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# Understanding the Reasons for the Underutilization of Pneumococcal Vaccination Among Community-Dwelling Older African Americans

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## Abstract

**OBJECTIVES—**To understand the potential roles of various patient and provider factors in the underutilization of pneumococcal vaccination among Medicare-eligible older African Americans.

**DESIGN—**The Cardiovascular Health Study.

**SETTING—**Four US states.

**PARTICIPANTS—**795 pairs of community-dwelling Medicare-eligible African American and white adults, ≥65 years, balanced by age and gender.

**MEASUREMENTS—**Data on self-reported race, receipt of pneumococcal vaccination and other key socio-demographic and clinical variables were collected at baseline.

**RESULTS—**Participants had a mean (±SD) age of 73 (±6) years and 63% were women. Pneumococcal vaccination was received by 22% African Americans and 28% whites (unadjusted odds ratios {OR} for African Americans, 0.75; 95% confidence interval {CI}, 0.60–0.94; P=0.013). This association remained significant despite adjustment for socio-demographic and clinical confounders including education, income, chronic obstructive pulmonary disease and prior pneumonia (OR, 0.74; 95% CI, 0.56– 0.97; P=0.030). However, the association was no longer significant after additional adjustment for the receipt of influenza vaccination (OR, 0.79; 95% CI, 0.59–1.06; P=0.117). A receipt of an influenza vaccination was associated with higher odds of receiving a pneumococcal vaccination (unadjusted OR, 6.43; 95% CI, 5.00–8.28; P<0.001) and the association between race and pneumococcal vaccination lost significance when adjusted for influenza vaccination alone (OR, 0.81; 95% CI, 0.63–1.03; P=0.089).

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**Author Contributions:**
Ali Ahmed and Linda G. Jones were responsible for concept, design, analysis and interpretation of data, and preparation of manuscript. Shamima Akhter, James Ekundayo, and Yan Zhang conducted statistical analyses with assistance from Inmaculada Aban and Ali Ahmed. All authors interpreted the data, participated in critical revision of the manuscript for important intellectual content, and approved the final version of the manuscript. Ali Ahmed, Shamima Akhter, James Ekundayo, and Yan Zhang had full access to the data.

**CONCLUSION—**The strong association between the receipt of influenza and pneumococcal vaccinations suggests that patients' and providers' attitudes toward vaccination, rather than traditional confounders such as education and income, may help explain the underutilization of pneumococcal vaccination among older African Americans.

### Keywords

Racial variations; pneumococcal vaccination; older adults

## INTRODUCTION

Pneumococcal pneumonia is responsible for more deaths annually than any other vaccine-preventable bacterial disease and is the 5th leading cause of death for person ≥65 years in the United States. [1, 2] Although pneumococcal vaccines are available free of cost to Medicare beneficiaries and are effective in reducing the incidence and severity of invasive pneumococcal disease, these vaccines are underutilized, especially among the minority older adults.[3–7] The objective of this study was to understand the potential roles of patient and provider factors in the underutilization of pneumococcal vaccination among community-dwelling African American older adults enrolled in Medicare.

## METHODS

### Study Design and Participants

The Cardiovascular Health Study (CHS) is an ongoing epidemiological study of cardiovascular disease in community-dwelling older adults, which is funded by the National Heart Lung and Blood Institute (NHLBI). Detailed descriptions of the rationale and design of the CHS have been previously reported. [8, 9] Briefly, the CHS recruited 5,888 adults ≥65 years of age between 1989 and 1993 from Forsyth County, North Carolina, Sacramento County, California, Washington County, Maryland, and Pittsburgh county, Pennsylvania. The recruitment in CHS occurred in two phases. An original cohort of 5201 mostly white participants was recruited between 1989 and 1990, which was later supplemented by the recruitment of a second cohort of 687 African American participants between 1992 and 1993.[8, 9] For the current analysis, we used public-use copies of the CHS data obtained from the NHLBI. Of the 5888 original CHS participants, 5795 consented to be included in the de-identified public-use copy of the dataset and are included in our analysis.

### Race, Pneumococcal Vaccination and Other Baseline Characteristics

CHS participants self-reported race at baseline. Of the 5795 CHS participants, 901 were African Americans, 4855 were whites and 39 were from other racial / ethnic backgrounds. We restricted our analysis to 5756 African Americans and whites. Data on socio-demographic and other clinical variables including education, income, use of influenza vaccination, and prior pneumonia and chronic obstructive pulmonary disease were collected at baseline.[8, 9] Data on baseline cognitive function was assessed using mini-mental state examination test. The receipt of a pneumococcal vaccination was ascertained at baseline by asking the questions: "Have you ever had a shot to prevent pneumonia (pneumovax)?"

### Assembly of the Study Cohort

Of the 5756 African American and white CHS participants, 5498 had data on influenza and pneumococcal vaccination and, 5139 also had data on education and income. Of the 5139 participants, 795 (15.5%) were African-Americans. To minimize the confounding effect of the other two key demographic variables, age and sex, we assembled a cohort of 795 pairs of African Americans and whites who were balanced on age and sex.

### Statistical Analysis

We used the Chi square and student t-test for descriptive analyses as appropriate. To determine the unadjusted association between race and pneumococcal vaccination, we used a bivariate logistic regression model in which race was the independent variable and pneumococcal vaccination was the dependent variables. To identify potential roles of various patient and provider characteristics that might explain the underutilization of pneumococcal vaccination among African American older adults, we constructed a multivariable logistic regression model, in which we sequentially entered various baseline characteristics as covariates. To determine the role of traditional confounders of racial disparity, in the first step, we adjusted for education (≥college=1), and income (≥ $25,000=1). In step 2, we made additional adjustments for marital status (married=1), living situation (living alone=1), current smoking (yes=1), and alcohol consumption. In step 3, we adjusted for general health (fair to poor=1), depression and cognitive function scores. In step 4, we adjusted for heart failure, pneumonia, chronic obstructive pulmonary disease, stroke, coronary artery disease, hypertension, diabetes mellitus, chronic kidney disease, arthritis and cancer. And, in the final step, we adjusted for the receipt of influenza vaccination. Because influenza vaccination may be considered a marker of both patients' and providers' attitude toward prevention in general, and vaccination, in particular, we repeated our model, adjusting for influenza vaccination in the first step. This allowed us to determine the singular confounding effect of influenza vaccination on the association between race and pneumococcal vaccination. We subsequently adjusted for other covariates, entering them into the model in the order described above. Finally, we examined the associations of other baseline characteristics with pneumococcal vaccination in the final step of each model. A p-value of 0.05 was considered statistically significant. Confidence intervals were set at the 95% confidence level, and all statistical tests were performed as two-sided. We used SPSS for Windows (Version 18) for all data analysis.[10]

## RESULTS

### Baseline Characteristics

The participants (n=1590) had a mean (±SD) age of 73 (±6) years and 63% were women, which was by design the same for both African American and white participants (Table 1). Compared to whites, African American older adults were more likely to be unmarried, live alone, have lower education and income, be current smokers, and consume more alcohol. They also had a higher prevalence of hypertension, diabetes, heart failure, and stroke, but had a lower prevalence of chronic kidney disease and cancer. There were no differences in the prevalence of pneumonia and chronic obstructive pulmonary disease between the races. However, African American older adults were less likely to have received influenza vaccinations (Table 1).

### Association between Race and Pneumococcal Vaccination

Pneumococcal vaccination was received by 28% and 22% of whites and African-Americans respectively (unadjusted odds ratio {OR} when African Americans were compared with whites, 0.75; 95% CI, 0.60–0.94; P=0.013; Table 2). This association remained significant despite adjustment for education and income (OR, 0.79; 95% CI, 0.63– 0.999; P=0.049), and other important socio-demographic and clinical variables chronic obstructive pulmonary disease and pneumonia (OR, 0.74; 95% CI, 0.56– 0.97; P=0.030; Table 2). However, the association became non-significant after additional adjustment for the receipt of influenza vaccination (OR, 0.79; 95% CI, 0.59–1.06; P=0.117; Table 2).

When we adjusted for influenza vaccination alone, the association between race and pneumococcal vaccination also became non-significant (OR, 0.81; 95% CI, 0.63–1.03;

P=0.089; Table 3). Additional adjustment for the socio-demographic and clinical variables mentioned above did not alter the association between race and pneumococcal vaccination (OR, 0.79; 95% CI, 0.59– 1.06; P=0.117; Table 3).

### Associations of Other Baseline Characteristics and Pneumococcal Vaccination

Influenza vaccination use was associated with higher odds for the receipt of pneumococcal vaccination (unadjusted OR, 6.43; 95% CI, 5.00–8.28; P<0.001), which remained significant after multivariable adjustment for other covariates (Table 4). Associations of other baseline characteristics with pneumococcal vaccine are displayed in Table 4.

## DISCUSSION

The findings of the current study demonstrate that the underutilization of pneumococcal vaccination among community-dwelling Medicare-eligible older African Americans may be explained by the racial variation in the receipt of influenza vaccination, but not by the traditional confounders of racial disparity such as imbalances in education, income, or morbidity burden. Because utilizations of influenza and pneumococcal vaccinations are closely related and may reflect patients' and providers' attitudes toward prevention and vaccination, these findings suggest that utilization of pneumococcal vaccination among older African Americans may be improved by improving patients' and providers' attitudes toward vaccination, in general, and by improving utilization of influenza vaccination in particular.

The low rate of utilization of pneumococcal vaccination in community-dwelling Medicare-eligible older adults is rather surprising. Pneumococcal vaccine is recommended for adults ≥65 years and has been covered by Medicare since 1981. The vaccine is effective in reducing the incidence and severity of invasive pneumococcal disease,_is generally well-tolerated and is usually a single-dose vaccination.[6, 11–16] One potential explanation for the underutilization of pneumococcal vaccination may be the lack of awareness of the danger of pneumococcal disease and of the benefits of pneumococcal vaccination in apparently healthy older adults. The lack of awareness as a potential reason for underutilization is supported by our observation of increased odds of pneumococcal vaccination among those with chronic obstructive pulmonary disease and prior pneumonia.

The unadjusted association between African American race and the receipt of pneumococcal vaccination may in part be explained by the imbalances in key baseline socio-demographic characteristics including education and income.[17–20] For example, a higher proportion of African American older adults in our study had lower education and lower income than their white counterparts. Although the pneumococcal vaccination is fully covered by Medicare, it may still be underutilized by older adults with lower income due to limitations related to access to care and transportation. Older adults with lower education are likely to have lower health literacy and would thus be less likely to understand and accept preventive measures such as vaccination. However, findings from our multivariable model suggest that education, income and other important socio-demographic variables do not fully account for the significant underutilization of pneumococcal vaccination among African American older adults. [21, 22]

Lack of contact with health-care providers or missed opportunities to vaccinate during contact have been suggested as reasons for underutilization of vaccination.[15, 23–26] In particular, doctors' recommendations for vaccination have been shown to positively influence patients' decision to be vaccinated.[4, 27] This is consistent with our observation that hypertension and arthritis, the two most common morbidities among older adults,[28] were associated with increased odds of pneumococcal vaccination. Older adults with these

conditions are likely to have more frequent visits with health-care providers, which may increase the opportunity for vaccination.

The loss of the significant bivariate association between race and pneumococcal vaccination after the singular adjustment for influenza vaccination suggests that this association can be explained by the racial imbalance in the utilization of influenza vaccination. The role of influenza vaccination as a confounder is evident from its strong association with both the exposure (race) and outcome (pneumococcal vaccination) in our study (Tables 1 and 4). Because, unlike the pneumococcal vaccination, the influenza vaccination is offered annually and may be a better marker for patients' and physicians' attitudes and practices toward vaccination as a preventive measure, older adults who receive influenza vaccinations may also be more likely to receive pneumococcal vaccination.

Underutilization of pneumococcal vaccines, in general, and by age, sex, race, and regional variation in particular have been previously described.[3–5, 13, 15, 27, 29, 30] However, to the best of our knowledge, this is the first report of a detailed analysis of race-related underutilization of the pneumococcal vaccine that provides insights into potential underlying reasons for the racial variation in the utilization of pneumococcal vaccination. These findings have significant public health and clinical implications. Pneumococcal pneumonia is the most common cause of community-acquired pneumonia, with mortality as high as 50% and being responsible for 25–35% pneumonia-related hospitalizations.[1, 2] It is important to note that concomitant bacteremia occurs in about 10–25% of elderly patients who have pneumococcal pneumonia, which is associated with poor prognosis, but may be reduced by pneumococcal vaccination. The incidence of bacteremia is 3–5 fold higher among African Americans,[31, 32] which further highlights the importance for improving the utilization of pneumococcal vaccination for older African Americans.

Several limitations of our study must be acknowledged. CHS participants were recruited between 1989 and 1993 and the rate of pneumococcal vaccination has improved since that time. However, racial disparity in the use of pneumococcal vaccination persists.[3, 33, 34] According to the CDC, in 2008 while the overall rate for pneumococcal vaccination among older adults was about 60%, it was about 44% for older African Americans.[33] Therefore, despite the age of the dataset, these findings are still relevant and may provide important insight for improvement of pneumococcal vaccination rates among contemporary older adults. Another limitation of this study is the potential for recall bias because pneumococcal vaccination use was self reported. While it would be ideal to verify self-reports with chart review or claims data, self-report remains the method of choice for collection of such data at the national level.[3, 33, 34] Finally, site specific enrollment information was unavailable for the CHS, therefore potential differences by site of enrollment could not be evaluated.

In conclusion, the underutilization of pneumococcal vaccination by older African Americans is more likely due to racial variation in the utilization of influenza vaccination, and less likely due to traditional confounders of racial disparity such as racial imbalances in education and/or income. These findings provide important insights into the racial disparity in the utilization of pneumococcal vaccination that persists despite overall improvement in the utilization of pneumococcal vaccination.

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## Table 1

Baseline characteristics of age- and sex-balanced African Americans and whites in the Cardiovascular Heart Study (CHS)

| n (%) or mean (±SD) | Whites (n=795) | African Americans (n=795) | P value |
|---|---|---|---|
| Age, years | 73 (±6) | 73 (±6) | 1.000 |
| Female | 499(63%) | 499 (63%) | 1.000 |
| Married | 543 (68%) | 354 (45%) | <0.001 |
| Living alone | 80 (10%) | 256 (32%) | <0.001 |
| College or higher education | 333 (42%) | 272 (34%) | 0.002 |
| Income $25,000 or more | 298 (38%) | 156 (20%) | <0.001 |
| Current smoker | 93 (12%) | 133 (17%) | 0.004 |
| Alcohol, units /week | 2.2 (±5.4) | 1.6 (±6.2) | 0.047 |
| Body mass index, kg/m$^2$ | 26.4 (±4.1) | 28.2 (±4.5) | <0.001 |
| Mini-mental state examination score of 30 | 27.9 (±2.4) | 25.6 (±3.7) | <0.001 |
| Self-reported fair to poor general health | 176 (22%) | 338 (43%) | <0.001 |
| Influenza vaccination | 347 (44%) | 300 (38%) | 0.016 |
| Heart failure | 32 (4%) | 55 (7%) | 0.011 |
| Coronary artery disease | 146 (18%) | 155 (20%) | 0.565 |
| Hypertension | 458 (58%) | 587 (74%) | <0.001 |
| Diabetes | 119 (15%) | 199 (25%) | <0.001 |
| Chronic kidney disease | 176 (22%) | 115 (15%) | <0.001 |
| Stroke | 24 (3%) | 57 (7%) | <0.001 |
| Chronic obstructive pulmonary disease | 106 (13%) | 103 (13%) | 0.824 |
| Pneumonia | 227 (29%) | 202 (25%) | 0.207 |
| Arthritis | 403 (51%) | 453 (57%) | 0.012 |
| Cancer | 99 (13%) | 67 (8%) | 0.009 |
| Medications | | | |
| ACE inhibitors | 57 (7%) | 118 (15%) | <0.001 |
| Beta blockers | 113 (14%) | 84 (11%) | 0.027 |
| Calcium channel blockers | 91 (11%) | 195 (25%) | <0.001 |
| Diuretics | 225 (28%) | 271 (34%) | 0.013 |
| Aspirin | 28 (4%) | 41 (5%) | 0.110 |
| Statins | 15 (2%) | 34 (4%) | 0.006 |
| NSAIDs | 95 (12%) | 121 (15%) | 0.057 |
| Pulse rate, beats/min | 68 (±11) | 69 (±11) | 0.009 |
| Systolic blood pressure, mm Hg | 135 (±22) | 142 (±23) | <0.001 |
| Diastolic blood pressure, mm Hg | 70 (±11) | 75 (±11) | <0.001 |
| Serum creatinine, mg/dL | 0.92 (±.29) | 1.07 (±.66) | <0.001 |

## Table 2

Step-wise associations of race and the receipt of pneumococcal vaccination (influenza vaccination entered last in model)

| | Odds ratio (95% confidence interval); P value | |
|---|---|---|
| | **Whites (n=795)** | **African Americans (n=795)** |
| N (%) receiving pneumococcal vaccination | 221 (28%) | 178 (22%) |
| Step 1: Unadjusted | 1.00 (Reference) | 0.75 (0.60 – 0.94); P =0.013 |
| Step 2: Step 1 + education (≥college=1) and income (≥$25,000/year=1) | 1.00 (Reference) | 0.79 (0.63 – 0.999); P =0.049 |
| Step 3: Step 2 + demographic variables* | 1.00 (Reference) | 0.76 (0.60 – 0.97); P =0.029 |
| Step 4: Step 3 + general health, depression and mini-mental state examination score | 1.00 (Reference) | 0.77 (0.59 – 0.99); P =0.041 |
| Step 5: Step 4 + medical history** | 1.00 (Reference) | 0.74 (0.56– 0.97); P =0.030 |
| Step 6: Step 5 + influenza vaccination | 1.00 (Reference) | 0.79 (0.59 – 1.06); P =0.117 |

* Demographics: being married, living alone, current smoking, alcohol consumption,

** Medical history: heart failure, pneumonia, chronic obstructive pulmonary disease, stroke, coronary artery disease, hypertension, diabetes mellitus, chronic kidney disease, arthritis and cancer

## Table 3

Step-wise associations of race and the receipt of pneumococcal vaccination (influenza vaccination entered first in model)

| | Odds ratio (95% confidence interval); P value | |
|---|---|---|
| | **Whites (n=795)** | **African Americans (n=795)** |
| Step 1: Unadjusted | 1.00 (Reference) | 0.75 (0.60 – 0.94); P =0.013 |
| Step 2: Step 1 + influenza vaccination | 1.00 (Reference) | 0.81 (0.63 – 1.03); P =0.089 |
| Step 3: Step 2 + education (≥college=1) and income (≥$25,000/year=1) | 1.00 (Reference) | 0.83 (0.65 – 1.07); P =0.146 |
| Step 4: Step 3 + demographic variables* | 1.00 (Reference) | 0.80 (0.61 – 1.04); P =0.089 |
| Step 5: Step 4 + general health, depression and mini-mental state examination score | 1.00 (Reference) | 0.80 (0.61 – 1.06); P =0.125 |
| Step 6: Step 5 + medical history** | 1.00 (Reference) | 0.79 (0.59– 1.06); P =0.117 |

* Demographics: being married, living alone, current smoking, alcohol consumption,

** Medical history: heart failure, pneumonia, chronic obstructive pulmonary disease, stroke, coronary artery disease, hypertension, diabetes mellitus, chronic kidney disease, arthritis and cancer.

## Table 4

Other Correlates of Pneumococcal Vaccination Use

| Covariates | Receipt of Pneumococcal Vaccination, n (%) | OR (95% Confidence Interval) *P*-Value | |
|---|---|---|---|
| | | Unadjusted | Adjusted* |
| Age† | | | |
| <72 (n=2,199) | 514 (23) | Reference (1.00) | Reference (1.00) |
| ≥72 (n=2,940) | 884 (30) | 1.41 (1.24–1.60) <.001 | 1.31 (1.13–1.52) <.001 |
| Sex† | | | |
| Male (n=2.216) | 606 (27) | Reference (1.00) | Reference (1.00) |
| Female (n=2,923) | 792 (27) | 0.99 (0.87–1.12) .84 | 1.02 (0.87–1.19) .80 |
| Married | | | |
| No (n=693) | 172 (25) | Reference (1.00) | Reference (1.00) |
| Yes (n=897) | 227 (25) | 1.03 (0.82–1.29) .82 | 0.84 (0.61–1.17) .31 |
| Annual income, $ | | | |
| <25,000 (n=1,136) | 262 (23) | Reference (1.00) | Reference (1.00) |
| ≥25,000 (n=454) | 137 (30) | 1.44 (1.13–1.84) .003 | 1.20 (0.87–1.66) .26 |
| Education | | | |
| <College (n=985) | 209 (21) | Reference (1.00) | Reference (1.00) |
| ≥College (n=605) | 190 (31) | 1.70 (1.35–2.14) <.001 | 1.39 (1.04–1.85) .03 |
| Influenza vaccination | | | |
| No (n=943) | 107 (11) | Reference (1.00) | Reference (1.00) |
| Yes (n=647) | 292 (45) | 6.43 (5.00–8.28) <.001 | 5.80 (4.45–7.55) <.001 |
| Pneumonia | | | |
| No (n=1,161) | 246 (21) | Reference (1.00) | Reference (1.00) |
| Yes (n=429) | 153 (36) | 2.06 (1.62–2.63) <.001 | 1.82 (1.39–2.40) <.001 |
| Chronic obstructive pulmonary disease | | | |
| No (n=1,381) | 318 (23) | Reference (1.00) | Reference (1.00) |
| Yes (n=209) | 81 (39) | 2.12 (1.56–2.87) <.001 | 1.65 (1.16–2.34) .005 |
| Hypertension | | | |
| No (n=698) | 165 (24) | Reference (1.00) | Reference (1.00) |
| Yes (n=892) | 234 (26) | 1.15 (0.91–1.45) .24 | 1.17 (0.90–1.53) .26 |
| Arthritis | | | |
| No (n=734) | 156 (21) | Reference (1.00) | Reference (1.00) |
| Yes (n=856) | 243 (28) | 1.47 (1.17–1.85) .001 | 1.44 (1.10–1.87) .007 |
| Cancer | | | |
| No (n=1,424) | 345 (24) | Reference (1.00) | Reference (1.00) |
| Yes (n=166) | 54 (33) | 1.51 (1.07–2.13) .02 | 1.30 (0.88–1.93) .18 |

*Model adjusted for other covariates described in step 6 in Table 2.

†Data for age and sex come from prebalanced data set (N=5,139). Adjusted odds ratio (OR) comes from model adjusted for other covariates described in step 6 in Table 2 plus age and sex. Data for other covariates come from postmatched cohort (N=1,590).