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Pressure Injuries in Nursing Homes: Investigating Racial/Ethnic Differences Using National Data

RESEARCH

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ABSTRACT

Context: In the United States, Black nursing home (NH) residents have higher rates of pressure injury (PI) than White residents. Although some studies ascribe this to a relatively high proportion of Black residents in NHs with poor outcomes and limited resources, the factors that associate with PIs and their consequences across and within NHs remain poorly understood. Also, little is known about PIs among residents of differing races and ethnicities.

Objectives: Using four national datasets from 2016–2017, we evaluated U.S. NHs to characterize differences in PI-related outcomes among non-Hispanic Whites, non-Hispanic Blacks, Hispanics, Asians, American Indian or Alaska Natives, and Native Hawaiian or Other Pacific Islanders, and clarified the impact of resident-, facility-, and community-level characteristics on these outcomes.

Methods: We calculated the annual incidence rate of PIs, the probability of PI healing, and the prevalence of PI-associated pain and analgesic prescription. We determined the bivariate associations between each of these outcomes and race/ethnicity, and between each outcome and multiple potential covariates. Multivariable analyses then evaluated the associations between each outcome and race/ethnicity while adjusting for covariates.

Findings: In the bivariate analyses, the annual incidence rate of stage 2, 3, 4, and unstageable PIs for Whites was lower than Blacks and Hispanics, similar to American Indians or Alaska Natives, and higher than Asians and Native Hawaiians or Other Pacific Islanders. In the multivariable analyses, the PI incidence rate ratio was higher only among American Indians or Alaska Natives, and this difference was associated with a NH-level variable—the proportion of racial and ethnic minority residents. Other outcomes did not vary by race/ethnicity. An adjusted exploratory analysis was conducted to help explain the difference between the bivariate and multivariable analyses and revealed an important within-NH difference: Compared to Whites, the

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PI incidence rate ratios were higher in women who were Black, or American Indian or Alaska Native.

Limitations: Our findings are correlational and may be impacted by unevaluated variables and the limitations of administrative data.

Implications: In U.S. NHs, the annual incidence rate of PIs varies by race/ethnicity. Facility characteristics strongly influence this variation. Higher incidence rate ratios among racial and ethnic minority residents also are explained by differences within NHs and are striking among subgroups, including female residents who are Black, or American Indian or Alaska Native. Future research should evaluate the sexes separately and explore both across-NH and within-NH differences to determine whether there are structural inequities, bias, and disparate care.

INTRODUCTION

Pressure injuries (PIs) occur in 10–20% of nursing home (NH) residents and cause serious morbidity, increased utilisation of health care services, and excess mortality (Hajhosseini et al., 2020; White-Chu et al., 2011). Numerous surveys have identified resident-level and facility-level risk factors for PIs, including advanced age, chronic medical conditions, malnutrition, incontinence, prolonged length of stay, limited NH staffing and high staff turnover, and a lack of system-level prevention practices (Ahn et al., 2016; Cakmak et al., 2009; Hajhosseini et al., 2020).

In the United States, PI incidence and healing are also associated with resident race or ethnicity (Baumgarten et al., 2004; Bliss et al., 2015; Bliss et al., 2017). Some surveys suggest that this finding is explained by a high prevalence of poor outcomes in NHs with large concentrations of Black and Hispanic residents (Cai et al., 2010; Campbell et al., 2016; Howard & Taylor, 2009; Li et al., 2011; Li, Harrington, Mukamel, et al., 2015; Li, Harrington, Temkin-Greener, et al., 2015). Studies have been limited, however, and there are significant gaps in knowledge about the factors that explain the impact of PIs among racial and ethnic minorities, including populations that have not been extensively examined in prior research, such as Asians, American Indian or Alaska Natives, and Native Hawaiians or Other Pacific Islanders. This is of increasing importance given that the population of racial and ethnic minority residents in NHs is rising (Gruneir et al., 2008; Jang et al., 2019).

Studies of racial and ethnic differences in PI-related outcomes are needed to inform future health policy and quality initiatives that equitably promote the prevention and treatment of PIs and should be informed by the emerging understanding of the roles that systemic racism, discrimination, and other inequities play in health disparities (Bailey et al., 2017; Braveman et al., 2022; Shippee et al., 2020). Systemic racism, which refers to structures, policies, standards, and biases that unfairly benefit the majority race or ethnicity, and disadvantage racial and ethnic minorities, can impact individuals, organisations, and communities. In the long-term care setting, it may result in disparate care within facilities, the racial segregation of NHs, or the concentration of racial and ethnic minorities in NHs that have worse outcomes, are under-resourced, or are in areas of high social deprivation (Sloane et al., 2021). The U.S. National Institute on Minority Health and Health Disparities (NIMHD) has proposed a conceptual framework for health disparities research, which deconstructs this complex interplay of factors into five domains (biological, behavioural, sociocultural, environmental, and health care system) and four socioenvironmental levels of influence (individual, interpersonal, community, and societal) (NIMHD, 2017). This framework highlights the array of potential explanatory variables that might be explored when investigating potential disparities in racial and ethnic minorities, and also may be applied to other populations experiencing potential disparities, such as members of sexual and gender minority groups or those with social disadvantage due to extreme poverty. This framework may be particularly useful in the design of studies that can simultaneously evaluate multiple variables in large administrative datasets related to the individual (e.g., illness characteristics), the treatment setting (e.g., proportion of racial and ethnic minority NH residents), or the community (e.g., setting or regional poverty level) (Ahn et al., 2016; Campbell et al., 2016; Coleman et al., 2013; Comondore et al., 2009; Hajhosseini et al., 2020; Mor et al., 2004; Spector et al., 1988).

We merged two years of national NH data (2016 and 2017) and applied the NIMHD framework as a guide to examine racial and ethnic differences in PI incidence and healing, and PI-associated pain and analgesic use. Our aim was to characterise differences in PI-related outcomes among multiple racial and ethnic minority populations and clarify the potential impact of resident-, facility-, and community-level characteristics on these outcomes.

METHODS

Approval for the study was granted by the Albert Einstein College of Medicine Institutional Review Board. Resident consent was not required for the analysis of de-identified datasets obtained from the federal government through a data use agreement or available in the public domain.

STUDY POPULATION

We obtained national datasets that capture information about NH residents and facilities, and the communities in which they are located. In the U.S., there are more than 15,600 NHs, most of which are certified to provide long-term care and short-term skilled nursing care (Harris-Kojetin et al., 2019). The residents of NHs are mostly older adults who require room and board while receiving a variety of health and personal care services. The residents who require long-term care typically have multiple chronic conditions and a high level of disability. These residents receive nursing services, 24-hour supervision, assistance with activities of daily living, and rehabilitation services. Those residents who require skilled nursing support are mostly admitted for rehabilitation, often as part of transitional care between the hospital and home. These residents vary in the severity of illness and the specific needs addressed by the NH. NHs themselves also vary substantially in terms of ownership, funding, and the services provided. About 70% of NHs are privately owned and designated as for-profit entities; others are privately owned non-profit or government-owned entities (Harris-Kojetin et al., 2019). The quality of services offered, including staffing levels by nurses and care staff varies greatly and is associated with ownership, location, and other factors (Harrington et al., 2001; Spilsbury et al., 2011; U.S. Government Accountability Office, 2010).

DATA SOURCES

Data files from the 2016 and 2017 Long-Term Care Minimum Data Set version 3.0 (MDS 3.0), provided by the Centers for Medicare and Medicaid Services, were merged with three public use files (PUFs) from the same years: The Provider of Services (POS) file, Nursing Home Compare data, and the American Community Survey. The MDS 3.0 was merged with the POS and Nursing Home Compare data files by a provider number variable. The MDS 3.0 is a standardised, federally mandated assessment of health status for all NH residents in Medicare or Medicaid certified facilities. It is available from a federal repository and federal policies protect confidentiality and safeguard against misuse. It contains 172 items assessing sociodemographic and medical characteristics, physical and psychosocial functioning, cognition, pain, treatments, and payment source, and is administered on admission and, at minimum, approximately every 90 days thereafter. Each assessment indicates the presence and severity of PIs (i.e., nurse documentation of no PIs, or one or more stage 1, 2, 3 or 4, or unstageable PIs) and also records pain and analgesic prescribing using standardised questions. The POS file contains administrative data, updated quarterly, from hospital and non-hospital health care facilities, including name, location, and types of Medicare services provided. The Nursing Home Compare data file contains yearly information on the characteristics of Medicare or Medicaid certified NHs, including nurse staffing, bed count, and ownership status. The American Community Survey is a national population-based survey that obtains yearly census data on social, economic, housing, and demographic characteristics by geographic region.

DESCRIPTION OF VARIABLES

The MDS 3.0 categorises race and ethnicity as: non-Hispanic White, non-Hispanic Black, Hispanic, Asian, American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, and other multi-racial. Residents with missing data for the race and ethnicity variable were excluded from both the bivariate and multivariable analyses that included race.

Five PI-related outcome variables were derived from the MDS 3.0 assessments: 1) *annual incidence rate of stage 2,3,4, or unstageable PIs,* 2) *probability of PI healing,* 3) *PI-associated pain intensity,* 4) *PI-associated pro re nata (PRN or as-needed) analgesic (opioid) prescribing,* and 5) *PI-associated scheduled analgesic (opioid) prescribing.* The first two of these variables were based on NH admissions. A NH admission had a start date, an end date, and at least two consecutive MDS 3.0 assessments. The start date for the first NH admission was the date of the first MDS 3.0 assessment in 2016 or 2017; the date of the first MDS 3.0 assessment completed in 2016 was used if the resident was living in the NH prior to 2016. The end date of the first admission was defined by the earliest of three events—completion of a discharge MDS 3.0 assessment, the final assessment that occurred in the 2016-2017 dataset, or the end of a six-month period with no MDS 3.0 assessments. The six-month gap in assessments was used to define an admission's end date based on the observation that assessments were rarely resumed after two consecutive missing quarterly assessments. For those residents with more than one NH admission, subsequent start dates were the dates of the first MDS 3.0 assessment after the event that ended the prior admission, and the end dates were identified using the same criteria as the first admission.

The first outcome variable was the *annual incidence rate of stage 2,3,4, or unstageable PIs.* These stages, all of which are associated with medical complications (Cai et al., 2010), were recorded by registered nurses employed by the NH, who evaluated each area of skin injury using descriptions provided in the MDS 3.0 (e.g., stage 2—partial thickness loss of dermis with a red or

pink wound bed; stage 3—full thickness tissue loss; stage 4—full thickness tissue loss with exposed bone, muscle, or tendon; and unstageable—wound bed unseen due to necrosis or eschar formation). To calculate the annual incidence rate of stage 2,3,4, or unstageable PIs, each resident was first designated as having or not having an incident PI. An incident PI was recorded as present if for any admission, the resident's starting MDS 3.0 showed no PI present and the ending MDS 3.0 showed that a PI at stage 2 or worse was present (i.e., using the M300 items in the MDS 3.0). The population at risk was normalised by the duration of NH care, which measured the NH length of stay as the interval between the date of the first assessment and either the date of the assessment initially recording the presence of a PI or the end date of the last admission. The final calculation expressed the outcome in terms of the percentage of residents with at least one stage 2,3,4, or unstageable PI per year in the population at risk.

The second outcome variable, *probability of PI healing*, included all those admissions starting with an MDS 3.0 assessment documenting any type of PI. Healing was defined by the absence of any PI in one or more subsequent MDS 3.0 assessments 90–104 days following the first MDS 3.0 assessment with a documented PI (Bliss et al., 2017). The probability of healing indicated the complete resolution of PIs after a PI was documented.

The three other outcome variables were determined at the level of the individual MDS 3.0 assessment, rather than the admission, and used only those assessments with documentation of one or more stage 2,3,4, or unstageable PIs. *Pain intensity* was obtained from those assessments recording information from residents who could self-report and whose description of the pain was recorded by the nurse (using the MDS 3.0 J0600B item). *Pro re nata (PRN) analgesic prescribing* (using J0100B item) and *scheduled analgesic prescribing* (using the J0100A item) were recorded on each assessment and graded "yes" or "no", respectively.

Numerous potential PI-related covariates were extracted from the datasets. These covariates were at the resident-, facility-, or community-level, were reflected in the NIMHD framework's domains and levels of influence, and were selected based on information from prior NH studies of PIs or the clinical experience of the study team. Resident characteristics obtained from the MDS 3.0 included age, sex, medical diagnosis, prognosis, unintended weight loss or malnutrition, mobility, and mental status (Ahn et al., 2016; Coleman et al., 2013; Hajhosseini et al., 2020; Spector et al., 1988). All these variables were taken from the first assessment of each admission and rules were established to manage discrepancies that occurred across admissions. For example, if a discrepancy occurred in the designation as male/female, the sex category recorded more frequently was used, and if the age varied across assessments, an average was used if the difference did not exceed five years and age was considered missing if the discrepancy was more than five years. Medical diagnosis was often missing, and any diagnosis specified in any assessment during an admission was used in the analysis. For those residents with multiple medical diagnoses, each recorded diagnosis was separately considered as a variable and used in the analysis. We did not include a variable depicting the number of chronic medical conditions per individual given the challenges of documentation at different time points during varying durations of care (Kaldy, 2011), and instead relied on other resident-level variables to describe the extent to which illness was advanced, including prognosis, evidence of malnourishment, bedbound status, and others.

NH facility characteristics derived from the POS and Nursing Home Compare included location by zip code, location by state, ownership type, urban-rural classification, number of registered nurse (RN) hours and total nurse staffing per resident per day, and the number of federally certified beds (Comondore et al., 2009; Mor et al., 2004). Community-level data included the poverty quintile for each NH location, derived from the American Community Survey (Mor et al., 2004).

DATA ANALYSES

Data from 2016 and 2017 were combined and all residents with two or more MDS 3.0 assessments were included in the analysis. Analyses were performed in Stata version 17.0 (StataCorp LLC, 2019). Data were extracted and analysed between September 2019 and August 2022.

Bivariate associations were determined between each of the five PI outcome variables, respectively, and all other variables. For race and ethnicity categories and the other categorical covariates, the bivariate analyses compared the values for each outcome across the categories of the variable. For the continuous covariates, such as age, the means for those with and without each outcome were compared. The outcome of pain intensity was considered a quasi-continuous variable and bivariate associations with categorical covariates compared the mean value of the pain intensity score at each category level. Due to extremely large sample sizes, statistical significance cannot be used to indicate the clinical importance of any of the bivariate associations. Rather, each association was considered clinically meaningful if the size of the outcome difference was relatively large, compared to the expectation of no difference, and the confidence intervals did not overlap.

Multivariable analyses also were separately conducted for each outcome variable. These analyses determined the association between the outcome variable and other variables, including the race and ethnicity variable

and potential resident-, facility-, and community-level variables selected as likely confounders. Variables were considered to be confounders if the bivariate analyses demonstrated that they were associated with both the race and ethnicity variable and the outcome variable. A random effects Poisson regression analysis with admissions nested within NHs evaluated the annual incidence rate and estimated the incidence rate ratio of PIs associated with each racial and ethnic category, adjusted by the covariates selected for this analysis. Random effects logistic regression analyses were conducted to calculate the odds ratio of PI healing, PRN analgesic prescribing, and scheduled analgesic prescribing in relation to each variable. A random effects linear model was used to evaluate pain intensity. Standard errors in each of these analyses were adjusted for clustering of residents within NHs.

Many of the bivariate associations between race and ethnicity and PI-related outcomes did not continue when these associations were adjusted for covariates. This observation underscored the importance of these covariates in interpreting the outcomes related to race and ethnicity. To improve this interpretation, we undertook exploratory analyses focused specifically on one outcome, the annual incidence rate of PIs. We started with its bivariate associations with race and ethnicity categories and then sequentially adjusted the analysis using different sets of covariates. The aim was to determine which type of adjustment variable—resident-, facility-, or community-related—applied to the bivariate associations created a model that most resembled the fully adjusted multivariable analysis. The first adjustment added sex to the association between the race and ethnicity variable and the annual incidence rate, given the prominence of sex differences in the bivariate analyses. The second adjustment included other resident-level variables, specifically, medical diagnosis, prognosis, mobility, mental status, and short length of NH stay. The third and fourth were facility and community variables, respectively, including proportion of racial and ethnic minority residents in the NH, facility profit status, staffing, facility size, and poverty level of the NH location.

RESULTS

SAMPLE CHARACTERISTICS

During 2016 and 2017, 4,999,999 individuals resided in 15,791 U.S. NHs (Table 1). The mean resident age was 77.2 years (SD = 12.75) and 60.7% were women. More than three-quarters (78.2%) were non-Hispanic White; 11.4% were non-Hispanic Black, 5.3% were Hispanic, 1.6% were Asian, 0.3% were American Indian or Alaska Native, and 0.1% were Native Hawaiian or Other Pacific Islander. Medical diagnoses, mental status, and functional status varied widely. The most prevalent diagnoses were diabetes (35.1%), dementia (26.4%), chronic pulmonary disease (24.9%), heart failure (23.0%), end-stage renal disease (16.3%), and peripheral vascular disease (10.5%).

Facility characteristics also varied (Table 1). The mean NH proportion of racial and ethnic minority residents was 0.19 (SD = 0.22); 27.6% of NHs had populations that were ≥25% racial and ethnic minority and 11.1% had populations that were ≥50% racial and ethnic minority. Most NHs (71.7%) were in urban settings and 28.3% were rural. More than two-thirds (69.5%) were for-profit, 23.7% were nonprofit, and 6.8% were government-owned. The average number of certified beds was 105.9 (SD = 61.2) and the average number of staffing hours per resident per day was 4.2 (SD = 1.0). A total of 45.5% of the nursing homes were located in zip codes designated in the two highest poverty quintiles and 32.0% were in zip codes associated with the two lowest poverty quintiles (Table 1).

During 2016 and 2017, there were 7,051,036 admissions, approximately 2 million more than the number of NH residents during this period. Many residents had multiple admissions and almost two-thirds (61.8%) had at least one admission with <30 days elapsing between the initial MDS 3.0 assessment and the discharge assessment.

Among all NH residents during 2016 and 2017, the estimated annual incidence rate of stage 2,3,4, or unstageable PIs was 17.8%. Among residents with any stage PI, the probability of healing was 71.0%. Nearly all (99.9%) of the MDS 3.0 assessments recording a PI and the self-report of pain intensity noted the presence of some pain in the preceding five days; the mean pain score across these assessments was 5.6 on a scale normalised to a zero to 10 score. In 53.2% and 44.0% of these assessments, PRN and scheduled analgesics were ordered, respectively (Table 2).

BIVARIATE AND MULTIVARIABLE ANALYSES: RACE AND ETHNICITY

The bivariate analyses revealed many associations between the outcomes and other variables (Tables 4 and 5). The unadjusted annual incidence rate of PIs among non-Hispanic Whites—17.14% (95% confidence interval [CI] [17.07, 17.21])—was lower than non-Hispanic Blacks (20.63%, 95% CI [20.45, 20.81]) and Hispanics (17.94%, 95% CI [17.68, 18.20]), higher than Asians (14.34%, 95% CI [13.92, 14.78]) and Native Hawaiians or Other Pacific Islanders (15.12%, 95% CI [13.37, 17.03]), and similar to American Indian or Alaska Natives (16.87%, 95% CI [15.89, 17.90]). Compared to non-Hispanic Whites, non-Hispanic Blacks had a lower probability of PI healing and lower use of both PRN and scheduled analgesic use, and Hispanics and Asians had lower pain intensity and were prescribed fewer PRN and scheduled analgesics. In

RESIDENT CHARACTERISTICS	***N***	**% OR *M* ± *SD***
Age (years) (*M* ± *SD*)	4,992,810	77.18 ± 12.75
Race/ethnicity		
Non-Hispanic White	3,908,957	78.18
Non-Hispanic Black	571,819	11.44
Hispanic	264,369	5.29
Asian	78,128	1.56
American Indian or Alaska Native	16,872	0.34
Native Hawaiian or Other Pacific Islander	5,935	0.12
Other multi-racial	54,489	1.09
None specified[1]	99,430	1.99
Female	3,034,346	60.72
Specific medical diagnoses[2]		
Diabetes	2,475,593	35.11
Alzheimer's Dementia/Dementia	1,862,966	26.42
Asthma/COPD/Chronic Lung Disease	1,756,107	24.91
Heart Failure	1,622,647	23.01
End Stage Renal Disease	1,151,499	16.33
Peripheral Vascular Disease	741,235	10.51
Cancer	588,128	8.34
Respiratory Failure	460,343	6.53
Parkinson's Disease	299,206	4.24
Cirrhosis	83,720	1.19
Nutritional status		
Malnutrition	415,875	5.90
Unintended weight loss	918,425	13.99
Life prognosis < 6 months	373,386	5.30
ADL assistance scores[3] (median, interquartile range)		
Bathing self-performance	6,368,068	3.00 (1.00)
Bed mobility self-performance	6,572,724	3.00 (1.00)
Brief Interview for Mental Status Score[4] (*M* ± *SD*)	5,731,349	11.73 ± 4.09
Short stay (admission duration ≤ 30 days)	7,051,036	61.84
Admission duration (median number of days, interquartile range)	4,999,999	18 (67.0)
FACILITY CHARACTERISTICS	***N* = 15,791 TOTAL FACILITIES**	**% OR *M* ± *SD***
Number of certified beds (*M* ± *SD*)		105.94 ± 61.16
Number of bedbound residents (*M* ± *SD*)		69.64 ± 13.66
Nursing home size (*n*, %)		
<50 beds	2,041	12.93
50–99 beds	5,866	37.15
100–199 beds	6,951	44.02
>199 beds	933	5.91

(Contd.)

FACILITY CHARACTERISTICS	*N* = 15,791 TOTAL FACILITIES	% OR *M* ± *SD*
Nursing home setting (%)		
Urban	11,236	71.71
Rural	4,432	28.29
Nursing home profit status (*n*, %)		
For profit	10,970	69.47
Not-for-profit	3,743	23.70
Government	1,078	6.83
Nurse staffing (*M* ± *SD*)		
Reported registered nurse staffing (hours per resident per day)	15,223	0.85 ± 0.60
Total staffing (hours per resident per day)[5]	15,223	4.16 ± 1.04
Nursing homes in each zip code poverty quintile[6] (*n*, %)		
Q1	1,832	11.71
Q2	3,165	20.24
Q3	3,525	22.54
Q4	4,104	26.24
Q5	3,014	19.27
Proportion racial/ethnic minority residents[7]	15,791	0.19 ± 0.22

Table 1 Characteristics of nursing home residents (n = 4,999,999) and nursing home facilities in the U.S. in 2016 and 2017.

Note: COPD = Chronic Obstructive Pulmonary Disease; ADL = Activities of Daily Living.

[1] Defined as a response of "No" to all race questions. [2] Medical diagnoses are not mutually exclusive; a resident can be counted for more than one diagnosis. [3] Rated from 0 ("total independence") to 4 ("total dependence"). [4] Total scores range from 0–15, severe cognitive impairment (0–7); moderate impairment (8–12); little to no impairment (≥13). [5] Sum of RN, licensed practical nurse, and nurse aide hours for each resident daily. [6] Q1, <10.0% of community residents living at or below federal poverty level, Q2, 10.0%–19.9%, Q3, 20.0%–29.9%, Q4, 30.0%–39.9%, and Q5, ≥40%. [7] Calculated by summing the number of admissions by race and ethnicity.

VARIABLE	TYPE OF MEASURE	VALUE
Stage 2, 3, 4 and unstageable pressure injury	Incidence	17.8%[1]
Pressure injury healing	Probability	0.71
Pain intensity	Rating Scale Mean	5.6
PRN medication use	Probability	0.53
Scheduled pain medication use	Probability	0.44

Table 2 Summary of outcome variables.

Note: PRN = Pro re nata, i.e., the administration of analgesics was not scheduled and provided on an as-needed basis.

[1] Annual incidence rate (%) is the estimated number of residents out of 100 who would develop a pressure injury during a one-year nursing home admission.

contrast, pain intensity was relatively higher among both American Indian or Alaska Natives and Native Hawaiians or Other Pacific Islanders. With the exception of a higher rate of PRN analgesic prescribing for the former group, the latter populations were prescribed less analgesic medication than non-Hispanic Whites.

In the multivariable analyses, some of these associations between the outcomes and race and ethnicity persisted, but most did not, and those associations that persisted had lesser magnitude (Table 6). With non-Hispanic Whites as the comparator, the incidence rate ratio [IRR] for Blacks was 1.02, 95% CI [1.00, 1.04] and almost the same. Compared to non-Hispanic Whites, the incidence rate ratio was lower among Hispanics (IRR 0.89, 95% CI [0.86, 0.90]), Asians (IRR 0.74, 95% CI [0.70, 0.77]), and Native Hawaiians or

RACIAL/ETHNIC STATUS	ANNUAL INCIDENT PRESSURE INJURIES (%)[1] (ANNUAL INCIDENCE, CONFIDENCE INTERVAL)			
	n	WOMEN	*n*	MEN
Non-Hispanic White	2,469,805	13.09 (13.01, 13.17)	1,482,931	19.62 (19.48, 19.76)
Non-Hispanic Black	320,047	17.34 (17.10, 17.58)	242,973	16.04 (15.78, 16.30)
Hispanic	141,747	14.10 (13.76, 14.45)	119,106	14.58 (14.20, 14.97)
Asian	40,015	10.14 (9.63, 10.67)	27,232	13.10 (12.34, 13.90)
American Indian or Alaska Native	8,179	14.91 (13.56, 16.36)	6,780	14.61 (13.12, 16.23)
Native Hawaiian or Other Pacific Islander	2,627	11.48 (9.26, 14.06)	2,011	13.76 (10.84, 17.22)
Other multi-racial	40,211	19.13 (18.32, 19.98)	30,046	21.70 (20.67, 22.77)
None specified	42,518	17.41 (16.41, 18.45)	29,158	22.94 (21.49, 24.46)

Table 3 Unadjusted pressure injury incidence rates by sex and racial status among nursing home residents in the U.S. in 2016 and 2017.

Note: Pressure injuries include Stages 2, 3, 4, and Unstageable. Due to extremely large sample sizes, statistical significance is not meaningful; associations discussed in the text are those that are large enough to be clinically meaningful and have CIs excluding no association.

[1] Annual incidence rate (%) is the estimated number of residents who would develop a pressure injury during a one-year nursing home admission.

Other Pacific Islanders (IRR 0.82, 95% CI [0.70, 0.96]), and higher among American Indian or Alaska Natives (IRR 1.13, 95% CI [1.04, 1.23]).

The multivariable analyses revealed no racial/ethnic differences in the probability of PI healing. All racial and ethnic minority groups also had pain intensity similar to non-Hispanic Whites, except for Asians, who had lower pain scores (difference = –0.31, 95% CI [–0.41, –0.20]). Notwithstanding the similarity in pain intensity scores, lower rates of PRN analgesic prescribing occurred among non-Hispanic Blacks (0.94, 95% CI [0.93, 0.95]) and Native Hawaiian or Other Pacific Islanders (0.73, 95% CI [0.64, 0.84]) and lower rates of scheduled analgesic prescribing occurred among non-Hispanic Blacks (0.90, 95% CI [0.89, 0.92]), Hispanics (0.96, 95% CI [0.94, 0.98]), and Native Hawaiian or Other Pacific Islanders (0.81, 95% CI [0.70, 0.93]).

BIVARIATE AND MULTIVARIABLE ANALYSES: OTHER VARIABLES

The bivariate analyses showed that the annual incidence rates for PIs were associated with numerous resident variables (Tables 4 and 5), including male sex, older age, malnutrition or unintended weight loss, prognosis less than six months, bedbound status, greater impairment in both physical and cognitive functioning, and short length of stay, as well as facility variables, including higher NH concentrations of racial and ethnic minority residents, larger NH size and lower staffing hours, urban location and location in lower poverty region, and for-profit status. With the exceptions of Alzheimer's disease and Parkinson's disease, having a medical diagnosis was also associated with a higher annual PI incidence rate. There were few associations with the probability of PI healing, but numerous bivariate associations with pain prevalence and analgesic prescribing, in varying patterns (Tables 4 and 5).

In the multivariable analyses (Table 6), resident-, facility-, and community-level characteristics had incidence rate ratios consistent with meaningful differences in the incidence rate of PIs, adjusted for covariates. Higher PI incidence rate ratios were associated with male sex, older age, several measures of physical and cognitive impairment, most medical diagnoses, and short length of stay. The NH variables associated with higher incidence rate ratios included higher concentrations of racial and ethnic minority residents, for-profit ownership, and location in a higher poverty region. Within this set of variables, resident sex had particular importance: Compared to males, female residents had substantially lower incidence rate ratios for PIs (0.71, 95% CI [0.70, 0.71]), higher pain scores (0.15, 95% CI [0.13, 1.16]), and higher rates of analgesic prescribing (PRN prescribing 1.39, 95% CI [1.38, 1.41] and scheduled prescribing 1.36, 95% CI [1.35, 1.37]).

EXPLORATORY ANALYSES

The bivariate analyses found higher incidence rates of PIs among non-Hispanic Blacks and Hispanics, respectively, than non-Hispanic Whites, but this finding did not persist after adjusting for other variables in the multivariable analysis. The multivariable analysis, however, identified an independent association between the incidence rate ratios of PIs and other variables, including the proportion of racial and ethnic minority residents in NHs, and the importance of resident sex. Exploratory analyses focused

FACILITY CHARACTERISTIC	ANNUAL PRESSURE INJURY INCIDENCE RATE[1] (%, CI)	PROBABILITY OF PRESSURE INJURY HEALING (PROPORTION, CI)	PAIN INTENSITY SCORE (*M*, CI) OR PEARSON *r* (CI)	ADMISSIONS WITH PRN ANALGESIC USE[1] (PROPORTION, CI)	ADMISSIONS WITH SCHEDULED ANALGESIC USE[1] (PROPORTION, CI)
Number of certified beds (mean, CI)	138.06 (137.76, 138.34)	140.73 (139.54, 141.91)	−0.05 (−0.05, −0.04)	134.01 (133.84, 134.17)	144.60 (144.39, 144.81)
	130.91 (130.86, 130.97)[2]	144.32 (142.41, 146.23)[2]		147.90 (147.70, 148.11)[2]	137.30 (137.14, 137.47)[2]
Nurse staffing (mean, CI)					
RN staffing (hours per resident per day)	0.85 (0.85, 0.85) 0.93 (0.93, 0.93)[2]	0.78 (0.77, 0.78) 0.78 (0.77, 0.79)[2]	0.01 (0.01, 0.01)	0.89 (0.89, 0.89) 0.81 (0.81, 0.81)[2]	0.86 (0.86, 0.86) 0.85 (0.84, 0.85)[2]
Total staffing (hours per resident per day)[3]	4.19 (4.19, 4.20) 4.31 (4.30, 4.31)[2]	4.10 (4.09, 4.11) 4.11 (4.09, 4.13)[2]	0.01 (0.01, 0.01)	4.26 (4.26, 4.26) 4.12 (4.12, 4.13)[2]	4.18 (4.18, 4.18) 4.21 (4.21, 4.21)[2]
Proportion racial/ethnic minority residents[4]	22.45 (22.37, 22.53) 20.02 (20.01, 20.04)[2]	0.27 (0.26, 0.27) 0.30 (0.29, 0.30)[2]	−0.01 (−0.02, −0.01)	0.21 (0.21, 0.21) 0.28 (0.28, 0.28)[2]	0.24 (0.24, 0.24) 0.24 (0.24, 0.25)[2]
Nursing home setting					
Rural	14.80 (14.68, 14.92)	0.73 (0.72, 0.75)	5.81 (5.79, 5.82)	0.56 (0.56, 0.56)	0.44 (0.43, 0.44)
Urban	18.68 (18.61, 18.75)	0.71 (0.70, 0.71)	5.61 (5.60, 5.61)	0.53 (0.53, 0.53)	0.44 (0.44, 0.44)
U.S. region					
New England	14.64 (14.42, 14.86)	0.75 (0.72, 0.77)	5.77 (5.74, 5.80)	0.57 (0.56, 0.57)	0.50 (0.49, 0.50)
Mid-Atlantic	18.83 (18.67, 18.99)	0.72 (0.70, 0.73)	5.50 (5.48, 5.52)	0.47 (0.46, 0.47)	0.48 (0.48, 0.48)
East North Central	17.11 (16.97, 17.25)	0.70 (0.69, 0.72)	5.63 (5.61, 5.64)	0.57 (0.56, 0.57)	0.43 (0.43, 0.43)
West North Central	12.19 (12.03, 12.36)	0.75 (0.72, 0.77)	5.94 (5.91, 5.96)	0.59 (0.59, 0.59)	0.52 (0.52, 0.52)
South Atlantic	21.59 (21.42, 21.75)	0.70 (0.68, 0.71)	5.65 (5.64, 5.67)	0.52 (0.52, 0.52)	0.43 (0.43, 0.43)
East South Central	18.31 (18.07, 18.56)	0.73 (0.71, 0.75)	5.59 (5.56, 5.61)	0.56 (0.55, 0.56)	0.38 (0.38, 0.38)
West South Central	17.04 (16.86, 17.22)	0.70 (0.68, 0.72)	5.57 (5.55, 5.59)	0.50 (0.50, 0.50)	0.38 (0.37, 0.38)
Mountain	16.72 (16.43, 17.02)	0.70 (0.67, 0.72)	5.75 (5.72, 5.78)	0.67 (0.66, 0.67)	0.45 (0.45, 0.46)
Pacific	20.03 (19.82, 20.25)	0.71 (0.70, 0.72)	5.65 (5.64, 5.67)	0.54 (0.54, 0.54)	0.43 (0.43, 0.43)
Nursing home profit status					
For profit	18.37 (18.30, 18.45)	0.70 (0.70, 0.71)	5.62 (5.61, 5.63)	0.53 (0.53, 0.53)	0.43 (0.43, 0.43)
Nonprofit	17.60 (17.47, 17.73)	0.74 (0.72, 0.75)	5.68 (5.66, 5.69)	0.56 (0.55, 0.56)	0.46 (0.45, 0.46)
Government-owned	13.32 (13.12, 13.52)	0.72 (0.69, 0.74)	5.88 (5.84, 5.91)	0.53 (0.52, 0.53)	0.47 (0.47, 0.48)

(Contd.)

FACILITY CHARACTERISTIC	ANNUAL PRESSURE INJURY INCIDENCE RATE[1] (%, CI)	PROBABILITY OF PRESSURE INJURY HEALING (PROPORTION, CI)	PAIN INTENSITY SCORE (*M*, CI) OR PEARSON *r* (CI)	ADMISSIONS WITH PRN ANALGESIC USE[1] (PROPORTION, CI)	ADMISSIONS WITH SCHEDULED ANALGESIC USE[1] (PROPORTION, CI)
Nursing home zip code poverty quintile[5]					
Q1	19.11 (18.93, 19.30)	0.71 (0.70, 0.73)	5.43 (5.41, 5.45)	0.54 (0.54, 0.54)	0.45 (0.45, 0.45)
Q2	18.26 (18.12, 18.40)	0.72 (0.71, 0.73)	5.62 (5.61, 5.64)	0.55 (0.55, 0.55)	0.45 (0.45, 0.45)
Q3	18.03 (17.90, 18.17)	0.71 (0.70, 0.73)	5.66 (5.65, 5.68)	0.55 (0.55, 0.55)	0.44 (0.44, 0.45)
Q4	17.25 (17.13, 17.37)	0.71 (0.70, 0.72)	5.70 (5.68, 5.71)	0.53 (0.53, 0.53)	0.44 (0.44, 0.44)
Q5	17.23 (17.10, 17.37)	0.69 (0.68, 0.71)	5.71 (5.70, 5.73)	0.50 (0.50, 0.50)	0.42 (0.42, 0.42)

Table 4 Bivariate associations between NH characteristics and pressure injury outcomes.

Note: Table presents findings for all associations studied. Due to extremely large sample sizes, statistical significance is not meaningful; associations discussed in the text are those that are large enough to be clinically meaningful and have CIs excluding no association.

CI = Confidence Interval.

[1] Values shown for residents with stage 2, 3, 4, or unstageable injuries only. [2] The first value and CI refer to those with the outcome, and the second value and CI refer to those without the outcome. [3] Sum of RN, licensed practical nurse, and nurse aide hours for each resident daily. [4] Calculated by summing the number of admissions by race. [5] Q1, < 10.0% of residents living in poverty, Q2, 10.0%–19.9%, Q3, 20.0%–29.9%, Q4, 30.0%–39.9%, and Q5, ≥40%.

RESIDENT CHARACTERISTIC	ANNUAL PRESSURE INJURY INCIDENCE RATE[1] (%, CI)	PROBABILITY OF PRESSURE INJURY HEALING (PROPORTION, CI)	PAIN INTENSITY SCORE (*M*, CI) OR PEARSON *R* (CI)	ADMISSIONS WITH PRN ANALGESIC USE[1] (PROPORTION, CI)	ADMISSIONS WITH SCHEDULED ANALGESIC USE[1] (PROPORTION, CI)
Race/ethnicity					
Non-Hispanic White	17.14 (17.07, 17.21)	0.72 (0.72, 0.73)	5.64 (5.64, 5.65)	0.56 (0.56, 0.56)	0.45 (0.44, 0.45)
Non-Hispanic Black	20.63 (20.45, 20.81)	0.68 (0.66, 0.69)	5.67 (5.65, 5.68)	0.46 (0.46, 0.46)	0.43 (0.43, 0.43)
Hispanic	17.94 (17.68, 18.20)	0.70 (0.68, 0.72)	5.57 (5.54, 5.60)	0.45 (0.45, 0.45)	0.42 (0.42, 0.43)
Asian	14.34 (13.92, 14.78)	0.74 (0.70, 0.78)	5.18 (5.10, 5.26)	0.31 (0.31, 0.32)	0.39 (0.38, 0.39)
American Indian or Alaska Native	16.87 (15.89, 17.90)	0.72 (0.62, 0.80)	6.11 (6.02, 6.20)	0.65 (0.63, 0.66)	0.48 (0.47, 0.49)
Native Hawaiian or Other Pacific Islander	15.12 (13.37, 17.03)	0.61 (0.36, 0.83)	5.90 (5.69, 6.11)	0.50 (0.48, 0.53)	0.40 (0.37, 0.42)
Other multi-racial	26.00 (25.33, 26.67)	0.63 (0.60, 0.67)	5.71 (5.67, 5.76)	0.52 (0.52, 0.53)	0.43 (0.43, 0.44)
None specified	25.53 (24.65, 26.43)	0.77 (0.70, 0.83)	5.39 (5.32, 5.46)	0.54 (0.53, 0.55)	0.42 (0.41, 0.42)

(Contd.)

RESIDENT CHARACTERISTIC	ANNUAL PRESSURE INJURY INCIDENCE RATE[1] (%, CI)	PROBABILITY OF PRESSURE INJURY HEALING (PROPORTION, CI)	PAIN INTENSITY SCORE (*M*, CI) OR PEARSON *R* (CI)	ADMISSIONS WITH PRN ANALGESIC USE[1] (PROPORTION, CI)	ADMISSIONS WITH SCHEDULED ANALGESIC USE[1] (PROPORTION, CI)
Sex					
Women	15.52 (15.45, 15.59)	0.71 (0.71, 0.72)	5.65 (5.64, 5.66)	0.55 (0.55, 0.55)	0.46 (0.46, 0.46)
Men	22.01 (21.90, 22.13)	0.71 (0.70, 0.71)	5.64 (5.63, 5.65)	0.51 (0.51, 0.51)	0.41 (0.41, 0.41)
Medical diagnosis[2] Cancer					
Yes	20.40 (20.17, 20.64)	0.72 (0.70, 0.73)	5.65 (5.63, 5.67)	0.57 (0.57, 0.58)	0.46 (0.46, 0.46)
No	17.56 (17.50, 17.62)	0.71 (0.70, 0.72)	5.64 (5.64, 5.65)	0.53 (0.53, 0.53)	0.44 (0.44, 0.44)
Heart Failure					
Yes	21.65 (21.51, 21.78)	0.72 (0.71, 0.73)	5.62 (5.60, 5.63)	0.55 (0.55, 0.55)	0.43 (0.43, 0.43)
No	16.43 (16.37, 16.50)	0.71 (0.70, 0.71)	5.66 (5.65, 5.67)	0.52 (0.52, 0.53)	0.44 (0.44, 0.44)
Peripheral Vascular Disease					
Yes	21.20 (21.03, 21.37)	0.68 (0.67, 0.70)	5.75 (5.73, 5.76)	0.55 (0.55, 0.56)	0.43 (0.43, 0.43)
No	17.14 (17.07, 17.20)	0.72 (0.71, 0.72)	5.62 (5.61, 5.62)	0.53 (0.53, 0.53)	0.42 (0.42, 0.43)
Cirrhosis					
Yes	20.36 (19.69, 21.05)	0.75 (0.70, 0.79)	5.95 (5.90, 6.00)	0.62 (0.61, 0.62)	0.41 (0.40, 0.42)
No	17.76 (17.70, 17.82)	0.71 (0.70, 0.72)	5.64 (5.63, 5.64)	0.53 (0.53, 0.53)	0.44 (0.44, 0.44)
End Stage Renal Disease					
Yes	21.76 (21.60, 21.93)	0.71 (0.70, 0.72)	5.66 (5.65, 5.67)	0.56 (0.56, 0.56)	0.43 (0.43, 0.43)
No	16.96 (16.89, 17.02)	0.71 (0.70, 0.72)	5.64 (5.63, 5.64)	0.52 (0.52, 0.52)	0.44 (0.44, 0.44)
Alzheimer's Dementia/Dementia					
Yes	12.21 (12.14, 12.28)	0.73 (0.72, 0.74)	5.33 (5.31, 5.34)	0.40 (0.40, 0.40)	0.43 (0.43, 0.43)
No	24.88 (24.77, 24.99)	0.70 (0.69, 0.70)	5.71 (5.71, 5.72)	0.60 (0.60, 0.60)	0.44 (0.44, 0.45)
Diabetes					
Yes	22.23 (22.12, 22.35)	0.70 (0.69, 0.71	5.69 (5.68, 5.70)	0.54 (0.54, 0.54)	0.45 (0.45, 0.45)
No	15.22 (15.15, 15.29)	0.72 (0.71, 0.73)	5.60 (5.59, 5.61)	0.53 (0.53, 0.53)	0.43 (0.43, 0.43)

(Contd.)

RESIDENT CHARACTERISTIC	ANNUAL PRESSURE INJURY INCIDENCE RATE[1] (%, CI)	PROBABILITY OF PRESSURE INJURY HEALING (PROPORTION, CI)	PAIN INTENSITY SCORE (*M*, CI) OR PEARSON *R* (CI)	ADMISSIONS WITH PRN ANALGESIC USE[1] (PROPORTION, CI)	ADMISSIONS WITH SCHEDULED ANALGESIC USE[1] (PROPORTION, CI)
Parkinson's Disease					
Yes	15.68 (15.46, 15.90)	0.72 (0.69, 0.74)	5.36 (5.33, 5.39)	0.42 (0.41, 0.42)	0.42 (0.42, 0.43)
No	17.94 (17.88, 18.00)	0.71 (0.70, 0.72)	5.65 (5.65, 5.66)	0.54 (0.54, 0.54)	0.44 (0.44, 0.44)
Asthma/COPD/Chronic Lung Disease					
Yes	18.07 (17.95, 18.18)	0.71 (0.70, 0.72)	5.75 (5.74, 5.76)	0.57 (0.56, 0.57)	0.46 (0.46, 0.47)
No	17.67 (17.60, 17.75)	0.71 (0.70, 0.71)	5.59 (5.58, 5.60)	0.52 (0.52, 0.52)	0.43 (0.43, 0.43)
Respiratory Failure					
Yes	32.06 (31.71, 32.40)	0.64 (0.63, 0.66)	5.72 (5.70, 5.74)	0.52 (0.52, 0.52)	0.44 (0.43, 0.44)
No	16.91 (16.85, 16.97)	0.72 (0.72, 0.73)	5.63 (5.63, 5.64)	0.53 (0.53, 0.54)	0.44 (0.44, 0.44)
Malnutrition					
Yes	28.29 (27.99, 28.59)	0.65 (0.63, 0.66)	5.83 (5.81, 5.85)	0.54 (0.54, 0.54)	0.44 (0.44, 0.44)
No	17.01 (16.95, 17.07)	0.72 (0.72, 0.73)	5.62 (5.61, 5.62)	0.53 (0.53, 0.53)	0.44 (0.44, 0.44)
Unintended weight loss					
Yes	21.54 (21.41, 21.67)	0.70 (0.69, 0.71)	5.70 (5.69, 5.71)	0.51 (0.51, 0.51)	0.46 (0.46, 0.46)
No	16.27 (16.20, 16.34)	0.71 (0.71, 0.72)	5.62 (5.61, 5.63)	0.54 (0.54, 0.54)	0.43 (0.43, 0.43)
Prognosis < 6 months					
Yes	21.63 (21.42, 21.84)	0.69 (0.68, 0.71)	5.75 (5.72, 5.77)	0.50 (0.49, 0.50)	0.52 (0.52, 0.52)
No	17.33 (17.27, 17.39)	0.71 (0.71, 0.72)	5.64 (5.63, 5.64)	0.54 (0.54, 0.54)	0.43 (0.43, 0.43)
Bedbound on admission					
Yes	20.81 (20.73, 20.88)	0.71 (0.70, 0.71)	5.64 (5.64, 5.65)	0.53 (0.53, 0.53)	0.45 (0.44, 0.45)
No	5.93 (5.86, 6.01)	0.81 (0.79, 0.84)	5.64 (5.62, 5.66)	0.58 (0.58, 0.59)	0.36 (0.36, 0.36)
Short-stay admission					
Yes	84.27 (83.75, 84.79)	N/A	5.64 (5.63, 5.65)	0.60 (0.59, 0.60)	0.37 (0.37, 0.37)
No	12.99 (12.94, 13.05)	N/A	5.65 (5.64, 5.65)	0.50 (0.50, 0.50)	0.47 (0.47, 0.47)

(Contd.)

RESIDENT CHARACTERISTIC	ANNUAL PRESSURE INJURY INCIDENCE RATE[1] (%, CI)	PROBABILITY OF PRESSURE INJURY HEALING (PROPORTION, CI)	PAIN INTENSITY SCORE (*M*, CI) OR PEARSON *R* (CI)	ADMISSIONS WITH PRN ANALGESIC USE[1] (PROPORTION, CI)	ADMISSIONS WITH SCHEDULED ANALGESIC USE[1] (PROPORTION, CI)
Age (years) (*M*, CI) or Pearson r (CI)	78.14 (78.10, 78.18) 76.94 (76.93, 76.95)[3]	74.84 (74.64, 75.05) 72.05 (71.71, 72.39)[3]	−0.14 (−0.14, −0.14)	74.62 (74.59, 74.65) 74.62 (74.59, 74.65)[3]	74.64 (74.61, 74.67) 76.86 (76.83, 76.88)[3]
Bed mobility self-performance score[4] (median, CI)	2.94 (2.93, 2.94) 2.44 (2.44, 2.44)[3]	2.88 (2.87, 2.89) 3.06 (3.04, 3.07)[3]	−0.03 (−0.03, −0.03)	2.90 (2.90, 2.91) 3.02 (3.02, 3.03)[3]	2.98 (2.98, 2.98) 2.94 (2.94, 2.95)[3]
Brief Interview for Mental Status score[5] (*M*, CI)	10.25 (10.23, 10.27) 11.80 (11.79, 11.80) [3]	10.62 (10.56, 10.69) 10.76 (10.65, 10.87)[3]	0.08 (0.08, 0.09)	11.84 (11.84, 11.85) 10.03 (10.02, 10.04)[3]	11.36 (11.35, 11.37) 10.79 (10.78, 10.80)[3]

Table 5 Bivariate associations between resident characteristics and pressure injury outcomes.

Note: CI = Confidence Interval; COPD = Chronic Obstructive Pulmonary Disease.

[1] Values shown for residents with stage 2, 3, 4, or unstageable injury only. [2] Medical diagnoses are not mutually exclusive; a resident can be counted for more than one diagnosis. [3] Values in the first row reflect the mean (or median), CI of the continuous explanatory variables among residents with the outcome, and values in the second row reflect this for residents without the outcome. [4] Scores range from 0 (total independence) to 4 (total dependence). [5] Total scores range from 0–15; severe cognitive impairment (0-7); moderate impairment (8–12); little to no impairment (≥13). Table presents results for all associations. Due to extremely large sample sizes, statistical significance is not meaningful; associations discussed in the text are those that are large enough to be clinically meaningful and have CIs excluding no association.

RESIDENT CHARACTERISTICS	PRESSURE INJURY INCIDENCE (IRR, CI)[1]	PRESSURE INJURY HEALING (OR, CI)[1]	MEAN PAIN INTENSITY RATING (COEFFICIENT, CI)[1]	PRN ANALGESIC USE[2] (OR, CI)[1]	SCHEDULED ANALGESIC USE[2] (OR, CI)[1]
Sex (Women)	0.71 (0.70, 0.71)	0.97 (0.91, 1.03)	0.15 (0.13, 1.16)	1.39 (1.38, 1.41)	1.36 (1.35, 1.37)
Age	1.01 (1.01, 1.01)	1.01 (1.01, 1.02)	−0.02 (−0.02, −0.02)	0.98 (0.98, 0.99)	0.98 (0.98, 0.98)
Race					
Hispanic	0.88 (0.86, 0.90)	1.13 (0.99, 1.29)	−0.03 (−0.07, 0.01)	1.04 (1.02, 1.06)	0.96 (0.94, 0.98)
Non-Hispanic Black	1.02 (1.00, 1.04)	1.08 (0.99, 1.18)	0.03 (−0.001, 0.05)	0.94 (0.93, 0.95)	0.90 (0.89, 0.92)
Asian	0.74 (0.70, 0.77)	1.23 (0.93, 1.63)	−0.31 (−0.41, −0.20)	0.69 (0.66, 0.72)	0.82 (0.79, 0.86)
American Indian or Alaska Native	1.13 (1.04, 1.23)	1.16 (0.71, 1.90)	−0.01 (−0.13, 0.12)	1.12 (1.04, 1.20)	0.98 (0.92, 1.06)
Native Hawaiian or Other Pacific Islander	0.82 (0.70, 0.96)	1.22 (0.33, 4.58)	−0.16 (−0.44, 0.11)	0.73 (0.64, 0.84)	0.81 (0.70, 0.93)
Other multi-racial	1.15 (1.11, 1.20)	0.84 (0.70, 1.02)	0.06 (0.002, 0.12)	1.06 (1.02, 1.09)	0.96 (0.93, 0.99)
None specified	1.07 (1.02, 1.13)	1.66 (1.07, 2.55)	−0.11 (−0.19, −0.03)	1.03 (0.98, 1.07)	0.88 (0.84, 0.92)
Brief Interview for Mental Status score[3]	1.01 (1.01, 1.01)	1.00 (0.99, 1.01)	0.02 (0.02, 0.03)	1.07 (1.07, 1.07)	1.04 (1.03, 1.04)

(Contd.)

RESIDENT CHARACTERISTICS	PRESSURE INJURY INCIDENCE (IRR, CI)[1]	PRESSURE INJURY HEALING (OR, CI)[1]	MEAN PAIN INTENSITY RATING (COEFFICIENT, CI)[1]	PRN ANALGESIC USE[2] (OR, CI)[1]	SCHEDULED ANALGESIC USE[2] (OR, CI)[1]
Medical diagnosis[4]					
Cancer	1.09 (1.08, 1.11)	0.96 (0.87, 1.06)	0.10 (0.07, 0.12)	1.15 (1.13, 1.16)	1.11 (1.09, 1.12)
Heart Failure	1.18 (1.16, 1.19)	1.05 (0.98, 1.13)	–0.02 (–0.04, –0.01)	0.99 (0.98, 1.00)	0.93 (0.92, 0.94)
Peripheral Vascular Disease	1.23 (1.21, 1.24)	0.80 (0.74, 0.86)	0.10 (0.08, 0.12)	1.17 (1.15, 1.18)	1.31 (1.30, 1.32)
Cirrhosis	1.15 (1.11, 1.20)	1.33 (1.03, 1.70)	0.16 (0.11, 0.22)	1.09 (1.05, 1.13)	0.80 (0.77, 0.83)
End Stage Renal Disease	1.13 (1.12, 1.14)	1.00 (0.93, 1.07)	–0.02 (–0.04, –0.01)	1.04 (1.03, 1.05)	0.88 (0.87, 0.89)
Alzheimer's Dementia/Dementia	0.60 (0.59, 0.61)	1.13 (1.05, 1.23)	–0.14 (–0.16, –0.11)	0.74 (0.73, 0.74)	1.04 (1.03, 1.06)
Diabetes	1.32 (1.31, 1.34)	0.99 (0.93, 1.05)	0.01 (–0.01, 0.03)	0.98 (0.98, 0.99)	1.02 (1.01, 1.03)
Parkinson's Disease	0.92 (0.90, 0.94)	1.08 (0.95, 1.24)	–0.14 (–0.18, –0.10)	0.80 (0.79, 0.82)	0.93 (0.92, 0.95)
Malnutrition	1.56 (1.54, 1.59)	0.79 (0.72, 0.85)	0.08 (0.06, 0.11)	1.03 (1.02, 1.04)	0.95 (0.93, 0.96)
Asthma/COPD/ Chronic Lung Disease	0.96 (0.95, 0.97)	1.09 (1.02, 1.17)	0.13 (0.11, 0.14)	1.14 (1.13, 1.15)	1.12 (1.11, 1.13)
Respiratory Failure	1.34 (1.32, 1.36)	0.88 (0.80, 0.96)	–0.08 (–0.11, –0.05)	0.94 (0.93, 0.95)	0.86 (0.85, 0.87)
Unintended weight loss	1.65 (1.63, 1.67)	0.93 (0.87, 1.00)	0.02 (0.01, 0.04)	1.03 (1.02, 1.04)	1.02 (1.01, 1.03)
Life prognosis < 6 months	1.32 (1.30, 1.34)	0.88 (0.80, 0.97)	0.18 (0.15, 0.21)	1.11 (1.10, 1.13)	1.49 (1.47, 1.52)
Bedbound on admission	1.87 (1.84, 1.91)	1.00 (0.84, 1.20)	0.19 (0.17, 0.22)	1.42 (1.40, 1.45)	1.25 (1.23, 1.27)
Bed mobility self-performance score[5]	1.71 (1.70, 1.73)	0.78 (0.73, 0.82)	0.02 (0.01, 0.04)	1.05 (1.04, 1.06)	1.09 (1.08, 1.09)
Short stay admissions[6]	5.02 (4.96, 5.09)	NA	0.07 (0.05, 0.08)	1.24 (1.23, 1.25)	0.72 (0.71, 0.73)
Number of certified beds	0.94 (0.91, 0.96)	1.04 (0.96, 1.12)	–0.004 (–0.06, 0.05)	0.95 (0.92, 0.98)	1.01 (0.97, 1.04)
Nursing home setting (Urban)	0.96 (0.94, 0.98)	0.98 (0.89, 1.08)	–0.05 (–0.10, -0.002)	1.00 (0.97, 1.03)	1.04 (1.01, 1.07)
U.S. region					
Mid-Atlantic	1.06 (0.87, 1.28)	0.71 (0.26, 1.97)	0.17 (–0.25, 0.59)	0.88 (0.69, 1.12)	0.45 (0.35, 0.58)
East North Central	0.79 (0.65, 0.96)	0.67 (0.24, 1.87)	–0.06 (–0.49, 0.37)	1.11 (0.87, 1.43)	0.72 (0.56, 0.93)
West North Central	0.91 (0.73, 1.13)	0.83 (0.23, 2.99)	0.14 (–0.35, 0.63)	0.69 (0.52, 0.92)	0.83 (0.62, 1.11)
South Atlantic	1.18 (0.96, 1.46)	0.89 (0.30, 2.59)	–0.18 (–0.65, 0.28)	0.70 (0.54, 0.92)	0.48 (0.37, 0.64)

(Contd.)

RESIDENT CHARACTERISTICS	PRESSURE INJURY INCIDENCE (IRR, CI)[1]	PRESSURE INJURY HEALING (OR, CI)[1]	MEAN PAIN INTENSITY RATING (COEFFICIENT, CI)[1]	PRN ANALGESIC USE[2] (OR, CI)[1]	SCHEDULED ANALGESIC USE[2] (OR, CI)[1]
East South Central	1.00 (0.83, 1.22)	0.70 (0.25, 1.95)	–0.63 (–1.06, –0.19)	0.94 (0.73, 1.21)	0.40 (0.31, 0.52)
West South Central	1.20 (1.00, 1.45)	0.63 (0.23, 1.72)	–0.27 (–0.69, 0.15)	0.93 (0.73, 1.19)	0.42 (0.33, 0.54)
Mountain	0.89 (0.67, 1.17)	1.44 (0.30, 7.01)	–0.10 (–0.67, 0.48)	1.53 (1.08, 2.17)	0.79 (0.56, 1.13)
Pacific	0.52 (0.34, 0.80)	0.79 (0.07, 8.81)	0.83 (–0.03, 1.68)	1.88 (1.04, 3.38)	1.51 (0.85, 2.69)
Nursing home profit status					
Not-for-profit	0.98 (0.95, 1.00)	1.10 (1.00, 1.20)	0.11 (0.07, 0.17)	1.06 (1.03, 1.08)	1.10 (1.07, 1.13)
Government-owned	0.93 (0.90, 0.97)	1.07 (0.91, 1.25)	0.18 (0.11, 0.26)	1.02 (0.98, 1.07)	1.11 (1.07, 1.16)
Nurse staffing					
RN staffing (hours per resident per day)	1.14 (1.12, 1.16)	0.97 (0.87, 1.09)	0.05 (0.02, 0.09)	1.13 (1.11, 1.16)	0.94 (0.92, 0.96)
Total staffing (hours per resident per day)[7]	1.02 (1.01, 1.03)	0.98 (0.94, 1.03)	0.001 (–0.02, 0.02)	1.01 (1.00, 1.02)	1.02 (1.01, 1.03)
Nursing home zip code poverty quintile[8]					
Q2	1.15 (1.11, 1.19)	1.04 (0.91, 1.19)	–0.05 (–0.11, 0.01)	1.02 (0.99, 1.06)	0.95 (0.92, 0.98)
Q3	1.29 (1.23, 1.34)	1.05 (0.89, 1.24)	–0.13 (–0.21, –0.06)	1.01 (0.97, 1.06)	0.89 (0.85, 0.93)
Q4	1.38 (1.32, 1.45)	1.11 (0.91, 1.36)	–0.10 (–0.20, –0.01)	1.01 (0.96, 1.06)	0.83 (0.79, 0.88)
Q5	1.56 (1.46, 1.68)	1.18 (0.88, 1.57)	-0.17 (-0.30, -0.05)	1.03 (0.96, 1.11)	0.76 (0.71, 0.82)
Proportion racial/ethnic minority residents[9]	1.07 (1.02, 1.12)	0.88 (0.74, 1.06)	-0.20 (-0.31, -0.09)	0.40 (0.38, 0.43)	0.85 (0.79, 0.91)
Harrell's C	0.68	0.67	0.90	0.72	0.70
N	3,945,916	22,351	352,941	512,875	512,875

Table 6 Multivariable associations between resident/facility characteristics and pressure injury outcomes.

Note: Table presents findings for all associations. Due to extremely large sample sizes, statistical significance is not meaningful; associations discussed in the text are those that are large enough to be clinically meaningful and have CIs excluding no association. IRR = Incidence Rate Ratio; OR = Odds Ratio.

[1] Reference group for each variable not shown; base rate for the reference group for injury incidence, healing, PRN and scheduled medication: 1.00; base value for pain intensity: 0.00; reference groups include men, non-Hispanic Whites, residents without the listed medical diagnosis or classification, long-stay admissions, rural setting, New England region, for-profit nursing homes, and nursing homes in Q1 poverty quintile. [2] Percentages shown for residents with stage 2, 3, 4, or unstageable injury. [3] Total scores range from 0–15, with scores between 0–7 = severe cognitive impairment; 8–12 = moderate impairment, and ≥13 = little to no impairment. [4] Medical diagnoses are not mutually exclusive; a resident can be counted for more than one diagnosis. [5] Scores range from 0 (total independence) to 4 (total dependence). [6] Categorized as an admission ≤30 days. [7] Sum of RN, licensed practical nurse, and nurse aide hours for each resident daily. [8] Q1, <10.0% of residents living in poverty, Q2, 10.0%–19.9%, Q3, 20.0%–29.9%, Q4, 30.0%–39.9%, and Q5, ≥40%. [9] Calculated by summing the number of admissions by race.

on one outcome, the incidence rate ratio, were conducted to clarify these differences between the bivariate and multivariable findings.

Both the bivariate and multivariable analyses found that resident sex was a salient covariate. For this reason, the first exploratory analysis assessed the potential influence of sex on the associations between the annual incidence rate of PIs and race and ethnicity by stratifying each racial and ethnic group by sex and evaluating the differences between males and females within racial and ethnic minority groups (Table 3). Unadjusted bivariate analyses confirmed large differences related to resident sex. Non-Hispanic White men had an annual PI incidence rate (19.62%, 95% CI [19.48, 19.76]) that was substantially higher than non-Hispanic White women (13.09%, 95% CI [13.01, 13.17]) and comparable sex differences were evident among Asians (males, 13.10%, 95% CI [12.34, 13.90] versus females, 10.14%, 95% CI [9.63, 10.67]) and Native Hawaiian or Other Pacific Islanders (males, 13.76%, 95% CI [10.84, 17.22] versus females, 11.48%, 95% CI [9.26, 14.06]). In contrast, non-Hispanic Black women had a higher annual incidence rate of PIs than non-Hispanic Black men (females, 17.34%, 95% CI [17.10, 17.58] versus males, 16.04%, 95% CI [15.78, 16.30]). The outcome did not differ by sex among Hispanic and American Indian or Alaska Native groups.

Sequential multivariable analyses were then conducted to determine whether adjustment by different groups of variables, beginning with resident sex, could account for the difference between the bivariate analyses and multivariable analysis. The first multivariable model evaluated the association between the incidence rate ratio of PIs and race and ethnicity after adjusting only by resident sex. The second adjusted for sex and other resident variables associated with PI incidence rate ratios (such as medical diagnoses), and the third adjusted for resident variables and facility variables associated with PI incidence rate ratios. Finally, a fourth model added a NH-level random effects term to the third model to represent all unobserved characteristics of the facilities.

These multivariable models (Table 7) found that associations between the incidence rate ratios for PIs and race and ethnicity persisted when the sample was disaggregated by sex and that the direction of the association was opposite in females and males. Females who were non-Hispanic Black, or American Indian or Alaska Native had higher incidence rate ratios for PIs, respectively, than non-Hispanic White females, whereas males in each of these groups had lower incidence rate ratios of PIs than non-Hispanic White males. These associations largely persisted through adjustments for other resident-related and facility-related variables.

DISCUSSION

In the NH population, PIs usually occur in older, medically vulnerable residents, most of whom have multiple chronic conditions (Ahn et al., 2016; Cakmak et al., 2009; Coleman et al., 2013; Spector et al., 1988). PIs are associated with pain, poor quality of life, hospitalisations, and mortality (Ahn et al., 2015; Allman et al., 1999; Gorecki et al., 2009; Landi et al., 2007), and these outcomes have justified national efforts to improve the prevention and management of PIs through initiatives that mitigate risk factors (Baier et al., 2003; Berlowitz, Brandeis, Anderson, et al., 2001; Berlowitz, Brandeis, Morris, et al., 2001; Rosen et al., 2006).

This study used large national datasets in the U.S. to evaluate the records of 4,999,999 residents in 15,791 NHs during 7,051,036 NH admissions, the aim of which was to understand the associations that exist between race and ethnicity and the incidence of PIs, the probability of PI healing, and the use (PRN or scheduled) of analgesics. Prior studies have found that race and ethnicity, particularly non-Hispanic Black race, is a risk factor for PI-related outcomes in NHs (Baumgarten et al., 2004; Bliss et al., 2015; Bliss et al., 2017) and some attribute this association to poor outcomes in a subgroup of NHs that have high concentrations of Blacks and Hispanics (Cai et al., 2010; Howard & Taylor, 2009; Li et al., 2011; Li, Harrington, Mukamel, et al., 2015; Li, Harrington, Temkin-Greener, et al., 2015). Our work was intended to expand and clarify this information by assessing multiple racial and ethnic minority groups, including those poorly represented in the literature, and evaluating numerous variables—resident-, facility-, and community-level—in alignment with the conceptual framework proposed by the NIMHD for studies of disparities in health systems. These characteristics may provide insight into the across- and within-facility factors that may explain PI-related outcomes and the extent to which they are impacted by structural racism and other sources of disparate care.

Bivariate analyses revealed associations between race and ethnicity and PI outcomes, including the annual incidence rate of PIs. Compared to non-Hispanic Whites, PIs were higher among both non-Hispanic Blacks and Hispanics, lower in Asians and Native Hawaiians or Other Pacific Islanders, and similar to non-Hispanic Whites among American Indian or Alaska Natives. After adjusting for numerous covariates, a higher incidence rate ratio was found among American Indian or Alaska Natives than all other racial and ethnic groups. The multivariable analysis found that the incidence rate ratio of PIs was independently associated with NHs that have a higher proportion of racial and ethnic minority residents. Other resident and facility variables revealed in the multivariable model included male sex, older age, several measures of physical and cognitive impairment, most

RACE	#1 SEX AND RACE ONLY	#2 ADJUSTMENTS: #1 PLUS OTHER RESIDENT-RELATED FACTORS	#3 ADJUSTMENTS: #1, #2, PLUS FACILITY-RELATED FACTORS	#4 ADJUSTMENTS: #1, #2, #3, PLUS NH-LEVEL RANDOM EFFECTS TERM
Males: Incidence rate ratios (95% CI) of racial/ethnic minorities relative to non-Hispanic White Males				
Non-Hispanic White	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)
Non-Hispanic Black	0.81 (0.79, 0.84)	0.83 (0.81, 0.85)	0.82 (0.80, 0.84)	0.81 (0.79, 0.83)
Hispanic	0.74 (0.71, 0.77)	0.78 (0.75, 0.81)	0.77 (0.74, 0.80)	0.75 (0.73, 0.78)
Asian	0.69 (0.64, 0.74)	0.65 (0.60, 0.70)	0.63 (0.58, 0.68)	0.63 (0.59, 0.67)
American Indian or Alaska Native	0.72 (0.64, 0.82)	0.84 (0.73, 0.96)	0.92 (0.80, 1.05)	0.92 (0.82, 1.04)
Native Hawaiian or Other Pacific Islander	0.72 (0.56, 0.93)	0.71 (0.55, 0.92)	0.68 (0.52, 0.87)	0.74 (0.58, 0.94)
Other multi-racial	1.08 (1.01, 1.15)	1.01 (0.95, 1.08)	0.98 (0.92, 1.05)	0.98 (0.92, 1.04)
None specified	1.20 (1.09, 1.33)	1.29 (1.18, 1.40)	1.27 (1.17, 1.37)	1.23 (1.15, 1.32)
RACE	**#1 SEX AND RACE ONLY**	**#2 ADJUSTMENTS: #1 PLUS OTHER RESIDENT-RELATED FACTORS**	**#3 ADJUSTMENTS: #1, #2, PLUS FACILITY-RELATED FACTORS**	**#4 ADJUSTMENTS: #1, #2, #3, PLUS NH-LEVEL RANDOM EFFECTS TERM**
Females: Incidence rate ratios (95% CI) of racial/ethnic minorities relative to non-Hispanic White Females				
Non-Hispanic White	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)
Non-Hispanic Black	1.33 (1.30, 1.37)	1.23 (1.21, 1.26)	1.21 (1.18, 1.24)	1.18 (1.16, 1.20)
Hispanic	1.08 (1.04, 1.12)	1.09 (1.05, 1.13)	1.07 (1.03, 1.11)	1.02 (0.99, 1.05)
Asian	0.80 (0.74, 0.86)	0.82 (0.76, 0.89)	0.80 (0.74, 0.87)	0.81 (0.76, 0.86)
American Indian or Alaska Native	1.18 (1.05, 1.32)	1.26 (1.13, 1.41)	1.35 (1.20, 1.51)	1.35 (1.22, 1.50)
Native Hawaiian or Other Pacific Islander	0.90 (0.72, 1.13)	0.86 (0.69, 1.08)	0.81 (0.65, 1.02)	0.85 (0.69, 1.06)
Other multi-racial	1.46 (1.37, 1.55)	1.35 (1.27, 1.43)	1.31 (1.23, 1.39)	1.28 (1.22, 1.35)
None specified	1.40 (1.30, 1.51)	1.44 (1.34, 1.55)	1.41 (1.32, 1.51)	1.38 (1.29, 1.47)

Table 7 Racial/ethnic-specific pressure injury incidence rate ratios, disaggregated by sex (N = 3,945,916).

medical diagnoses, short length of stay, for-profit status, and location in higher poverty region. Unexpectedly, given the known association between PIs and serious chronic illness (Jaul et al., 2018), neither Alzheimer's disease nor Parkinson's disease was associated with PI-related outcomes. This finding is unexplained, and studies are needed to determine whether the result can be replicated and explained through the evaluation of other variables (e.g., cognitive impairment).

Comparisons of our findings with prior studies of racial and ethnic differences in U.S. NHs are limited due to variation in study design, setting, and methodology. For example, some earlier studies found that non-Hispanic Black residents are more likely than non-Hispanic White residents to develop PIs (Baumgarten et al., 2004; Bliss et al., 2015; Bliss et al., 2017), but one study focused only on Black and White NH residents in Maryland (Baumgarten et al., 2004) and two studies focused on a single for-profit chain of NHs. These latter studies found no differences in the timing of PI development or PI healing among non-Hispanic Blacks, non-Hispanic Whites, American Indians/Alaska Natives, Asians/Pacific Islanders, and Hispanics. Risk factors for PI incidence did not differ among Black and White adults in one study (Bergstrom & Braden, 2002) but others suggest that Black residents are more likely than White residents to present with stage 4 PIs (Bliss et al., 2015) and experience poorer health status, multimorbidity, and functional and cognitive impairment, and have greater care needs, when they enter the NH (Institute of Medicine, 2003; Jones, 2000). Some authors cite multigenerational poverty, the impact of weathering, and structural racism contributing to delayed care or poor-quality care as potential explanations for these findings (Forrester et al., 2018; Institute of Medicine, 2003; Jones, 2000).

Our study noted differences in outcomes among racial and ethnic minority populations that have been rarely evaluated in the context of long-term care, specifically American Indians or Alaska Natives and Native Hawaiians or Other Pacific Islanders. A prior survey did not find differences in the time to PI development or treatment for these two populations (Bliss et al., 2015). Additional

studies of racial and ethnic minority populations that have not been the focus of earlier research are warranted (Bliss et al., 2015). Similarly, although our data align with studies from other countries that affirm the importance of PIs as a global health problem (Anthony et al., 2019; Li et al., 2020), prior research cannot be directly compared with our work. Studies are needed to evaluate differences in PI-related outcomes across racial and ethnic minority populations and provide information that can inform international initiatives to address this problem.

Earlier studies have repeatedly demonstrated the importance of both resident-level and facility-level risk factors for adverse PI-related outcomes (Ahn et al., 2016; Cai et al., 2010; Cakmak et al., 2009; Coleman et al., 2013; Howard & Taylor, 2009; Li et al., 2011; Li, Harrington, Mukamel, et al., 2015; Li, Harrington, Temkin-Greener, et al., 2015; Spector et al., 1988). This literature has particularly highlighted the importance of variation across NHs in both the quality of care overall and the potential for equitable care across racial and ethnic populations. Prior studies have noted the concentration of racial and ethnic minority populations in NHs with poor outcomes (Chisholm et al., 2013; Howard et al., 2002; Sharma et al., 2020; Smith et al., 2007) and have also found that NHs that have relatively poor outcomes are disproportionately located in regions with high rates of poverty. NHs located in disadvantaged areas may have lower levels of staffing, which also has been associated with poorer PI-related outcomes (Castle & Ferguson, 2010; Williams et al., 2017).

The bivariate analyses revealed relatively poor outcomes among NHs that have for-profit ownership, confirming prior studies (Castle & Ferguson, 2010; Mor et al., 2004; Williams et al., 2017). These associations became less prominent after adjustment for covariates. Large for-profit NHs that may disproportionately serve Black and Hispanic residents also may have characteristics that separately explain some of the variation in PI-related outcomes, such as limited resources and high staff turnover (Li et al., 2020; Smith et al., 2007).

We found an association between short length of stay in the NH (≤30 days) and adverse PI-related outcomes. Prior studies that have evaluated PIs in terms of care duration have focused on hospitalised patients or PI prevalence rather than incidence (Cox et al., 2020; Kayser et al., 2019; Strazzieri-Pulido et al., 2019). The relevance to our finding is uncertain. The finding that short NH stay may associate with poorer outcomes could reflect admission to the NH in a population of residents with short life expectancy due to advanced illness. Additional studies are needed to determine whether this group helps explain the finding.

Our multivariable analyses confirmed the importance of differences across NHs as potential drivers of racial or ethnic differences in PI-related outcomes (Cai et al., 2010; Howard & Taylor, 2009; Li et al., 2011; Li, Harrington, Mukamel, et al., 2015; Li, Harrington, Temkin-Greener, et al., 2015). Adjustment for covariates mostly eliminated the associations between resident race and ethnicity and PI-related outcomes that were observed in the bivariate analyses. To clarify the difference between the bivariate and multivariable analyses, we undertook a sequence of exploratory analyses to identify a smaller number of variables that may co-vary with race and ethnicity and be important within facilities. This approach may illuminate those disparities revealed in the unadjusted analyses that also are potentially related to structural racism. Unexpectedly, the exploratory analyses revealed a striking interaction between resident sex and race/ethnicity. Males and females in racial and ethnic minority groups both had incidence rate ratios for PIs that varied from non-Hispanic Whites, but in opposite directions. Compared to non-Hispanic White females, the incidence rate ratios for PIs were higher among females who were non-Hispanic Black, Hispanic, or American Indian or Alaska Native, respectively, whereas the incidence rate ratio for PIs was lower among males in each of these racial and ethnic minority groups than non-Hispanic White males. Most of these associations persisted as adjustments were added for numerous resident-related and facility-related variables. By disaggregating the sample by sex, these exploratory analyses revealed that there were independent associations between the incidence of PIs and resident race and ethnicity. These associations demonstrate that poorer outcomes occur among racial and ethnic minority female residents and White males. These findings may be due to within-facility differences in care or other factors that have not been previously measured in studies of this type.

Few prior studies have evaluated a potential interaction between sex and race/ethnicity in terms of the heightened risk of PI-related outcomes. A study of NH data from eight states found that differences in PI incidence after adjusting for clinical, sociodemographic, and facility characteristics were observed between Black and White females in small (<100 beds) and medium (100–199 beds) NHs, but not in large NHs (≥200 beds) (Howard et al., 2009); the difference was particularly notable among bedbound residents, with Black women experiencing a 28% higher risk compared to White women. Another NH study found minimal differences between males and females in PI incidence, it did not evaluate the interaction between sex and race/ethnicity or compare racial/ethnic outcomes within sexes (Lichterfeld-Kottner et al., 2020). A systematic review of 39 studies evaluated hospitalised patients and found that male sex was a risk factor for PI prevalence but not incident PIs (Li et al., 2020) and an earlier systematic review found an association between sex and PI-related outcomes in four of 15 studies, three of which found males to have higher PI risk (Coleman et al., 2013). Additional studies are needed to further understand the impact and meaning of sex differences in

PI outcomes and the interaction between sex and racial/ethnic status.

Our results should be interpreted in light of several study limitations. First, the associations identified in the multivariable analyses are correlations and causal relationships should not be inferred. Future studies will need to determine the causal links explaining the associations between race and ethnicity and PI outcomes, as well as the potential interaction with resident sex. Second, the variable definitions are limited by the source data and we could not determine, for example, whether pain-related information was recorded reliably or referred to pain caused specifically by PIs. Analgesic prescribing also lacked detail about specific drugs and doses administered, and medical diagnosis and race data were often not recorded. Accuracy of the data source also is always a concern, but multiple studies have confirmed the accuracy of MDS 3.0 data (Saliba & Buchanan, 2012) and fewer than 2% of the residents in our study had missing data for the race variable. Third, observational designs may introduce bias due to unmeasured confounding factors, and the interpretation of the associations is also constrained by the inability to evaluate some potentially important covariates, such as the severity of the medical conditions, incontinence, and body mass index, and the presence of a family caregiver, gender identification, and prior military service. The impact of these missing variables may be mitigated by the inclusion of factors that would be expected to correlate with these other variables, such as reduced mobility, bedbound status, cognitive impairment, and malnutrition. Fourth, it is possible that the rates at which key outcomes occur, such as the incidence of PIs, were underestimated because of the impact of conditions or events (like hospitalisation or death) that reduced the availability of MDS 3.0 assessments. All residents used in the analysis had at least two MDS 3.0 assessments, however, and the potential for confounding was presumably reduced by not including residents with a single assessment and by using the time between assessments to calculate PI incidence rates. Fifth, and relatedly, our inability to account for multiple hospitalisations that may have interrupted longer NH admissions also may have biased some associations. Finally, this study used data from 2016–2017, and the analysis of PI-related outcomes using more recent data is needed.

CONCLUSION

Notwithstanding these limitations, our findings represent new information drawn from a very large and relatively recent set of national data. Our evaluation of multiple racial and ethnic populations, the comprehensive assessment of five outcome variables, and the ability to assess a large number of resident-, facility-, and community-level characteristics guided by a national framework for disparities research are notable strengths and lend credence to the findings. The analyses confirm the complexity of the risk factors associated with PI incidence and consequences, confirm the impact of race and ethnicity, and raise new questions about the heightened risk in specific populations, and suggest both across-NH and within-NH differences. A potentially important interaction between race/ethnicity and resident sex was revealed. Future studies focused on the impact of systemic racism in U.S. NHs should evaluate whether care processes affect the sexes differently and continue to explore both across-facility and within-facility effects. Policy interventions aimed at reducing structural racism and inequities, and solutions to improve quality should be developed to address health disparities in PI outcomes.

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COMPETING INTERESTS

The authors have no competing interests to declare.

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