

# Does Frailty Modify the Effect of Race on Influenza Vaccination within Nursing Facilities in Michigan, 2005-2006?

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**Abstract** Nursing home racial composition is associated with vaccine uptake; black residents are less well immunized than white residents. To determine if health status modifies the effect of race on receiving vaccination among nursing home residents, we used cross-sectional data from the Centers for Medicare & Medicaid Services for Michigan from October 1, 2005 through March 31, 2006 in 291 racially mixed nursing facilities (n=66,895 residents). Analyses included multilevel models, stratified by the proportion of black residents in the nursing home, to assess whether frailty, measured with the Cognitive Performance Scale (CPS), the Activities of Daily Living (ADL), and the Changes in Health, End-stage disease and Symptoms and Signs (CHESS), contributed to vaccination inequity (i.e., white-black difference) within nursing homes. In facilities with few (<5%) blacks, the median vaccination inequity increased when comparing non-frail to frail (CPS) residents: from 4.4 to 14.5 percentage points; ADL: 3.6 to 8.7; and CHESS: 4.1 to 9.4. Among residents of nursing homes with majority (> 50%) blacks, the inequity decreased with increasing frailty (CPS: 8.7 to 0.8; ADL: 9.3 to 2.1; and CHESS: 6.7 to 4.6). Frail residents of minority status within a facility were less likely to be vaccinated than either healthier minority status residents or majority status residents, frail or healthy.

**Keywords:** vaccination, nursing home, frailty, racial inequity

## 1. Introduction

The influenza vaccine is recommended for nursing home residents and persons with chronic underlying conditions. A national white-black difference in vaccine receipt has consistently remained at about 8 percentage points [2,3]. The biggest inequities were associated with the nursing home itself (higher vs lower quality); however, there were also white-black differences within homes. In a study examining influenza vaccination in nursing homes in Michigan, racial differences *within* nursing homes were reported in vaccine receipt, refusals, and in being offered the vaccine, with and without adjustment for confounders [4]. The adjusted median range of inequity (i.e., white – black) *within* homes, stratified by proportion black residents in the facility, was 5.0 to 5.6 percentage points. The racial difference in refusing vaccine (range 2.1-2.5 percentage points) was about the same as the differences in not being offered the vaccine (2.2-3.0 percentage points) [1]. Offering an influenza vaccine is likely one of the least labor-intensive preventive care service offered in nursing homes and therefore racial differences in this service is likely

indicative of more serious racial differences in quality of care.

One study found that blacks often enter nursing homes in poorer health than whites [5]. We found in a previous study that very ill nursing home residents were less likely to receive the influenza vaccine [6]; however, we were unable to determine if those residents refused or were not offered the vaccine.

Several studies have shown that poorer health may also be associated with the inability to access health care services such as vaccination, among community-dwelling adults [7,8]. Because difficulty in accessing healthcare providers is not an obstacle in nursing homes, any *frailty*-related difference in nursing homes would likely be due to attitudes and beliefs by staff resulting in residents not being offered the vaccine, residents' or their guardians' refusal of the vaccine, or vaccination policies (e.g., timing, frequency of offering vaccine, protocols such as standing orders, etc.).

We hypothesized that the roughly 5.0-5.6 percentage point racial gap in vaccination among nursing home residents in Michigan [4] may be due to blacks being more frail and therefore were either not being offered the vaccine or refused the vaccine more often than their white counterparts. We used measures of cognition, functioning and end-stage symptoms and comorbidity, as reported for

nursing home residents to the Centers for Medicaid and Medicare Services’ (CMS).

## 2. Methods and Materials

### 2.1. Study Population

During the 2005-2006 influenza vaccination season (October 1 through March 31), there were 426 Medicare- and Medicaid-certified nursing facilities in Michigan. 18 were hospital-owned, post-acute recuperative facilities serving mainly Medicare-eligible residents. Since our study focused on the traditional nursing home population, we excluded those facilities, and 5 facilities that did not have complete data from the analyses. We included only residents from racially mixed (i.e., at least one black resident and at least one white resident) nursing homes (291 facilities out of 403) as our analysis aimed to evaluate the lower vaccination coverage among black nursing home residents. Less than 2% of nursing home residents in Michigan were other than white or black race and are therefore excluded [4].

We used LinkPlus software for de-duplication to identify unique residents with multiple assessments [9]. From October 1, 2005 through March 31, 2006, 72,458 resident assessments in racially mixed homes represented 66,895 unique residents. This includes all residents who lived in a *racially mixed* nursing facility in Michigan during the study.

### 2.2. Resident-Level Data

Nurses conduct resident assessments at nursing home admission and discharge, annually, when a significant change in health occurs, and according to Medicare or state requirements. The assessments reside in the CMS’ Minimum Data Set (MDS 2.0). Nurses record the assessment and care screening data in the resident assessment instruments (RAI) for all residents, pursuant to the Omnibus Budget Reconciliation Act of 1987 (OBRA 87) [10]. For residents with influenza immunization data (collected October 1 to June 30 annually), we obtained MDS data from the most current and/or most complete assessment conducted. Other data included the level of education, gender, age, primary payment source, and race. Instructions for completing the residents’ assessments includes reporting the race as the category ‘within which the resident places self [11]. The RAI has one variable for race/ethnicity with 5 category responses: 1) American Indian/Alaskan native, 2) Asian/Pacific Islander, 3) Black, not of Hispanic origin, 4) Hispanic, and 5) White, not of Hispanic origin. Residents whose race was reported as other than white or black comprised < 2% of the nursing home residents in Michigan and were excluded.

The MDS Cognitive Performance Scale (MDS-CPS) is based on 5 MDS items and classifies residents into 7 cognitive performance levels, 0 to 6 [12]. Residents were classified into 3 groups based on established cutpoints that have been validated with high sensitivity and specificity according to neurologic diagnostic criteria to be specifically used with the MDS [12]. We also found support of these categories by examining of logit plots of cognitive performance level by vaccination status (Table 1).

**Table 1. Scores on Frailty Measures and Frequencies of Vaccination by Race Among Residents of 291 Racially Mixed Nursing Homes, Michigan, 2005-2006**

N=291 racially mixed facilities	All		Race		Vaccination Status			Race					
			Whites	Blacks	Vaccinated	Refused	Not Offered&	Whites			Blacks		
								Vaccination Status			Vaccination Status		
								Vaccinated	Refused	Not Offered&	Vaccinated	Refused	Not Offered&
N	%	%	%	%	%	%	%	%	%	%	%	%	
<b>MDS* Activities of Daily Living (ADL) Scale</b>													
1st quartile	15,288	21.10	21.1	21.3	56.5	14.1	29.4	59.4	13.4	27.2	43.3	17.1	39.6
2nd quartile	18,239	25.17	25.3	24.4	56.8	14.0	29.2	59.9	13.4	26.7	41.4	17.0	41.6
3rd quartile	16,917	23.35	23.3	23.5	57.5	13.9	28.5	60.5	13.1	26.4	43.6	17.8	38.6
4th quartile	17,983	24.82	24.8	25.1	56.7	14.3	29.0	59.7	13.8	26.5	42.7	16.8	40.5
Missing	4,034	5.57	5.5	5.7	56.3	13.6	30.1	59.5	13.0	27.5	41.5	16.4	42.1
<b>Changes in Health, End-stage disease and Symptoms and Signs (CHES) score</b>													
0-1 (no clinical frailty)	43,898	60.58	60.7	60.2	56.8	14.1	29.1	59.8	13.4	26.7	42.6	17.2	40.2
2-5 (clinical frailty)	28,563	39.42	39.3	39.8	56.9	14.0	29.1	59.9	13.4	26.7	42.7	17.0	40.3
<b>MDS Cognitive Performance Scale (CPS)</b>													
Intact/Borderline (0-1)	23,681	32.68	32.6	33.2	56.6	14.2	29.2	59.9	13.5	26.6	41.6	17.4	41.0
Mild/Moderate impairment (2-3)	29,362	40.52	40.7	39.7	57.1	14.1	28.9	59.9	13.4	26.7	43.5	17.1	39.4
Moderately Severe to Very Severe impairment (4-6)	15,067	20.79	20.8	21.0	56.8	14.0	29.2	59.8	13.4	26.9	43.0	16.9	40.1
Missing	4,351	6.00	6.0	6.1	56.7	13.4	29.9	59.9	12.8	27.2	41.5	16.2	42.3
<b>End-stage disease, 6 or fewer months to live</b>													
Yes	2,168	3.2	3.4	2.3	62.4	14.1	23.5	65.5	13.3	21.2	40.7	20.0	39.3
No	65,400	96.8	96.6	97.7	56.7	14.1	29.2	59.7	13.4	26.9	42.7	17.1	40.1

Resident characteristics: race and vaccination													
Sex													
Female	48,358	66.7	68.1	60.5	59.0	14.1	27.0	61.7	13.4	24.9	44.5	17.4	38.1
Male	24,100	33.3	31.9	39.5	52.6	14.1	33.4	55.9	13.4	30.7	39.9	16.7	43.5
Medicaid as a payment source (per diem)													
Yes	16,157	22.3	20.9	28.7	74.3	12.6	13.1	79.6	10.9	9.5	56.0	18.4	25.6
No	56,304	77.7	79.1	71.3	51.8	14.5	33.7	54.6	14.1	31.3	37.3	16.6	46.1
Medicare as a payment source (per diem)													
Yes	35,580	39.5	40.5	33.4	61.3	14.0	24.7	63.9	13.5	22.6	42.7	17.1	40.2
No	54,543	60.5	59.5	66.6	60.0	57.6	63.0	63.3	11.6	25.1	43.2	16.8	40.0
Private pay as a payment source													
Yes	15,776	21.8	23.6	13.4	60.4	14.5	25.1	62.9	13.9	23.2	40.0	18.9	41.1
No	56,685	78.2	76.4	86.6	55.9	14.0	30.1	59.0	13.2	27.8	43.1	16.8	40.1
Education													
< HS	13,438	18.5	18.4	19.1	57.1	14.0	28.9	60.0	13.4	26.6	44.2	16.5	39.3
HS	19,111	26.4	26.3	26.6	57.2	13.9	28.8	60.3	13.3	26.3	43.0	16.8	40.3
> HS	9,206	12.7	12.7	12.8	55.7	14.8	29.5	58.6	14.1	27.2	42.2	17.7	40.1
Missing	30,706	42.4	42.5	41.6	56.8	14.0	29.2	59.9	13.2	26.9	41.9	17.5	40.7

\*MDS = Minimum Data Set

& Not Offered includes: Facility unable to obtain vaccine, resident not offered the vaccine for no reason, resident not in facility during influenza vaccination season according to report but not according to assessment date, and contraindication

The MDS Activity of Daily Living (ADL)—Long Form is a measure including 7 ADLs and the resident's relative independence in: 1) dressing; 2) personal hygiene; 3) toilet use; 4) locomotion or movement such as between rooms on the same floor; 5) transfer between surfaces such as beds and chairs; 6) bed mobility or how the resident moves to and from the lying position; and 7) eating. Each of the 7 ADLs can be scored from 0 to 4 resulting in a scale from 0 to 28. The scores for each ADL include 0= independent; 1=needs supervision; 2= needs limited assistance; 3= needs extensive assistance; and 4=total dependence or the activity did not occur [13]. Because we combined 7 ADLs, we used quartiles of the population to define this frailty measure as this was more meaningful than defining new categories for such a combination.

The Minimum Data Set—Changes in Health, End-stage disease and Symptoms and Signs (MDS-CHESS) score is a composite measure focused on changes in health, end-stage disease, and symptoms and signs of medical problems [14]. The MDS-CHESS is a 6-point scale, ranging from 0 (no instability) to 5 (high instability). The scale is created from four components. Individuals receive a score of 0 to 2 for the following 5 symptoms: dehydration, shortness of breath, vomiting, weight loss, or leaves  $\geq 25\%$  of food uneaten (0 for no symptoms; 1 for 1 symptom present; or 2 for  $\geq 2$  symptoms). Individuals receive an addition of 1 for each of the following: end-stage disease, decline in ADLs in the past 90 days (or since the last assessment if  $< 90$  days), and decline in cognition in the past 90 days (or since last assessment if  $< 90$  days). The CHESS score has been found to be a strong predictor of mortality, independent of age, gender, cognitive impairment, physical impairment (ADLs), and do-not-resuscitate (DNR) orders. The CHESS score is more predictive of mortality than the CPS or ADL scales [14]. To examine frailty using the CHESS score, we used categories recommended by the scale developers: residents were classified into 2 groups: 1) no clinical frailty (score of 0 or 1); and 2) clinical frailty (score of 2-5). Race and vaccination status data were available for all residents in the study, but 4,697 (6%) had data missing for

one or more of the frailty scales and were therefore excluded from the analyses.

The immunization supplement to the assessment instrument asks, "Did the resident receive the influenza vaccine in this facility for this year's influenza season?" The next question asks, "If influenza vaccine was not received, state reason: 1) not in facility during this year's flu season; 2) received outside of this facility; 3) not eligible; 4) offered and declined; 5) not offered [other]; and 6) inability to obtain vaccine [15]." We categorized residents as vaccinated whether they received the vaccine inside or outside the facility. Residents were categorized as not offered the vaccine if they were ineligible (e.g., contraindicated), were not offered [other], or the facility could not obtain vaccine. Residents were categorized as refused the vaccine if offered the vaccine but declined. There were no racial differences in proportions of residents ineligible, who accounted for  $<1\%$  of the population. We included these residents in the analysis. In addition, residents were categorized as not offered the vaccine if they were reported as not living in the facility during this year's influenza season but *their assessment was dated during the influenza season* ( $<5\%$  of the population).

### 2.3. Facility-level Data

We obtained facility-level data from the Online Survey and Certification Assessment Reporting System (OSCAR) submitted during 2005-2006 influenza vaccination season (October 1 through March 31) from CMS. OSCAR, a federal administrative database, contains structural, staffing and other information on nursing facilities. OSCAR includes data for all CMS-certified nursing homes. State survey and certification agencies collect the data, comprising part of the annual nursing home certification/ recertification process. Each facility completes a standardized form about the facility characteristics. We merged these data with the residents' MDS data by each facility of residence.

Reported facility-level covariates of interest include number of residents in the facility, proportion of black residents, number of nurse full-time equivalents, type of ownership, affiliation with a chain, CMS facility certification status (i.e., skilled nursing facility or nursing facility- Medicare and/or Medicaid certified), proportion of residents on Medicaid, and status of compliance with requirements for Medicare and/or Medicaid certification.

Because racial differences in vaccination have been reported in facilities with higher proportions of black residents, to appropriately assess *within* facility differences, we stratified facilities by percent of black residents: 0.1%-4.9%, 5%-19.9%, 20%-49.9%, and  $\geq 50\%$ . We chose these cutoffs to examine nursing homes with small proportions of black residents (e.g., 5%-19.9% and 20%-49.9%) and with homes with black majorities ( $\geq 50\%$ ).

## 2.4. Statistical Analysis

We present descriptive analyses for the population overall and report vaccination coverage received, refused, and not offered (includes contraindicated,  $<2\%$ ) by race and frailty in facilities grouped by percent of black residents.

Frailty, defined by the three scales individually, was assessed as a multiplicative interaction [16] with race to determine if vaccination status varied by race within frailty groups. We used a polytomous multilevel model to obtain adjusted probabilities for vaccination by race and included the three scales measuring frailty. The following resident-level covariates were included: age, gender, level of education, length of stay, Medicaid payment, and private payment. Nursing home-level covariates were: number of residents in the facility, proportion black residents in the facility during the influenza season, facility's affiliation with multi-facility chain, type of facility ownership, type of CMS certification, number of nurse full-time equivalents, compliance with program requirements for Medicare and/or Medicaid certification, and proportion of residents on Medicaid were all included as covariates. The frailty race interaction was assessed for each frailty scale in the overall population, within each of the 4 strata of nursing homes, providing 12 polytomous (i.e.,  $> 2$  category dependent variable) models. Multiplicative interaction terms were tested for each of the 3 frailty measurements in each of the 4 stratum of nursing homes. Statistical tests to assess significance of these interaction terms for *frailty* as a modifier of the effect of race on vaccination status are reported as p-values. To assess vaccination coverage *within* facilities, we used multilevel models to calculate probabilities of vaccine receipt, vaccine refusal, and vaccine not offered, for whites and blacks in each nursing home. Because the adjusted probabilities are facility-level estimates, they are interpreted as 'on average', black and white individual residents in the facility (i.e., controlling for the proportion of residents in the facility of each confounding variable held constant), holding nursing home constant. Data for individual nursing homes were categorized according to the percent black nursing home residents in the facility. To control for variability of vaccination *among* all nursing homes, we included random effects for each facility.

We used HLM v.6.08 software (Scientific Software International, Inc., Lincolnwood, IL) to conduct the multilevel analyses. The institutional review board of Emory University and the National Center for Immunization and Respiratory Disease's human subjects coordinator approved this study.

## 3. Results

### 3.1. Descriptive Population Data

Of the 66,895 residents in the study population, 11,756 (17.6%) were black and 55,139 (82.4%) were white. There was no racial difference in the approximately 8% of the residents who resided in  $>1$  nursing facility during the influenza vaccination season. Fewer than 4% of residents were legally responsible for themselves and there were no significant racial differences. The unadjusted vaccination coverage for Michigan residents of racially mixed homes ( $n=291$ ) was 56.9% (42.6% for black residents and 59.9% for white residents). Higher proportions of black residents were not offered the vaccine (40.2% vs 26.7%) and refused the vaccine (17.1% vs 13.4%) than white residents. In the 118 nursing homes with the fewest black residents, the proportion of black residents reported receipt of a Medicaid per diem was larger than the proportion of whites (26.8% vs 21.6%) and a larger proportion of white residents had private payment as a funding source than blacks (26.0% vs 18.4%). Residents on Medicaid had higher unadjusted vaccination coverage than did residents with a private funding source (74.3% vs 60.4%).

Whites did not vary from blacks by frailty; when comparing level of frailty between white and black residents, for each level of the ADL, CPS, and CHES scales, the difference in proportion between whites and blacks was  $\leq 1$  percentage point.

### 3.2. Multilevel Modeling Results

For frailty measured by the cognitive performance scale (CPS), the effect of race was modified by frailty for receipt of the vaccine ( $p=0.03$ ) only in the predominantly whites homes (0.1%-4.9% blacks). The white-black gap in vaccination among the moderately to very severely impaired residents was 14.5 percentage points, compared with the most intact residents, 4.4 percentage points. (Table 2) For frailty measured by the activities of daily living scale (ADL), the effect of race was modified by frailty for receipt of the vaccine ( $p=0.04$ ) in the predominantly whites homes (0.1%-4.9% blacks) and also in the predominantly black homes ( $\geq 50\%$  blacks,  $p=0.04$ ). In the predominantly white homes, the white-black gap in vaccination among the highest quartile of impaired residents was 8.7 percentage points, compared with the lowest quartile of impaired residents, 3.6 percentage points. In the predominantly black homes, the white-black gap in vaccination among the highest quartile of impaired residents was 2.1 percentage points, compared with the lowest quartile of impaired residents, 9.3 percentage points. For frailty measured by the CHES scale, the effect of race was modified by frailty for receipt of the vaccine ( $p=0.01$ ) only in the predominantly whites homes (0.1%-4.9% blacks). The white-black gap in vaccination among the most severely impaired residents was 9.4

percentage points, compared with the most intact residents, 4.1 percentage points.

We stratified adjusted probabilities of vaccination by race by proportion of black residents in the nursing home (Table 2) using polytomous multilevel models. Although the dependent variable in the model was at the resident level, the multilevel model accounts for variation at multiple levels and provides both facility- and resident-level estimates. For example, the median probability of

vaccination for the 40 facilities with  $\geq 50\%$  black residents was 39.2% for all borderline or intact (i.e., non-frail according to CPS) black nursing home residents, controlling for the facility average (of the facilities in that stratum) of the confounders listed. The median probability of refusing vaccination for the 33 facilities with 20%-49.9% black residents was 10.4% for all highly frail (according to CHES) white residents, controlling for the facility average of the confounders.

**Table 2. Adjusted vaccination coverage by percent black residents in the facility, effect modification of race with frailty, Michigan, 2005-2006**

	Cognitive Performance Scale			Activities of Daily Living			Changes in Health, End-Stage Disease, and Symptoms and Signs		
	Black	White	Difference	Black	White	Difference	Black	White	Difference
0.1%-4.9% Black									
1.*	70.5	75.1	4.4	71.5	75.1	3.6	70.7	75.1	4.1
2.	71.0	74.6	3.4	68.9	75.2	6.2	65.8	75.3	9.4
3.	59.7	74.6	14.5	66.7	75.5	8.0			
4.				66.2	75.1	8.7			
5%-19.9% Black									
1.*	60.6	66.1	5.0	61.4	66.1	4.2	60.7	66.1	5.0
2.	61.5	66.9	5.0	59.3	65.9	6.3	57.4	65.0	7.0
3.	58.1	67.0	8.5	61.3	68.2	6.2			
4.				60.1	66.6	6.2			
20%-49.9% Black									
1.*	51.3	57.7	6.1	52.1	57.7	5.4	53.0	57.7	4.1
2.	52.5	57.4	4.6	51.7	60.4	7.1	52.4	58.9	5.6
3.	52.1	55.4	3.2	56.3	58.0	1.7			
4.				53.5	57.6	4.0			
>50% Black									
1.*	39.2	49.3	8.7	36.5	49.3	9.3	42.0	48.9	6.7
2.	42.3	47.7	5.3	36.1	43.0	5.8	43.9	48.2	4.6
3.	42.0	41.7	0.8	36.7	38.9	2.5			
4.				36.8	40.7	2.1			

\*1=low frailty, 4=high frailty

Probabilities are **medians** for the facilities in that group and therefore do not add to 100%; 95% confidence intervals around the medians are reported.

\*Adjusted: Multilevel model included frailty scales (categorical variables) and covariates: sex, level of education, Medicaid, Private pay, Medicare, age, number of residents in the facility, proportion African-Americans in the facility, facility's affiliation with multi-facility chain, type of ownership, type of certification, compliance with program requirements for Medicare and/or Medicaid certification, number of nurse full-time equivalents, and proportions of residents on Medicaid, Medicare, and Private Pay

\*\*W-B diff: median white-black differences of facilities in each stratum.

In facilities with 0.1%-4.9% black residents, the facility inequity in vaccination was narrower among non-frail or borderline/intact residents according to the CPS and CHES scales and the first quartile of the ADL scale (White- Black (W-B): CPS: 4.4; ADL: 3.6; and CHES: 4.1). The inequities among the most highly frail residents

in the 118 facilities with fewer than 5% black residents was due to the large median inequity in not being offered the vaccine (W-B: CPS: -8.7; ADL: -6.0; and CHES: -7.2). (Table 3) The same trend occurred in nursing homes with 5%-19.9% black residents for all three scales.

**Table 3. Adjusted proportions not offered vaccine by percent black residents in the facility, effect modification of race with frailty, Michigan, 2005-2006**

	Cognitive Performance Scale			Activities of Daily Living			Changes in Health, End-Stage Disease, and Symptoms and Signs		
	Black	White	Difference	Black	White	Difference	Black	White	Difference
0.1%-4.9% Black									
1.*	15.2	14.0	-1.0	16.8	14.0	3.6	13.1	14.0	0.7
2.	13.9	13.9	0	18.3	14.3	6.2	21.1	13.8	-7.2
3.	22.5	13.9	-8.7	10.5	13.4	8.0			
4.				19.1	13.2	8.7			
5%-19.9% Black									
1.*	25.0	22.4	-2.5	24.1	22.4	-1.7	25.3	22.4	-2.8
2.	25.0	22.3	-2.6	26.8	22.2	-4.4	26.4	22.8	-3.7
3.	27.9	21.9	-5.7	23.5	21.2	-2.4			
4.				26.5	21.5	-4.4			
20%-49.9% Black									
1.*	27.2	23.0	-3.5	26.1	23.0	-2.3	26.4	23.0	-3.0
2.	25.9	22.9	-2.4	27.7	20.4	-6.9	26.1	23.2	-1.9

3.	26.6	24.7	-1.3	23.0	22.6	0.0			
4.				25.0	23.2	-1.0			
>50% Black									
1.*	42.1	33.4	-7.1	46.3	33.3	-11.5	38.6	33.2	-4.5
2.	39.5	35.4	-4.3	45.3	38.9	-4.8	37.1	34.6	-1.6
3.	39.3	42.0	2.5	45.0	43.8	-0.6			
4.				45.2	48.1	2.7			

\*1=low frailty, 4=high frailty

Probabilities are **medians** for the facilities in that group and therefore do not add to 100%; 95% confidence intervals around the medians are reported.

\*Adjusted: Multilevel model included frailty scales (categorical variables) and covariates: sex, level of education, Medicaid, Private pay, Medicare, age, number of residents in the facility, proportion African-Americans in the facility, facility's affiliation with multi-facility chain, type of ownership, type of certification, compliance with program requirements for Medicare and/or Medicaid certification, number of nurse full-time equivalents, and proportions of residents on Medicaid, Medicare, and Private Pay

\*\*W-B diff: median white-black differences of facilities in each stratum.

Among residents of nursing homes with  $\geq 50\%$  black residents, the non-frail residents had the greatest inequity in vaccination compared with their frail counterparts according to all scales (W-B: CPS: 8.7; ADL: 9.3; and CHES: 6.7). Within black majority facilities, the most highly frail white residents had lower vaccination coverage than their less frail white counterparts, but still higher vaccination coverage than frail blacks residents, according to two of the three frailty scales (W-B: ADL 4<sup>th</sup> quartile: 2.1; and CHES highly frail: 4.6). The narrower inequity in vaccination in those nursing homes among the frailest residents compared with less frail residents was associated with higher median probabilities of not being offered the vaccine among frail whites than among frail blacks for two of the three scales (W-B: CPS: 2.5; ADL:

2.7). We observed the same trend in inequity in nursing homes with 20%-49.9% black residents for the CPS and ADL scales, but less of a racial gap in vaccination uptake for the CHES scale among the frailest white and black residents.

The inequity in refusing the vaccine (<6%) did not vary much according to the CPS (range: median W-B difference in refusing: -1.1 to -5.4) and CHES (range: median W-B difference in refusing: -0.9 to -4.9) scales in any of the nursing homes; blacks consistently reported higher levels of refusing than whites, except in homes with  $\geq 50\%$  black residents among residents in the 1<sup>st</sup> quartile of ADL (median W-B difference in refusing: 0.9 percentage points). (Table 4)

**Table 4. Adjusted proportions refused vaccine by percent black residents in the facility, effect modification of race with frailty, Michigan, 2005-2006**

	Cognitive Performance Scale			Activities of Daily Living			Changes in Health, End-Stage Disease, and Symptoms and Signs		
	Black	White	Difference	Black	White	Difference	Black	White	Difference
0.1%-4.9% Black									
1.*	13.2	10.0	-3.2	10.7	10.0	-0.7	14.9	10.0	-4.9
2.	14.0	10.6	-3.4	11.6	9.7	-2.1	12.0	10.0	-2.0
3.	16.2	10.6	-5.4	21.3	10.2	-11.1			
4.				13.2	10.9	-2.4			
5%-19.9% Black									
1.*	12.2	9.8	-2.2	12.3	9.8	-2.4	11.9	9.8	-1.9
2.	11.5	9.2	-2.1	11.9	10.0	-1.6	13.5	10.4	-2.9
3.	12.0	9.4	-2.3	12.8	9.0	-3.6			
4.				11.8	10.0	-1.4			
20%-49.9% Black									
1.*	13.2	10.7	-2.1	13.7	10.7	-2.5	11.8	10.7	-0.9
2.	13.4	11.2	-1.8	11.7	11.1	-0.4	13.2	9.7	-3.0
3.	13.0	11.2	-1.5	12.6	10.9	-1.8			
4.				13.4	10.4	-2.8			
>50% Black									
1.*	13.6	11.5	-1.1	11.0	11.4	0.9	13.6	11.6	-1.7
2.	12.5	10.7	-1.5	13.3	11.9	-0.6	12.9	10.2	-2.7
3.	13.3	9.5	-3.9	12.6	10.7	-1.7			
4.				12.1	6.7	-5.9			

\*1=low frailty, 4=high frailty

Probabilities are **medians** for the facilities in that group and therefore do not add to 100%; 95% confidence intervals around the medians are reported.

\*Adjusted: Multilevel model included frailty scales (categorical variables) and covariates: sex, level of education, Medicaid, Private pay, Medicare, age, number of residents in the facility, proportion African-Americans in the facility, facility's affiliation with multi-facility chain, type of ownership, type of certification, compliance with program requirements for Medicare and/or Medicaid certification, number of nurse full-time equivalents, and proportions of residents on Medicaid, Medicare, and Private Pay

\*\*W-B diff: median white-black differences of facilities in each stratum.

### 4. Discussion

Frailty modified the race's effect on vaccination status in 2 of the strata of nursing homes: those with the fewest

(0.1% to 4.9%) and most ( $\geq 50\%$ ) blacks. High frailty was associated with a narrow W-B difference in vaccination among residents living in nursing homes in which blacks were in the majority (i.e.,  $\geq 50\%$  black residents). The reason for this small racial difference was primarily due to lower levels of offering vaccine to frail

white residents compared with less frail white residents according to the CPS and ADL frailty scales. A similar trend was found for black residents when they were in predominantly white homes (i.e., the 118 homes with 0.1%-4.9% black residents). The racial gap (W-B) in vaccine receipt was narrow for the healthiest residents according to the three frailty scales in these predominantly white homes because the healthier black residents in those homes are offered the vaccine more often. The W-B difference in refusing vaccine varied little by level of frailty for the CPS and CHESS scales within the 4 strata of nursing homes but did vary for the ADL scale in the racially mixed nursing homes with the most and the least black residents, possibly due to small sample size of minority residents in the most severe quartile of frailty according to the ADL scale in those homes.

Although a previous study found that frailty confounds the relationship between receipt of vaccine and influenza-related disease among community-dwelling seniors [8], race was not considered to be an important confounder of that relationship. Our results suggest that frailty modifies the effect measure of race on vaccination coverage *at the facility level in homes stratified by proportion of black residents*. A frail resident in the racial minority of the nursing home was less likely to be vaccinated than the frail resident who is in the racial majority of the same nursing home. The reason may be that the frail resident in the racial minority of the nursing home is more likely to not be offered the vaccine, rather than refusing the vaccine. This finding is consistent with the IOM report on racial disparities in health outcomes that found patient-level factors (including patient preferences and treatment refusal) contribute the least to disparities [17].

Some studies have conflated race with socio-economic indicators, obscuring their utility in outcomes research [18]. We controlled such factors separately. For example, level of education of black and white residents was similar in nursing homes with 0.1%-4.9% black residents (data not presented). However, in these 118 nursing homes, the proportion of black residents reported receipt of a Medicaid per diem was larger than the proportion of whites and a larger proportion of white residents had private payment as a funding source than blacks. Residents on Medicaid had higher unadjusted vaccination coverage than did residents with a private funding source so the finding that frail black residents were less likely to be vaccinated because they were not offered the vaccine in these homes is troubling. Previous provider-patient interactions or perhaps cultural differences may influence staff to be less likely to offer frail residents reported to be in the minority race of the nursing home the vaccine. It may be that residents' legal guardians or family members may also refuse vaccination for residents, particularly among the cognitively impaired residents who were reported to refuse the vaccine. According to the IOM, studies in various populations have shown that provider stereotyping and bias are likely influences on health outcomes for minority patients [17].

Although not being offered the vaccine did not vary to a sizable extent between the racial groups by level of frailty, 29% of all residents were not offered the vaccine and approximately 2-3 percentage points (i.e., half) of the inequity in receiving the vaccine within nursing homes

was due to blacks not being offered the vaccine more than their white counterparts. In a previous analysis we found that vaccination coverage was higher for all residents of nursing homes with standing order protocols (SOPs) for vaccinations and that the racial difference in vaccination among those homes was negligible [19]. SOPs for vaccination authorize nurses and other healthcare personnel, where allowed by state law, to assess patient's vaccination status and administer vaccinations according to a protocol approved by the institution, a physician, or other attending provider without the need for a physician's examination or direct order at the time of the interaction [20].

Although vaccine refusal did not vary to a sizable extent between the racial groups by level of frailty, 14% of all residents refused the vaccine and approximately half of the inequity in receiving the vaccine within nursing homes was due to blacks refusing vaccination more than their white counterparts. Further research may include an intervention study to determine if refusals among black residents could be lowered by addressing cultural competency of nursing home staff, among other possible reasons for refusals. Studies have found racial disparities in quality of care when staff are racially homogenous in nursing homes with racially mixed residents [21]. Our data, however, do not allow us to examine the role of staff racial composition in relation to resident's race. To lessen vaccine refusals, physicians could give strong recommendations for vaccination during visits with representatives of residents (only 4% of residents are legally responsible for themselves) [21]. These could be combined with addressing vaccine-related concerns, as was done successfully in one study of the pneumococcal vaccine among adult outpatients [22]. This approach could be adapted to the nursing home environment. Personalized presentation of information, along with quality assurance of staff communications' skills, would be important training components.

A limitation of our analyses is that the vaccination questions on the MDS form have not been validated; it is unclear how often the resident refuses or whether the legal guardian refuses vaccine. In addition, our data are cross-sectional during the influenza vaccination season. The date of vaccination was unknown so we could not tie the health condition of the resident to the day of vaccination, per se. However, because on average residents had > 1 assessment during the study period, we used the record that would indicate the highest level of frailty. Also, our results may not generalize to other states.

Understanding why frailty is associated with residents' minority status, white or black, according to racial mix of that home and not being offered the influenza vaccine could help reduce disparity. Also, frailty contributed little to the racial difference in refusing vaccine. These findings strengthen the case for further research into what is driving the racial gap in refusing and not offering the influenza vaccine within nursing homes.

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certify that, there are no conflicts of interest for any of the authors.

We also certify that, all authors participated sufficiently in the work to take public responsibility for the content. We certify that 1) we have made substantial contributions to the conception and design or analysis and interpretation of data; and 2) we have substantial contributions to drafting the article or revising it critically for important intellectual content; and 3) we have received approval of this version of the article submitted for your review.

We certify that the manuscript represents valid work, and neither this manuscript nor one with substantially similar content under our authorship has been published or is being considered for publication elsewhere.

We attest that, if requested by the editors, we will provide the data or will cooperate fully in obtaining and providing the data on which the manuscript is based for examination by the editors and their assignees.

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### Conflict of Interest Disclosures

Stefan Gravenstein is a consultant for Novavax, Merck, GlaxoSmithKline, and on the Speakers Bureau for SanofiAvenstis Pasteur, and GlaxoSmithKline.

### Author Contributions

Barbara Bardenheier was involved with the study concept and design, data analysis and interpretation, and preparation of the manuscript. Carolyn Furlow was involved with the data analysis, data interpretation, and critical review of the manuscript. Faruque Ahmed contributed to the analysis and interpretation of data, revising it critically for important intellectual content, and final approval of the version to be published. Carol Hogue was involved in reviewing data analysis and interpretation and preparation of the manuscript. Stefan Gravenstein contributed to concept, design, interpretation, and manuscript.

Elements of Financial/Personal Conflicts	Barbara Bardenheier		Carolyn Furlow		Faruque Ahmed		Carol J. R. Hogue		Stefan Gravenstein	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Employment/Affiliation		X		X		X		X		X
Grants/Funds		X		X		X		X		X
Honoraria		X		X		X		X		X
Speaker Forum		X		X		X		X		X
Consultant		X		X		X		X	X	
Stocks		X		X		X		X		X
Royalties		X		X		X		X		X
Expert Testimony		X		X		X		X		X
Board Member		X		X		X		X		X
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