

Conclusion—Lung function appears to vary by sex in this sample of African–Americans. Furthermore, among women, lung function should be considered as an important indicator of health. Every effort should be made to improve lung function in African–Americans, but interventions and health promoting strategies may need to be sex specific.

Disability is a major public health concern that increases with age and varies by race and sex.^{1, 2} The population of adults 65 years of age and older is estimated to increase from 12 to 20% of the US population by 2030,³ with the population of black older adults expected to increase by 164% in contrast to 77% for white older adults. Despite recent declines in the disability rate among older adults in the US,^{4, 5} the absolute number of disabled older adults will increase as a result of an increase in the population of older adults. Prevalence rates of disability are higher for black people compared to white people. For example, among

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persons aged 65 and older, 26% of black versus 17% of white men and 36% of black versus 30% of white women have a disability.⁶ Given the increased proportion of aged minorities and magnitude of the observed race-related differences, identifying and understanding factors that prevent disability should be a high priority.^{1, 7}

Lung function is an often overlooked, yet important, indicator of health across the age spectrum, which varies considerably by race and sex.^{8–15} For example, as indicated by spirometry, black people and women have poorer lung function than white people and men respectively.^{10, 16} Progressive loss of lung function can lead to chronic obstructive pulmonary disease (COPD) which is the fourth leading cause of death in the USA and is increasing in prevalence in women and black people.^{17, 18} Furthermore, disability from this disease is large and expected to worsen.^{19, 20}

Previous studies have examined the association between lung function and disability; yet little is known about this relationship in community dwelling populations. The authors are aware of only one study that has examined lung function and disability in community dwelling adults.⁸ In this sample of moderately to severely disabled women 65 years of age and older in the Women's Health and Aging Study, Simpson and colleagues observed a negative relationship between lung function and reported disability.⁸ Most studies of lung function and disability have focused on individuals with COPD.^{21–24} Findings from these studies indicate that poor lung function is related to greater disability. Because previous research is limited to participants who have been diagnosed with COPD or participants of one sex, the need exists for further research among individuals who reside in the community where there is strong potential for primary prevention. Likewise, the relationship between lung function and disability is not well understood and neither is the effect of sex on this relationship.

This study will enhance investigators' understanding of the association between lung function and disability, and whether this relationship varies by sex using a sample of middle to old age African-Americans. Studies with a sufficient number of African-Americans with valid, objective lung function measures and disability are rare. Examining the association between lung function and disability among African-Americans provides the opportunity to observe these relationships in the absence of confounding of race. Furthermore, with-in group investigation provides the opportunity to examine with-in group heterogeneity and examine how social variables contribute to this variability.²⁵ The objective of this study was to examine the cross-sectional relationship between lung function and disability. Further, because women are more likely to be disabled and have higher rates of morbidity than men,²⁶ the extent that the relationship between lung function and disability varies by sex was examined.

METHODS

Study population

The Carolina African American Twin Study of Aging (CAATSA) was designed to examine the health status, cognitive functioning, and physical and psychosocial functioning of adult African-American twins aged 22 and older.²⁷ This population-based sample of participants was identified from birth records between the years of 1913 and 1975 from 23 vital statistics offices in North Carolina counties. Birth records were then entered into a computerised database of twin births. After the records were computerised, potential participants were located through voter registries and telephone White Page searches. The protocol for data collection consisted of two parts. The survey was administered in person by a trained interviewer and consisted of a structured questionnaire that included demographic and socioeconomic information, self-reported health behaviours, chronic conditions, perceived

stress, personality, memory and well-being. Additionally, assessments of blood pressure and peak expiratory flow (PEF) were obtained following the survey. Participants were enrolled between 1999 and 2003. All participants provided informed consent and the study was approved by the Institutional Review Board at the University of North Carolina Chapel Hill and Pennsylvania State University. Additional information regarding the CAATSA study design can be found elsewhere.²⁷

The final sample resulted in 710 interviews with 286 pairs of twins, 31 pairs of siblings and 72 surviving members of non-intact twin pairs. Of the 710 participants in the study, 689 had valid PEF measurements. Among the 21 participants that were excluded, 19 had unacceptable PEF readings and two had missing height information, which was used to create the per cent of predicted PEF. Comparing participants with and without valid PEF measurements, those who did not have valid measurements were older and had a poorer health profile, as indicated by higher rates of obesity and disability, and a greater number of prevalent health conditions.

Measure of disability

Disability, the dependent variable, was derived from the participant's report of difficulty in performing basic activities of daily living, which included eating, dressing, grooming, walking, bathing, using the toilet, and transferring in and out of bed.²⁸ There were four possible response categories: never need help (1), have difficulty but can do without help (2), have difficulty and need help (3), and never do the activity (4). A binary variable was created for each activity of daily living to indicate whether the individual had difficulty in performing that specific activity or not. After summing these seven binary variables, a dichotomous variable for disability was created to identify those individuals who had difficulty in at least one of the activities of daily living. This approach is similar to what other investigators have previously done.^{29, 30}

Measure of lung function

Lung function was measured using a Mini-Wright peak flow meter, which assessed the PEF for each individual. While standing, participants covered the end of the tube of the peak flow meter with their lips, took a deep breath, and blew as hard as possible after taking a deep breath for 1 s. Participants conducted this test three times with at least a 30 s interval between each PEF reading. The variable PEF was the average of three trials. Predicted PEF was based on age-, sex- and race-normalized values of a random sample of healthy non-smoking subjects in the USA.³¹ Once the predicted PEF values were determined, the per cent of predicted PEF was derived from dividing the observed PEF values by predicted PEF values.³¹ Impaired lung function was defined as per cent of predicted PEF <80.³²

Covariates

Demographic characteristics included: age (years), sex (1 = female; 0 = male), educational attainment (years completed) and income, which was measured using self-reported family income based on participant selection of 1 of 16 categories ranging from \$100 to over \$1500 per month in \$100 increments. For descriptive purposes, three categories are presented (less than \$1000, between \$1000 and \$1500, and greater than \$1500 per month), but include family income with the 16 categories in the analyses. Health-related factors included: obesity, defined as body mass index greater than or equal to 30 (1 = yes, 0 = no), smoking status (0 = never, 1 = former, 2 = current), and prevalent health conditions. Participants reported whether they had been told by a doctor if they had: diabetes, heart disease, high blood pressure or arthritis. Each of the conditions were coded as binary variables (1 = present; 0 = absent) and summed to create a variable representing the total number of chronic health conditions, which was then dichotomised as having two or more conditions

compared to one or none. This classification is consistent with what others have previously described.^{26, 33, 34}

Statistical methods

The mean and proportional differences were examined by sex for the demographic characteristics, health-related factors, lung function, and disability using Student's *t* and χ^2 tests respectively. Multivariable logistic regression models were conducted to estimate the association between lung function and disability. To determine the impact of each group of variables on the parameter estimate for lung function, three different logistic regression models were examined using progressively more complex models. Model 1 included lung function and age; model 2 included factors in model 1 plus the other demographic characteristics; and model 3 included variables in model 2 plus the health-related factors. Because the sample consisted of adult twin pairs, the independence of observations assumption was violated, which deemed standard regression procedures inappropriate. Therefore, to account for twin pair dependency both in the outcome and covariates, a multilevel model approach was employed using Proc Glimmix (SAS Institute, Inc., Cary, North Carolina). A multilevel approach assumes that each participant is nested within a twin pair and allows for a varying degree of covariation among twins depending on their twin status (ie monozygotic, dizygotic, same-sex dizygotic or sibling). *P* values <0.05 were considered statistically significant and all tests were two-sided. Analyses were conducted using SAS, version 9.1.3, software (SAS Institute, Inc., Cary, North Carolina).

RESULTS

The distribution of the baseline characteristics for the total sample and by sex is presented in Table 1. Of the 689 participants, the mean age was 49.5 (standard deviation 14.5) years and the average number of years of education completed was 12.8 (standard deviation 3.4). The majority of the participants were female, had a monthly family income greater than \$1500, and had impaired lung function; whereas less than half of the participants were obese, current smokers, had two or more prevalent health conditions, or disabled. When examining the baseline characteristics by sex, women had completed more years of education (*p* = 0.006) but fewer had a monthly family income greater than \$1500 (*p* < 0.001) compared to men. Also, women were more likely to be obese (*p* = 0.021) and disabled (*p* = 0.016), despite better lung function (*p* = 0.018) and fewer current smokers (*p* < 0.001) compared to men. No sex differences were apparent with regard to age and number of prevalent health conditions.

The odds of being disabled associated with lung function stratified by sex are displayed in table 2. Accounting for age (model 1), women with impaired lung function had a 2.2 times higher odds (95% CI 1.33 to 3.65) of being disabled compared to those with normal lung function. In model 2, the impact of SES was examined on the relationship between lung function and disability. As expected, this relationship remained significant, although attenuated, after controlling for SES measures (OR 1.92; 95% CI 1.12 to 3.28). In model 3, it was examined how health factors influenced the association between lung function and disability. When adding the health-related factors, women with impaired lung function still increased the odds of being disabled albeit diminished (OR 1.77; 95% CI 1.02 to 3.06) than those with normal lung function. No association between lung function and disability was observed in men.

DISCUSSION

As the USA grows older in the next 20–30 years, current estimates suggest that disability will be a significant issue, particularly for older African-Americans.¹ The current study

suggests that our understanding of disability is greatly enhanced by assessing lung function and that this association varies by sex. These findings extend previous research that found lung function is associated with disability^{8, 20–24}, by examining the relationship between lung function and disability in a sample of community dwelling African–Americans and examining this relationship by sex. The present results indicate that women with impaired lung function had nearly twice the odds of being disabled than women with normal lung function, even after controlling for demographic and health-related characteristics. However, lung function was not related to disability among men.

The present results regarding lung function and disability among women are in agreement with previous studies.^{8, 20} In a community dwelling sample of 1002 moderately to severely disabled women,⁸ poor lung function, classified as FEV1, FVC, and FEV1/FVC, was associated with deficits in ability. Using the same data examining race differences in lower extremity function and decline, Thorpe and colleagues²⁰ found that African–American women had lower mean FEV1 values than white women and lung function was independently associated with lower extremity function. Of note, however, in this study is the strong association of impaired lung function with disability among women even after adjustment for the demographic and health-related variables. This suggests that other unmeasured factors may be involved. Greater cumulative exposure to environmental and occupational hazards may contribute to impaired lung function and subsequently lead to disability. An emphasis on the environment where an individual lives and work should be considered in future research.

It is unclear why lung function was not related to disability in men. There were more men with low lung function than women but the reverse was true for disability. As in previous research, it was also found that women were more likely to report more diagnoses of chronic conditions relative to men.^{26, 33} The presence of more than one chronic condition an individual reports is related to disability.^{33, 34} Although this is true for both sexes, women have greater disability.²⁶ This premise is supported in CAATSA with women having more than fourfold odds of being disabled with two or more chronic conditions. However, this relationship was not apparent in men. Perhaps, men are more likely than women to be disabled from other causes such as occupational accidents or specific chronic conditions such as stroke or COPD, measures that were not well captured in the current analyses. In addition, it may be a matter of selective survival for men. The men may be experiencing mortality more than disability so that those in our analyses represent a higher proportion of those who may be protected from disability regardless of lung function.

Few data sources are available to examine the association between disability and lung function with valid spirometry measures and a sufficient number of community dwelling African–Americans, resulting in a major strength of the study and making a contribution to the disability literature. Nevertheless, several aspects of this study warrant comment. The data for this study are cross-sectional, thus precluding any statements regarding the temporal sequence of the relationship between lung function and disability. It is unclear from the results here whether lung function predisposes one to disabling conditions, whether disability decreases overall physical leading to lower lung function, or whether the two co-occur arising from singular or multiple causal agents. An examination of the relationship between disability and lung function is needed, preferably with individuals free of disability at study inception. Data regarding patient adherence and treatment of asthma and COPD were not collected and the number of participants who reported being diagnosed with asthma (men 18 (7.6%); women 43 (12.4%)) was not sufficiently large enough to provide reliable estimates in the regression analyses. Additional studies should include patient adherence and treatment of COPD and asthma. The present sample only included African–Americans; therefore, it would be worthwhile to examine this relationship between lung

function and disability among other racial/ethnic groups with an age range similar to the one in this study.

In summary, this study provides evidence that, in a sample of community dwelling African-Americans, the relationship between lung function and disability varies by sex. Women with impaired lung function had greater odds of being disabled than women with normal lung function. This relationship was not observed in men. The findings presented here suggest that lung function serves as an important indicator of health as African-Americans age, particularly among women. The additional risk for the development of COPD in those with impaired lung function¹⁶ and among African-American women make this an important marker for assessments of health. Every effort should be made to improve lung function in African-Americans, but interventions and health promoting strategies may need to be sex specific.

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What is already known on this subject

- Previous studies have examined the relationship between lung function and disability; however, most of the subjects in these studies include participants who have been diagnosed with COPD, or participants of one sex.
- Little is known about this relationship in community dwelling populations where the potential for interventions leading to primary prevention are amenable.

What this study adds

- This study will enhance investigators' understanding of the association between lung function and disability, and whether this relationship varies by sex using a sample of middle to old age African-Americans.
- Studies with a sufficient number of African-Americans with valid, objective lung function measures and disability are rare.

Table 1

Distribution of characteristics of the total sample and by sex for participants in the Carolina African American Twin Study of Aging, 1999–2003

Characteristic	Total (N = 689)	Women (N = 414)	Men (N = 275)	p Value
Age (years)	49.5 (14.5) *	49.8 (14.4)	49.2 (14.7)	0.624
Education (years completed)	12.8 (3.4)	13.1 (3.4)	12.4 (3.3)	0.006
Income (%)				
<\$1000	21.7	24.8	17.0	
\$1000–\$1500	16.5	19.1	12.5	
>\$1500	61.7	56.0	70.4	<0.001
Female (%)	60.0	–	–	–
Obese (%)	40.9	44.4	35.6	0.021
Smoking status (%)				
Never	48.9	56.7	37.3	
Former	29.1	24.4	36.2	
Current	21.8	18.8	26.3	<0.001
Two or more prevalent health conditions (%) [†]	28.3	30.6	24.7	0.089
Per cent of predicted PEF* <80 (%)	51.9	48.3	57.4	0.018
Disability (%) [‡]	21.7	24.8	17.0	0.016

PEF, peak expiratory flow.

* Means (SD).

[†] Prevalent health conditions consisted of ever being told by a doctor that you have: diabetes, heart disease, hypertension, or arthritis.

[‡] Disability was defined as reported difficulty in performing at least one of the seven basic activities of daily living (ie eating, bathing, grooming, walking, dressing, transferring in and out of bed, and using the toilet).

Table 2

Odds ratios and 95% confidence intervals for the association between disability and lung function by sex in the 689 participants in the Carolina African American Twin Study of Aging, 1999–2003

Characteristic	Odds ratio (95% confidence interval)		
	Model 1	Model 2	Model 3
Women			
Per cent of predicted PEF* <80	2.20 (1.33 to 3.65)	1.92 (1.12 to 3.28)	1.77 (1.02 to 3.06)
Age	1.07 (1.05 to 1.09)	1.05 (1.03 to 1.07)	1.03 (1.01 to 1.06)
Education		0.95 (0.87 to 1.04)	0.96 (0.88 to 1.04)
Income		0.89 (0.84 to 0.95)	0.91 (0.85 to 0.97)
Smoking status [†]			
Never			1
Former			0.93 (0.49 to 1.77)
Current			1.44 (0.70 to 2.98)
Obese			1.03 (0.58 to 1.82)
Two or more prevalent health conditions			4.43 (2.39 to 8.22)
Men			
Per cent of predicted PEF <80	2.14 (0.98 to 4.69)	1.87 (0.78 to 4.46)	2.00 (0.79 to 5.03)
Age	1.07 (1.05 to 1.10)	1.07 (1.04 to 1.10)	1.06 (1.03 to 1.10)
Education		1.02 (0.90 to 1.15)	1.01 (0.89 to 1.16)
Income		0.91 (0.82 to 1.01)	0.92 (0.82 to 1.02)
Smoking status [†]			
Never			1
Former			0.82 (0.29 to 2.29)
Current			0.82 (0.26 to 2.54)
Obese			0.96 (0.42 to 2.15)
Two or more prevalent health conditions			2.01 (0.86 to 4.70)

* PEF, peak expiratory flow.

[†] The reference category for smoking status is never smokers.