Utilization of hip and knee MRI in patients 50 and above with atraumatic pain: An analysis of the National Ambulatory Medical Care Survey

(Introduction and Methods part only)

Methods: NAMCS weighted survey data were obtained (2007-2019) for ambulatory visits in patients aged 50 and above with atraumatic hip or knee pain. The outcome variable was MRI ordering status, and analyzed characteristics included patient age, race/ethnicity, payor, physician specialty, metropolitan statistical area, and a coexistent radiograph order. Multivariable logistic regressions assessed the association between MRI ordering status and the analyzed patient characteristics. All tests were two-sided (p-value of 0.05).

Introduction:

The utilization of musculoskeletal diagnostic imaging in the middle-aged and older patient population is a progressively important consideration in the United States healthcare system. Musculoskeletal disorders accounted for the largest category of healthcare spending, amounting to $380.9 billion in 2016 [1]. In the United States, the population of adults aged 65 and above has grown substantially over the last decade and is projected to comprise 21.6% of the overall population by the year 2040 [2]. Medicare enrollees, followed by commercially insured patients aged 45 to 64 demonstrate the highest overall utilization of non-invasive diagnostic imaging across all imaging modalities in the United States healthcare system [3]. These findings highlight the need to explore current practices and to define the appropriate use of musculoskeletal imaging in the middle aged and older U.S. patient population.

The utilization of advanced musculoskeletal imaging in the setting of hip or knee pain deserves special attention. As major weightbearing joints, the hip and knee are prone to the development of osteoarthritis with advancing age, a condition affecting 14% of adults in the United States [4]. For chronic atraumatic hip or knee pain, radiographs are recommended for initial imaging [5, 6]. MRI is a second-line imaging modality and requires judicious use. Appropriate resource allocation, clinical decision support, clear patient expectations, and education of clinicians ordering musculoskeletal MRI in this population are measures which would promote the delivery of value-based care.

Despite its increasing economic importance, little is known about MRI utilization for hip and knee pain in middle-aged and older patients. The purpose of this study, therefore, was to examine the national utilization of hip and knee MRI for ambulatory patient visits in the age 50 and above population with atraumatic pain, utilizing the National Ambulatory Medical Care Survey (NAMCS) Database.

Methods:

Study Design:

A retrospective, cross-sectional, observational study was performed utilizing data from the National Ambulatory Medical Care Survey (NAMCS), a publicly available, de-identified dataset, therefore exempt from approval by the Institutional Review Board. The design of this study was constructed in accordance with the "Strengthening the reporting of observational studies in epidemiology" (STROBE) guidelines for observational studies[7].

Data Source:

NAMCS is a nationally representative survey which is supervised by the National Center for Health Statistics (NCHS) and is administered annually to non-federally employed office-based physicians providing direct outpatient care, in order to demonstrate the utilization of ambulatory medical care services in the United States (https://www.cdc.gov/nchs/ahcd/about_ahcd.htm) [8]. NAMCS survey data are obtained

by the participating ambulatory physicians or the affiliated medical staff on a randomly assigned week, with the assigned sampling rate based both upon the number of days within the week the participating physician is scheduled to see patients and the number of scheduled patients the participating physician is expected to see. The survey data obtained within the randomly selected week are then weighted to extrapolate an annual national estimate which is used for analysis [9]. A detailed description of the survey instrument, the sampling design, and the downloadable survey data is available for review on the NCHS website [10].

NAMCS survey data were downloaded from 2007 to 2019, with the 2017 survey data not included in the analysis due to processing delays, preventing its public release [11]. Survey data within this timeframe were obtained for all patient visits for patients aged 50 and above presenting with knee or hip pain.

Study Variables:

Outcome variable:

The primary outcome variable for the surveyed patient visit was MRI ordering status. Though the type of MRI ordered is not specified in the NAMCS survey data, for the purposes of this study, a hip or knee MRI order was inferred based on the primary presenting complaint of hip or knee pain with a positive MRI ordering status. Subjects having a primary complaint of trauma were excluded.

Predictor variables:

Analyzed self-reported patient characteristics included patient age, sex, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or non-Hispanic other), and source of payment (private insurance, Medicare, Medicaid, self-pay, or other). A more granular assessment of race/ethnicity was not available within the original dataset.

Additionally, the physician specialty category (primary care, medical care specialty, or surgical care specialty), and metropolitan statistical area (MSA) were recorded. A MSA (corresponding to the location of the physician interview) is defined as a geographic region based on a county or a group of counties with a population of at least 50,000 and adjacent counties with economic ties to the central area[12].

The ordering status of radiographs at the time of the sampled visit was also assessed as a patient characteristic, as the ACR Appropriateness Criteria considers radiographs to be the most appropriate initial imaging study for all patients with chronic hip and knee pain[5, 6]. Similar to the MRI ordering status, the type of ordered radiograph was not specified in the survey data but was inferred based upon the primary presenting complaint of hip or knee pain. Finally, the weighted and unweighted counts for MRI orders for both hip and knee pain visits were recorded for each year to assess annual trends.

Statistical Analysis:

NAMCS survey weights were applied to the sampled population to project a national estimate representative of the U.S. population, with the weighted data used for the analysis. Descriptive statistics were obtained for each self-reported patient characteristic (patient age, sex, race/ethnicity, and source of payment), physician specialty category, metropolitan statistical area, and radiograph ordering status to determine the association of each factor with MRI ordering status, with both the number of observations and weighted counts recorded.

A multivariate logistic regression analysis was used to assess the association between MRI ordering status and patient variables, including patient sex, age, race/ethnicity, payment source, physician specialty, and metropolitan statistical area. The results were reported as adjusted odds ratios, with a 95% confidence interval. All tests were two-sided and utilized a *p-value* of ≤ 0.05. The statistical analysis was performed using Stata 18 statistical software (StataCorp LLC).

Results:

Summary Statistics:

Within our study period, there were 2,614 patient visits for knee pain and 926 patient visits for hip pain in the sampled population of patients aged 50 and above, with 144 knee pain visits and 62 hip pain visits having an associated MRI order. Utilizing

standard NAMCS survey weights, the sampled data reflects a total of 88,978,804 knee pain visits and 28,675,725 hip pain visits.

In general, hip or knee pain ambulatory visits in the 50 and above population were most common for patients who were female (61.3% of knee pain visits and 55.3% of hip pain visits), white (75.7% of knee pain visits and 82.3% of hip pain visits), insured with Medicare (44.8% of knee pain visits and 52.1% of hip pain visits), and seen by a surgical care specialist (65% of knee pain visits and 52.8% of hip pain visits). Patient visits for hip or knee pain were more common in a more urban-based healthcare setting (metropolitan statistical area; 89.6% of knee pain visits and 88.8% of hip pain visits). The highest proportion of knee pain visits were in the 60–69-year age group (31.5%), while the highest proportion of hip pain visits were in the 70-79 year old age group (29.4%). Descriptive statistics for the study population with hip or knee pain, including data on patient age, sex, race/ethnicity, payment source, physician specialty, metropolitan statistical area, and radiograph ordering status are detailed in **Table 1**.

Of the patient visits for knee pain, 4,690,943 (5.3%) had an associated MRI order, while 2,023,226 (7.1%) of hip pain visits had an associated MRI order. Overall, 2,454,433 (8.4%) of knee pain visits and 575,155 (5.0%) of hip pain visits had an order for both radiographs and MRI within the same patient visit. For 26,784,912 (30.1%) of knee pain visits and 10,864,915 (37.9%) of hip pain visits only radiographs were ordered, while 57,502,948 (64.6%) of knee pain visits and 15,787,584 (55%) of hip pain visits had no ordered imaging.

Regression Modeling:

Results of the multivariate logistic regression analysis are presented in **Table 2**. For knee pain patient visits, patients aged 80 years and above age (p=0.04) and black patients (p=0.03) were each less likely to have an MRI order. For knee pain patient visits, there was no difference in MRI ordering status based on patient sex, source of payment, physician specialty, or MSA status.

For hip pain patient visits, patients were less likely to have an MRI order if uninsured (p=0.01), and more likely to have an MRI order if seen by a surgical care subspecialty (p=0.01). For hip pain patient visits, no difference in MRI ordering status was seen based on patient sex, age group, race/ethnicity, or MSA status.

The weighted number of MRI orders by year is demonstrated in **Figure 1**, showing the lowest number of MRIs ordered both for the knee (5,239,987) and the hip (1,868,705) in 2016, while knee MRI orders peaked in 2018 (11,156,693), and hip MRI orders peaked in 2019 (3,108,323).

Table 1. Total unweighted and weighted counts and weighted demographic data for the sampled visits by MRI ordering status.

	Knee Pain		Hip Pain	
	MRI Ordered	**Total Pain Cohort**	**MRI Ordered**	**Total Pain Cohort**
Total Count (unweighted)	144 (5.5%)	2,614	62 (6.7%)	926
Total Count (weighted)	4,690,943 (5.3%)	88,978,804	2,023,226 (7.1%)	28,675,725
Sex				
Female	2,818,192 (5.2%)	54,550,877 (61.3%)	934,982 (5.9%)	15,871,472 (55.3%)
Male	1,872,752 (5.4%)	34,427,927 (38.7%)	1,088,244 (8.5%)	12,804,253 (44.7%)
Age Group				
50-59	1,797,163 (7.2%)	24,860,761 (27.9%)	405,562 (5.5%)	7,437,710 (25.9%)
60-69	1,792,004 (6.4%)	28,055,926 (31.5%)	559,998 (7.1%)	7,895,489 (27.5%)
70-79	839,604 (3.7%)	22,782,111 (25.6%)	840,346 (10.0%)	8,421,064 (29.4%)
>=80	262,172 (2.0%)	13,280,006 (14.9%)	217,320 (4.4%)	4,921,462 (17.2%)
X-ray ordered				
No	2,236,510 (3.7%)	59,739,459 (67.1%)	1,448,070 (8.4%)	17,235,655 (60.1%)
Yes	2,454,433 (8.4%)	29,239,345 (32.9%)	575,155 (5.0%)	11,440,070 (39.9%)
Race/Ethnicity				
White	4,004,807 (5.9%)	67,392,087 (75.7%)	1,612,020 (6.8%)	23,613,836 (82.3%)
Black	148,146 (2.0%)	7,307,456 (8.2%)	311,065 (12.0%)	2,589,183 (9.0%)
Hispanic	436,313 (4.2%)	10,466,738 (11.8%)	30,964 (1.6%)	1,936,332 (6.8%)
Asian or other race	101,677 (2.7%)	3,812,522 (4.3%)	69,176 (12.9%)	536,374 (1.9%)
Source of payment				
Private Insurance	2,619,658 (7.8%)	33,391,446 (37.5%)	863,028 (7.9%)	10,956,516 (38.2%)
Medicare	1,528,132 (3.8%)	39,866,973 (44.8%)	1,079,164 (7.2%)	14,934,756 (52.1%)
Medicaid	107,115 (1.8%)	5,816,555 (6.5%)	16,134 (1.8%)	898,149 (3.1%)
Worker's Comp.	115,828 (8.8%)	1,319,378 (1.5%)	0 (0.0%)	79,561 (0.3%)
Uninsured	81,942 (1.9%)	4,302,465 (4.8%)	862 (0.2%)	436,434 (1.5%)
Unknown/other	238,268 (5.6%)	4,281,987 (4.8%)	64,037 (4.7%)	1,370,310 (4.8%)
Physician specialty				
Primary care specialty	1,309,538 (5.5%)	23,823,363 (26.8%)	254,468 (2.6%)	9,769,659 (34.1%)
Surgical care specialty	3,073,899 (5.3%)	57,797,109 (65.0%)	1,469,837 (9.8%)	15,071,726 (52.6%)
Medical care specialty	307,506 (4.2%)	7,358,331 (8.3%)	298,921 (7.8%)	3,834,340 (13.4%)
MSA or non-MSA area				
MSA (Metropolitan Statistical Area)	4,218,377 (5.3%)	79,745,064 (89.6%)	1,920,542 (7.5%)	25,471,361 (88.8%)
Non-MSA	472,566 (5.1%)	9,233,739 (10.4%)	102,684 (3.2%)	3,204,364 (11.2%)

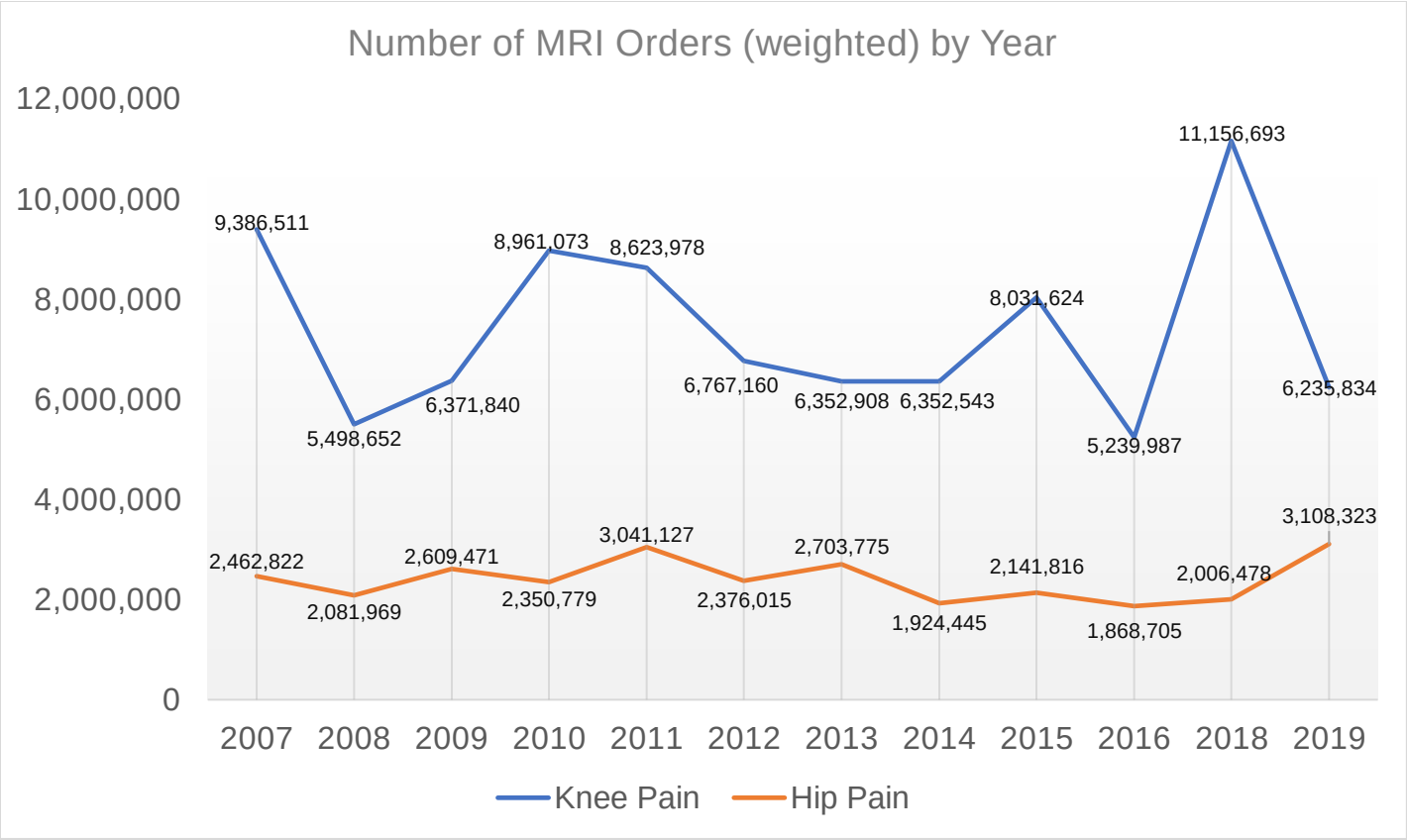
MSA-Metropolitan Statistical Area, UW-Unweighted, W-Weighted

Table 2. Adjusted odds ratios analyzing variables associated with MRI utilization.

	Knee Pain		Hip Pain	
Variable	**Odds Ratio (95% CI)**	**p value**	**Odds Ratio (95% CI)**	**p value**
Sex				
Female	Reference		Reference	
Male	0.98 (0.56-1.71)	0.95	1.38 (0.57-3.30)	0.48
Age Group				
50-59	Reference		Reference	
60-69	0.92 (0.46-1.85)	0.81	1.43 (0.49-4.20)	0.52
70-79	0.58 (0.28-1.22)	0.15	2.36 (0.51-10.97)	0.28
>=80	0.32 (0.11-0.96)	**0.04***	1.10 (0.26-4.67)	0.89
Race/ethnicity				
White	Reference		Reference	
Black	0.29 (0.10-0.91)	**0.03***	2.12 (0.70-6.45)	0.19
Hispanic	0.75 (0.31-1.83)	0.53	0.25 (0.04-1.56)	0.14
Asian or other race	0.52 (0.11-2.37)	0.39	2.11 (0.23-19.34)	0.51
Source of payment				
Private insurance	Reference		Reference	
Medicare	0.65 (0.34-1.27)	0.21	0.81 (0.21-3.11)	0.76
Medicaid	0.27 (0.07-1.15)	0.08	0.37 (0.06-2.19)	0.28
Worker's Comp	1.08 (0.22-5.29)	0.92	**No observations**	
Uninsured	0.24 (0.04-1.51)	0.13	0.04 (0.00-0.41)	**0.01***
Unknown/other	0.79 (0.26-2.44)	0.69	0.69 (0.14-3.43)	0.65
Specialty				
Primary care	Reference		Reference	
Surgical care	0.93 (0.42-2.10)	0.87	3.87 (1.43-10.46)	**0.01***
Medical care	0.85 (0.27-2.67)	0.78	3.17 (0.91-11.10)	0.07
MSA Status				
MSA	Reference		Reference	
Non-MSA	0.86 (0.44-1.67)	0.65	0.53 (0.12-2.32)	0.40

*-statistically significant
Odds ratios adjusted for patient age, gender, race/ethnicity, source of payment, physician specialty category, and MSA status.

Figure 1. Graphic representation of the weighted number of hip and knee MRI exams ordered by year during ambulatory encounters for hip and knee pain. Data from the National Ambulatory Medical Care Survey 2007-2019.



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