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A Dartmouth Atlas Surgery Report

Trends and Regional Variation in Hip, Knee, and Shoulder Replacement

April 6, 2010

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Introduction

Once considered surgical breakthroughs, hip, knee, and shoulder replacement have become routine procedures. Every year, hundreds of thousands of Americans suffering from pain or disability as a result of degenerative joint disease experience remarkable improvements in quality of life that would not have been possible without the surgery. The procedures are generally safe and effective, and patients are usually highly satisfied with the results, which helps to explain why the procedures are now so common. As the population ages and people expect to live longer and more active lives, demand for joint replacement is likely to continue to grow.

Still, for some patients the potential downsides of joint replacement—or arthroplasty, as it is often referred to in the medical literature—outweigh the likely benefits, even if their condition makes them suitable candidates. Some are not bothered much by their symptoms; others prefer to delay the procedure as long as possible to avoid the risk of needing a second operation if the prosthetic joint fails. If encouraged to take an active role in determining the course of treatment, these patients may opt for non-surgical alternatives to help manage their symptoms. Ideally, each patient would be well informed about the risks and benefits of joint replacement before deciding to undergo the procedure in order to ensure that their treatment matches their personal values and can meet their expectations. In this analysis, however, we found patterns in the use of hip, knee, and shoulder replacement among Medicare beneficiaries that raise concerns about both possible underuse (whether all who could benefit are being offered the procedure) and overuse (whether some patients are receiving a procedure that they might choose to delay or forego if they had received balanced information on risks and benefits).

From 2000-01 to 2005-06, rates of hip, knee, and shoulder replacement all rose substantially among Medicare beneficiaries, and there was widespread variation in the use of these procedures across geographic regions and by race. The Dartmouth Atlas Project has detailed similar variation in the use of other elective procedures. One possible interpretation of this variation is that the decision to undergo the procedure may be influenced more by physician judgments than by the preferences and values of the individual patients. Another explanation might be that patients in some geographical areas do not have adequate access to joint replacement. These findings highlight the need for improved physician and patient education and the use of shared decision-making to determine whether a patient should undergo joint replacement.

Factors to consider before undergoing joint replacement

Most patients who undergo joint replacement suffer from osteoarthritis, the deterioration of cartilage in the joint and the leading cause of disability in the elderly in the United States.[1] There are a number of non-surgical treatment options available, particularly for early stages of osteoarthritis. For some patients, these alternatives may be sufficient to manage their symptoms. For others, joint replacement will eventually become the best option for treatment.

The American Academy of Orthopaedic Surgeons and the Osteoarthritis Research Society International have offered consensus guidelines for the treatment of osteoarthritis.[2,3] These groups recommend that, before turning to surgery, patients try non-surgical options that have been shown to have some success, such as weight loss, exercise, activity modification, or the use of walking aids or orthotics. One study, for example, found that six weeks of aquatic physical therapy improved function and decreased pain in about three-quarters of patients with osteoarthritis of the hip or knee. Only 17% of patients in the control group, which received no aquatic physical therapy, experienced similar improvements.[4] If these treatments prove insufficient or the disease worsens, medications may be able to help manage symptoms. Acetaminophen and non-steroidal anti-inflammatory drugs are often recommended and have been shown to reduce pain and improve function compared to a placebo for both hip and knee osteoarthritis.[5] Replacement should be considered only when these non-surgical alternatives have been exhausted. Substantial damage to the joint should be confirmed with the use of imaging, and the patient should have significant pain or loss of function that cannot otherwise be managed.[1,6,7]

Most patients who turn to joint replacement to treat their symptoms are satisfied with the results. Several large clinical studies have reported patient satisfaction rates approaching 90% for hip replacement, and, according to the National Institutes of Health, about 85% of patients who undergo knee replacement are satisfied with the results.[6,8] Patient satisfaction with shoulder replacement is also very high, with a reported satisfaction rate of about 97%.[9]

Despite this success, there are several areas of concern. Joint replacements have typically been recommended for elderly patients, but they are becoming more common in younger age groups. For these patients, there is an increased risk that the prosthetic joint will fail, both because they are likely to live longer than older patients and because they are expected to use the prosthetic joint more aggressively. The ten-year survival rate of prosthetic joints used in knee replacement is about 90%, but that rate falls to 80% after twenty years.[6] Survival rates of prosthetics used in hip replacement also appear to be lower in younger patients.[10] If an implant fails, a second (revision) replacement to replace the prosthetic joint can be required. Revision replacement has a higher failure rate than primary replacement, requires more technical expertise on the part of the surgeon, and is significantly more expensive. Furthermore, there are fewer surgeons who have the ability to perform revision replacement than primary replacement, so access to this procedure may be limited in some areas.

Another concern is that it can be difficult to determine which patients will have poor outcomes from joint replacement, particularly for knee replacement. There are some patients for whom knee replacement does not substantially relieve pain and restore function, and some experience chronic, medically unexplained pain following the procedure.[11] In one study, seven years after knee replacement, 30% of patients reported developing moderate-to-severe pain at some point since their initial recovery from surgery.[12]

Even when patients are satisfied overall with the results of joint replacement, some of their expectations may not be met.[13] Those who expect improvements in their ability to take part in less essential activities, such as exercise, tend to be less satisfied than patients who hope only to improve essential abilities, such as walking.[14] One survey of patients who underwent hip replacement showed that, before the surgery, 99% expected to improve their ability to walk and 95% expected to improve their ability to exercise and play sports. Most patients did experience improvements in both of these areas, but there was a significant difference—91% reported an improved ability to walk, compared to 78% who reported improvement in being able to exercise or play sports. Only 43% of patients had all of their expectations met, indicating that they may have entered into the procedure without a thorough understanding of expected outcomes and potential benefits.[8]

Finally, even when the possible benefits of joint replacement are clear to physicians, patients often prefer not to undergo surgery. For example, a study of 2,411 patients in Ontario with severe hip and knee osteoarthritis found that only 16% of the patients were interested in surgery when they were fully informed of the risks and benefits of each treatment choice.[15]

Based on the data presented here, it appears that patients in some regions and among some populations may not be getting adequate access to the procedures, while patients in other regions and among other populations may be undergoing the procedures at higher rates than necessary.

Trends in the use of joint replacement

Rates of hip, knee, and shoulder replacement have all grown substantially in recent decades.[16] Medicare records show that the procedures continued to increase in use among the Medicare population from 2000-01 to 2005-06. During that period, the overall rate of hip replacement per 1,000 Medicare beneficiaries rose from 3.5 to 4.0, an increase of 15%. The increase in use of knee replacement was even more dramatic. In 2000-01, the rate of knee replacement stood at 6.0 per 1,000 Medicare beneficiaries. By 2005-06, there was an increase of 48% to 8.8 procedures per 1,000 beneficiaries. The rate of the procedure increased in almost every hospital referral region. Shoulder replacement is far less common than hip or knee replacement, but, as with those procedures, the rate increased from 2000-01 to 2005-06. In 2000-01, there were 0.5 shoulder replacements performed per 1,000 Medicare beneficiaries. Procedure rates increased over the next five years to 0.8 per 1,000 beneficiaries, an increase of 67%.

Table 1. National average rates of joint replacement per 1,000 Medicare enrollees, 2000-01 and 2005-06

	2000-01	2005-06	Percent increase
Hip arthroplasty	3.5	4.0	15%
Knee arthroplasty	6.0	8.8	48%
Shoulder arthroplasty	0.5	0.8	67%

These rates include both primary and revision replacements. Part of the increase in rates of the procedures is the result of a growing need for revision surgeries as more and more older prosthetics begin to malfunction or wear out, requiring replacement. As younger patients continue to increase their use of joint replacement, rates of revision will likely continue to rise, contributing to the overall increase in use of joint replacement.

Regional variation in hip replacement

There was marked variation between hospital referral regions in the rate of hip replacement in both 2000-01 and 2005-06. In 2000-01, Alexandria, Louisiana, had the lowest rate of hip replacement, at 1.2 per 1,000 beneficiaries. The rate in Boulder, Colorado, was more than five times higher, at 6.7 per 1,000. In 2005-06, Bryan, Texas, had the nation's lowest rate, at 1.8 per 1,000, and Ogden, Utah, had the highest rate, at 7.2 per 1,000. Other regions with rates lower than the national average in both 2000-01 and 2005-06 included Honolulu (1.5 per 1,000 in 2000-01; 1.9 per 1,000 in 2005-06), Fort Smith, Arkansas (1.6; 2.6), and Wilkes-Barre, Pennsylvania (2.2; 1.9). Regions with rates higher than the national average in both 2000-01 and 2005-06 included Grand Forks, North Dakota (5.9; 6.3), Lansing, Michigan (5.8; 6.2), and Fort Myers, Florida (5.3; 6.1).

Extensive variation was apparent even within individual states. For example, in 2000-01, rates of hip replacement in California ranged from 2.5 per 1,000 in San Jose to 5.7 per 1,000 in Salinas. In 2005-06, the variation in California was even wider, from a low of 2.7 per 1,000 in Los Angeles to a high of 6.7 per 1,000 in San Luis Obispo. There was significant variation within smaller states as well. In 2000-01, rates in Iowa were as low as 3.4 per 1,000 in Dubuque and as high as 6.3 per 1,000 in Sioux City. As in California, the gap grew over the next five years, from a low of 3.5 per 1,000 in Cedar Rapids to a high of 7.1 per 1,000 in Sioux City.

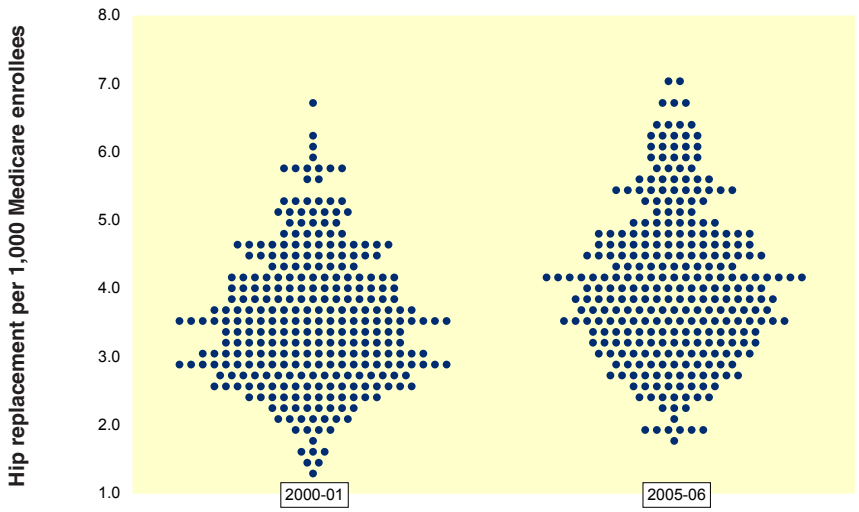
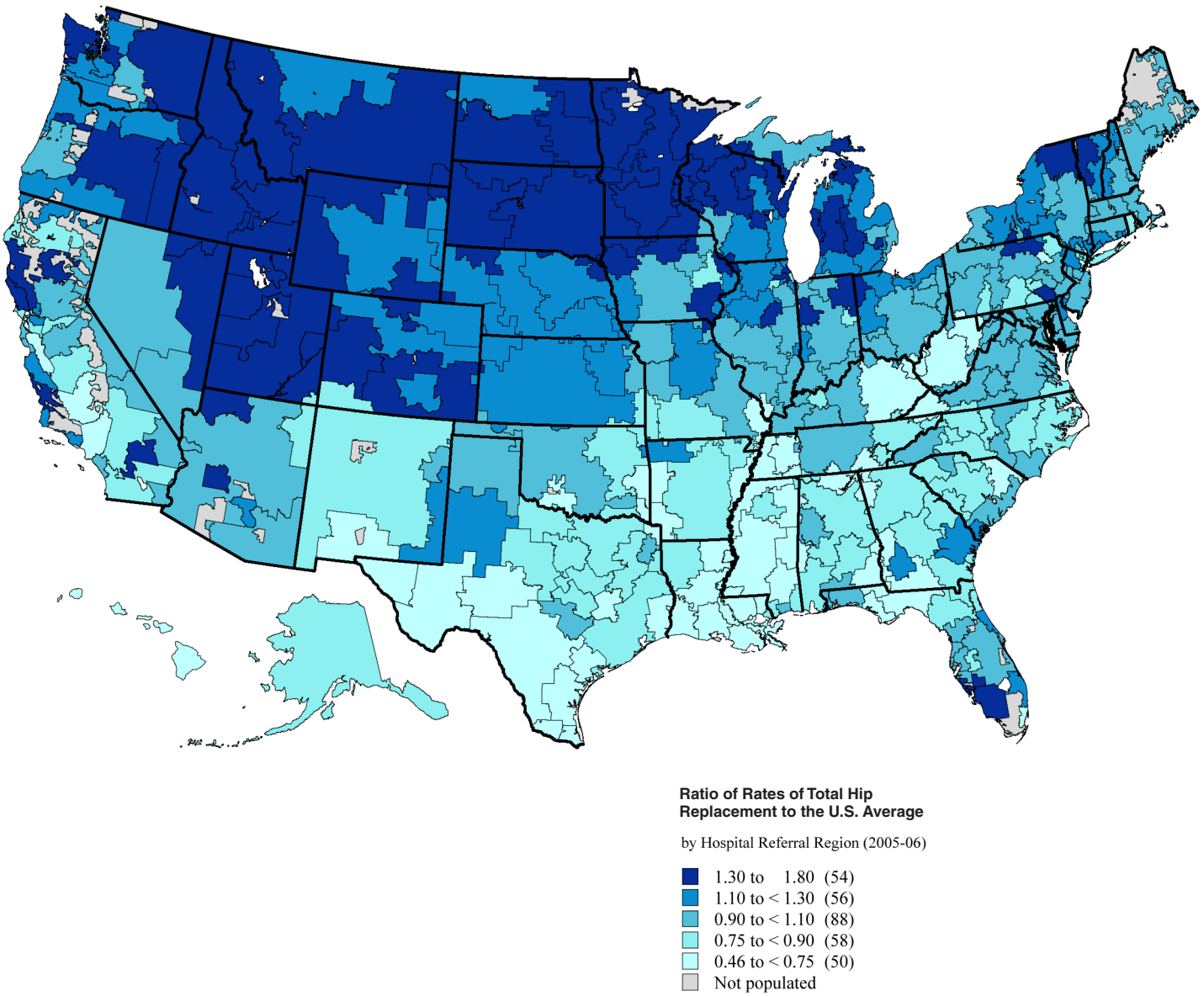
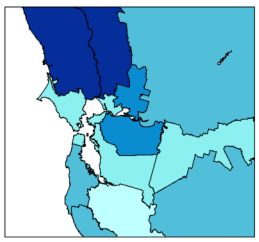


Figure 1. Rates of hip replacement among hospital referral regions, 2000-01 and 2005-06



Map 1. Hip replacement among hospital referral regions, 2005-06



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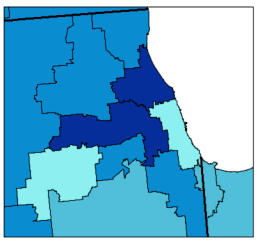

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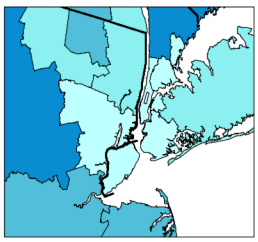

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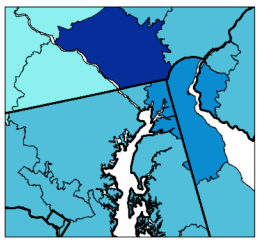

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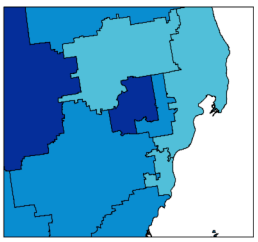


Detroit

Regional variation in knee replacement

Rates of knee replacement varied widely in both 2000-01 and 2005-06. In 2000-01, Honolulu had the lowest rate, at 2.5 per 1,000 Medicare beneficiaries. Elyria, Ohio, had the highest rate, at 10.5 per 1,000. In 2005-06, Manhattan had the lowest rate, at 4.0 per 1,000, while Lincoln, Nebraska, had the highest rate, at 15.7 per 1,000. Other regions with rates lower than the national average in both 2000-01 and 2005-06 included Paterson, New Jersey (3.1 per 1,000 in 2000-01; 4.4 per 1,000 in 2005-06), Kingsport, Tennessee (3.1; 4.9), and Oxford, Mississippi (4.5; 5.5). Regions with rates higher than the national average in 2000-01 and 2005-06 included Sioux Falls, South Dakota (9.1; 14.3), Topeka, Kansas (9.9; 13.4), and Casper, Wyoming (7.4; 12.9).

This variation existed both nationally and within individual states. In 2000-01 in New York, for example, the rate of knee replacement ranged from 2.9 per 1,000 in Manhattan to 6.1 per 1,000 in Rochester. In Texas, rates ranged from 5.4 per 1,000 in Houston to 10.1 per 1,000 in Lubbock. In Florida, surgeons performed 3.6 procedures per 1,000 beneficiaries in Miami but 8.0 per 1,000 in Fort Myers.

Similar variation was still evident in 2005-06. In New York, the rate in Manhattan remained the lowest in the state, at 4.0 per 1,000 beneficiaries, while Syracuse had the highest rate, at 8.6 per 1,000. In Texas, Houston continued to have one of the lowest rates in the state, at 8.5 per 1,000, while the rate in Lubbock climbed to 12.3 per 1,000. In Florida, rates in both Miami and Fort Myers increased, but the difference between the two grew even larger than it was in 2000-01, with the rate in Miami rising to 5.2 per 1,000 and the rate in Fort Myers increasing to 12.1 per 1,000.

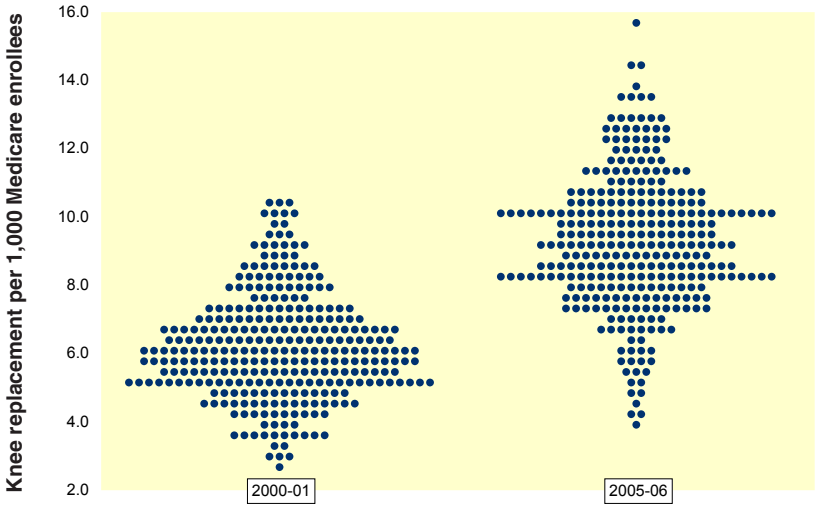
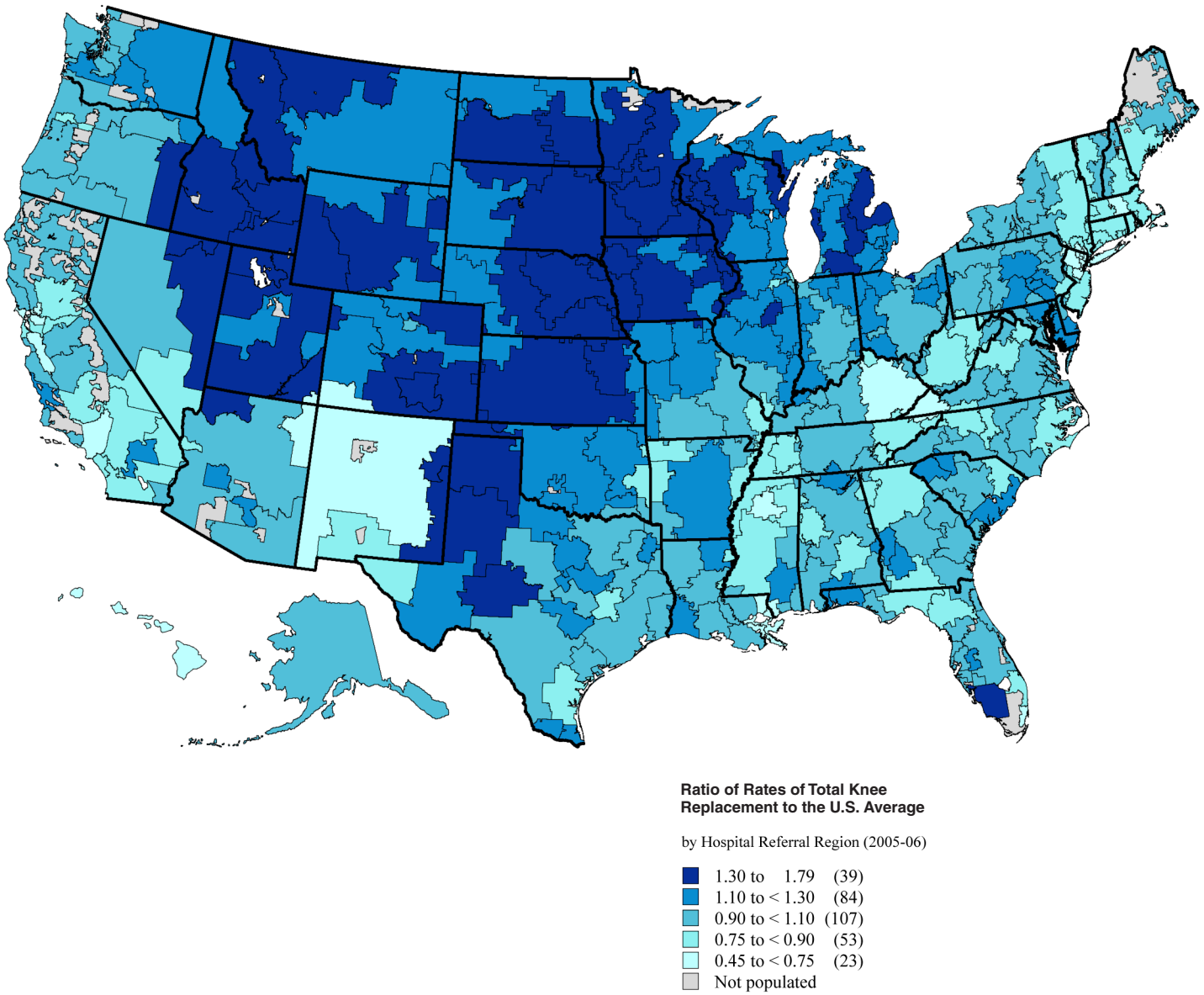
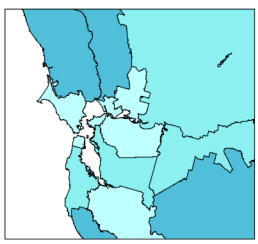


Figure 2. Rates of knee replacement among hospital referral regions, 2000-01 and 2005-06



Map 2. Knee replacement among hospital referral regions, 2005-06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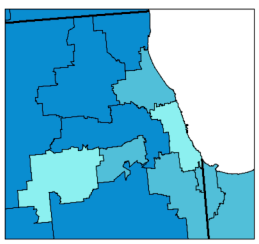
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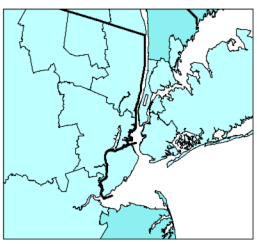
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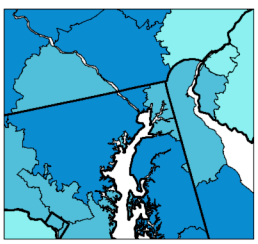
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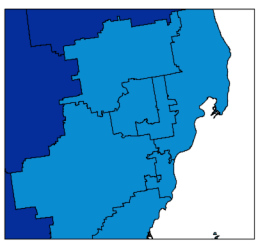

Detroit

Regional variation in shoulder replacement

Rates of shoulder replacement were much lower than rates of hip and knee replacement, but the use of the procedure still varied widely by region. In 2000-01, the lowest rate of shoulder replacement was found in Lexington, Kentucky, at 0.2 per 1,000 Medicare beneficiaries, and the highest was in Fort Collins, Colorado, at 1.8 per 1,000. In 2005-06, Syracuse, New York, had the lowest rate, at 0.3 per 1,000 beneficiaries; the rate in Provo, Utah, was about ten times higher, at 3.0 per 1,000. Other regions with rates lower than the national average in both 2000-01 and 2005-06 included East Long Island, New York (0.2 per 1,000 in 2000-01; 0.4 per 1,000 in 2005-06), Los Angeles (0.4; 0.5), and Pittsburgh (0.4; 0.5). Regions with rates higher than the national average in both 2000-01 and 2005-06 included Great Falls, Montana (1.3; 1.7), Omaha, Nebraska (0.9; 1.1), and Minneapolis (0.7; 1.1).

As was the case with hip and knee replacement, there was significant variation within individual states as well as nationally. In 2000-01 in Virginia, for example, rates of shoulder replacement varied more than threefold, from 0.2 per 1,000 Medicare beneficiaries in Arlington to 0.9 per 1,000 in Richmond. In 2005-06, variation remained high, with the lowest rate in the state at 0.7 per 1,000 beneficiaries in Arlington and the highest at 1.3 per 1,000 in Newport News. In Illinois, rates in 2000-01 ranged from 0.3 per 1,000 in Peoria to 0.8 per 1,000 in Springfield. In 2005-06, rates ranged from 0.6 per 1,000 in Chicago to 1.7 per 1,000 in Aurora.

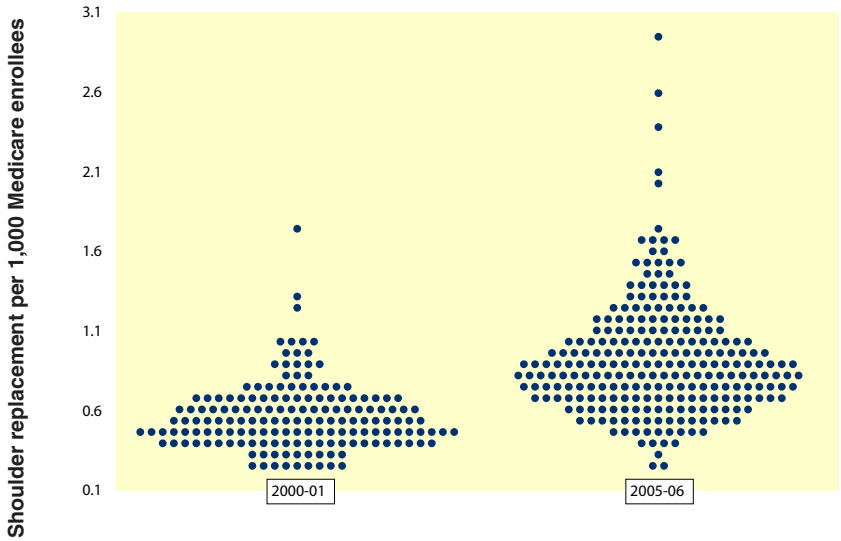
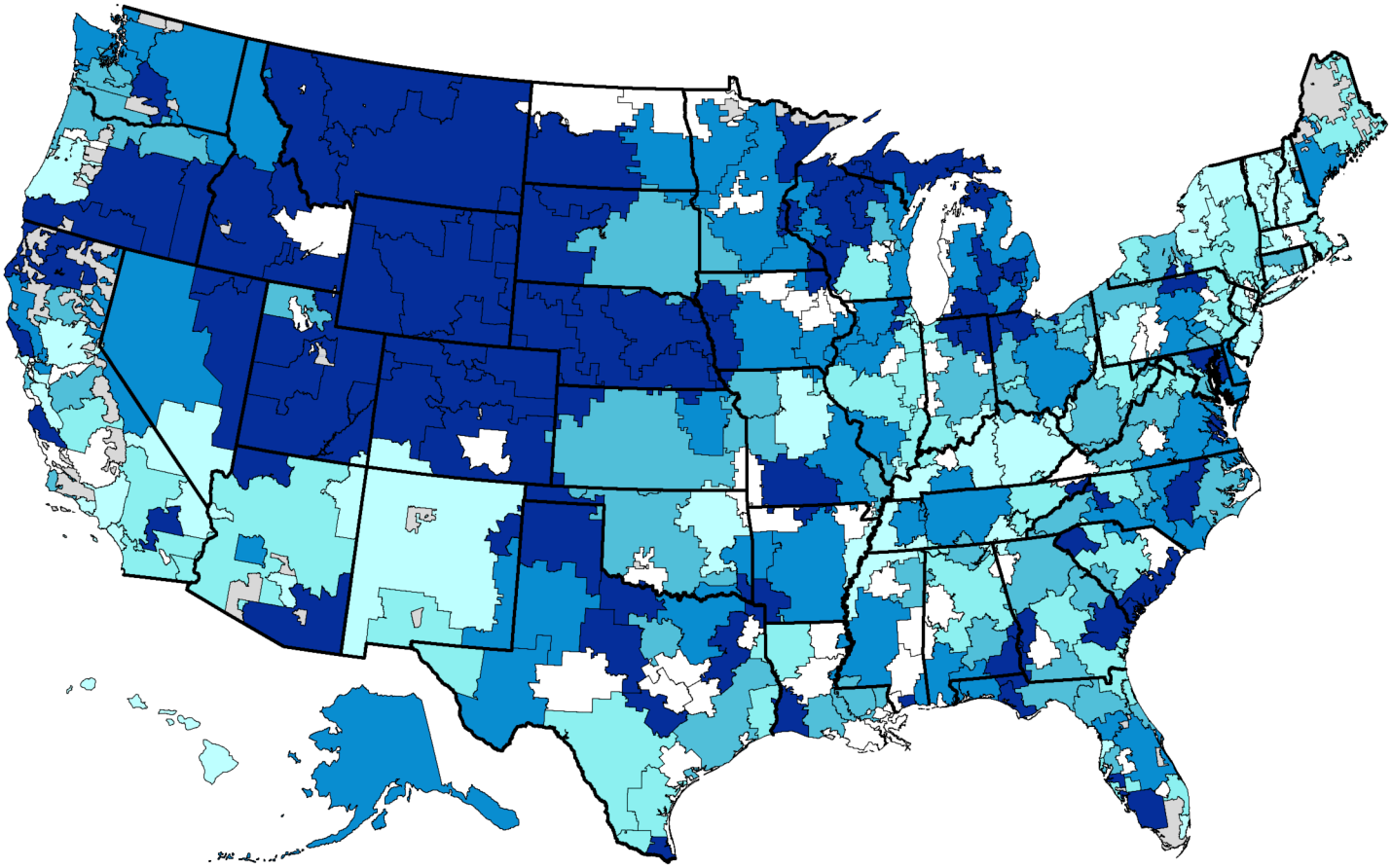
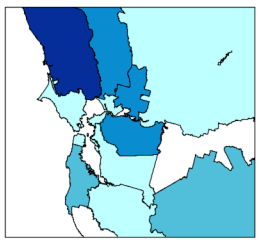


Figure 3. Rates of shoulder replacement among hospital referral regions, 2000-01 and 2005-06



Map 3. Shoulder replacement among hospital referral regions, 2005-06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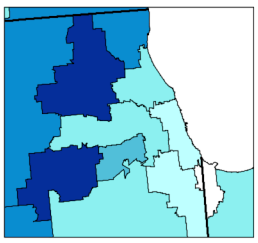
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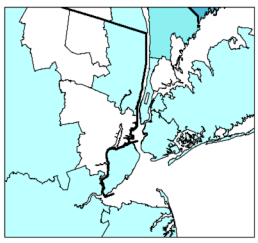
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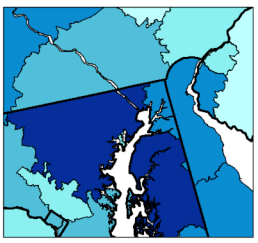
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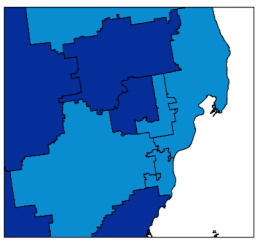
Detroit

Differences in joint replacement by race

It is well documented that black patients are less likely than white patients to undergo hip or knee replacement.[6,17,18] The difference is particularly dramatic when comparing use of the procedures by white and black men. An analysis of Medicare patients from 1998 to 2002 revealed that the rate of knee replacement for white men (4.8 per 1,000 beneficiaries) was more than double the rate for black men (1.8 per 1,000), despite some evidence suggesting that black men are more likely to suffer from hip and knee osteoarthritis than white men.[19,20]

The data from Medicare enrollees in 2000-01 and 2005-06 show that differences persist in the use of joint replacement by race. Nationally, the rate of hip replacement among black Medicare beneficiaries in 2000-01 was 1.9 per 1,000; for all other enrollees, it was 3.6 per 1,000. Both rates increased by a similar degree over the next five years, but the disparity remained, with black enrollees undergoing hip replacement at a rate of 2.2 per 1,000, compared to a rate of 4.1 per 1,000 for all other Medicare beneficiaries. The rates of knee replacement reflect similar differences. In 2000-01, the rate among black Medicare beneficiaries was 4.0 per 1,000, whereas the rate for all other enrollees was 6.1 per 1,000. By 2005-06, the rates had increased to 5.6 per 1,000 for black enrollees and 9.1 per 1,000 for all others. The rate of shoulder replacement among black Medicare beneficiaries in 2000-01 was 0.2 per 1,000. For all other beneficiaries, the rate was 0.5 per 1,000. In 2005-06, the rates stood at 0.2 per 1,000 for black beneficiaries and 0.9 per 1,000 for all others.

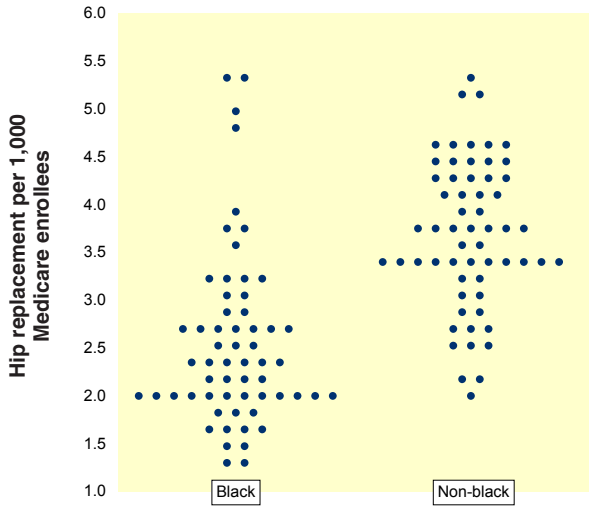

Figure 4. Rates of hip replacement by race among hospital referral regions, 2005-06

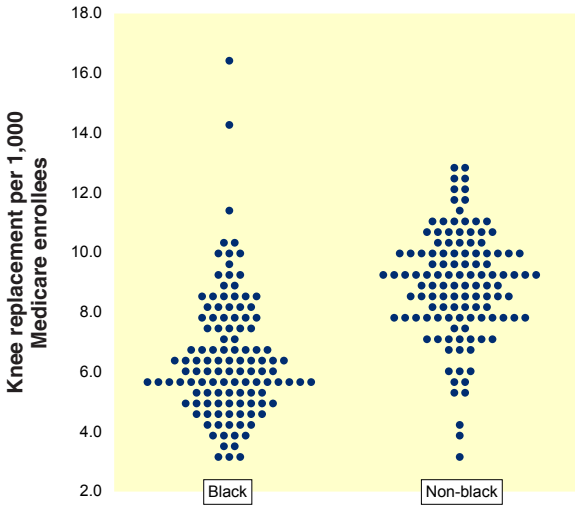

Figure 5. Rates of knee replacement by race among hospital referral regions, 2005-06

These racial differences were much more apparent in some regions than in others. In St. Louis, Missouri, the rate of hip replacement for black Medicare beneficiaries in 2005-06 was 2.2 per 1,000; it was 4.1 per 1,000 for all other Medicare beneficiaries. Similarly, in Kansas City, Missouri, rates of hip replacement were 2.0 per 1,000 for blacks and 4.3 per 1,000 for all others. Rates of knee replacement in these regions also differed. In 2005-06, rates of knee replacement in St. Louis were 4.9 per 1,000 for black Medicare beneficiaries and 9.9 per 1,000 for all other beneficiaries. In Kansas City, the rates were 5.0 per 1,000 for blacks and 10.6 for all others.

Although in most regions there were important racial differences in replacement rates, in a few places the differences were small. In Dayton, Ohio, black Medicare beneficiaries were slightly *more* likely than other beneficiaries to undergo hip replacement in 2005-06. There, black beneficiaries underwent 4.8 procedures per 1,000 enrollees, compared to 4.7 per 1,000 for all others. In San Francisco, the rate of knee replacement in 2005-06 was 6.0 per 1,000 for both blacks and non-blacks.

Explaining variation in the use of joint replacement

There are a number of possible explanations for the variation seen in rates of joint replacement. Although there are now guidelines available to help determine when in the course of osteoarthritis treatment replacement should be considered, some of those guidelines were issued only recently (after the time period studied in this analysis). For example, the recommendations presented by the Osteoarthritis Research Society International were published in 2008.[3]

Geographic variation in rates of the procedures may also indicate that physicians in some regions are simply more likely to recommend replacement than are physicians in other regions, due either to differences in the supply of surgeons who can perform the procedures or to physician preferences. Given the complexity of determining when replacement is the best option for osteoarthritis treatment, physician preferences can have an influence on the patient's decision to undergo joint replacement.[21] There is also evidence that recommendations made by physicians are affected by more than just a patient's condition. In the case of knee replacement, some studies have shown that physicians are more likely to recommend the procedure to men than to women when treating patients with identical health status.[22,23]

It is not well understood why rates of hip and knee replacement differ so widely by race. Research has shown that this cannot be explained by socioeconomic factors.[6,17,24] There is some evidence, however, that black and white patients have different perceptions of the effectiveness of the procedures.[25,26] One study reported that black male veterans with moderate-to-severe osteoarthritis of the knee were more likely than white male veterans to use over-the-counter medications and to cut down on regular activities, and less likely to believe that joint replacement would relieve their symptoms.[18]

Encouraging informed patient choice and shared decision-making

For procedures such as hip, knee, and shoulder replacement, in which outcomes are closely tied to patients' expectations, it is essential that patients have a thorough and realistic understanding of the risks and potential benefits. This is particularly important given the rising use of joint replacement. There is evidence that patients may choose less invasive treatment options when they are well informed about their choices.[15,27]

The use of decision aids to help educate patients about their options can improve patient participation in the decision-making process. Shared decision-making also reduces patients' anxiety when it comes to making difficult choices about their care.[28-30] If consensus recommendations about non-surgical treatments are incorporated into decision aids, patients will be better able to choose whether to opt for those treatments rather than for surgery. The process of shared decision-making is invaluable for helping patients to clarify their personal goals and values, consider their available options, and come to a decision that is in line with their preferences. If shared decision-making is more widely incorporated into osteoarthritis treatment, rates of joint replacement may well rise in areas where it is currently underused and decrease in areas where high rates of replacement reflect an over-reliance on surgery.

Conclusion

Between 2000-01 and 2005-06, rates of hip, knee, and shoulder replacement grew substantially among the United States Medicare population. These increases are the result of the rising use of both primary replacement to treat osteoarthritis and revision joint replacement in patients whose original prosthetic joint failed. As more patients who undergo joint replacement live longer, the need for revision replacement to repair aging and deteriorating prosthetics will likely continue to rise.

Regional variation was significant at both the beginning and end of this period. In 2005-06, rates of hip and knee replacement in high-use regions were almost four times higher than rates in low-use regions. The rate of shoulder replacement was more than ten times higher in the highest-use region than in the lowest-use region. There were also differences in the use of these procedures by race, with black patients less likely to undergo joint replacement than other patients. To address these discrepancies, patients must be able to take an active, informed role in the decision-making process. One way to move toward this goal is to provide evidence-based tools, such as patient decision aids, which have been shown to be an effective means of helping patients make difficult decisions about their health care. The incorporation of evidence-based consensus recommendations into the treatment of osteoarthritis may help reduce variations caused by physician preferences by charting a consistent timeline for treatment as degenerative joint disease progresses.

Methods

Databases:

We measured the incidence of total (both primary and revision) hip, knee, and shoulder replacement during two time periods: 2000-01 and 2005-06. We used 20% national random samples from the Centers for Medicare and Medicaid Services (CMS) Part B files for each year to identify all hip, knee, and shoulder replacement procedures performed on Medicare-eligible beneficiaries during each of those years. The Denominator file was used to determine demographic information (age, sex, and race), residence (ZIP code), and program eligibility. We excluded patients under age 65, those with unknown race, and patients who were members of HMOs at any time during the study periods.

Procedure Selection and Analysis:

To examine each of the procedures, we measured the incidence of their Current Procedural Terminology (CPT) codes. Table 2 shows the CPT codes used to identify joint replacement during the periods 2000-01 and 2005-06. The numerator for calculating the crude rate consisted of the number of procedures in each year; the denominator consisted of the number of beneficiaries in the 20% Part B sample eligible as of June for each year (a mid-year denominator.)

Table 2. Joint Replacement CPT Codes

Procedure	CPT Codes**
Total hip replacement	27130, 27134, 27137, 27138
Total knee replacement	27446, 27447, 27487 (Excludes 821.00-821.39 distal femur fracture; 823.00-823.12 tibial plateau fracture)
Total shoulder replacement	23470, 23472, 23616

**Excludes all neoplasms: 140-239.9; pathologic fractures: 733.1, 733.10, 733.13, 733.95
Non-union/malunion of fracture: 733.8, 733.81-733.82

To study geographic variation in procedure rates, we examined the rates of hip, knee, and shoulder replacement within each of the 306 hospital referral regions (HRRs) in the United States. HRRs, as described in earlier work by the Dartmouth Atlas of Health Care, represent distinct tertiary medical care markets and are served by at least one tertiary care center and several smaller centers. After determining the crude rates of joint replacement within each HRR during each of the years in our analysis, we adjusted each for differences in age, sex, and race across regions using the indirect method.

Appendix Table: Total joint replacement per 1,000 Medicare enrollees

HRR number	HRR name	State	Hip replacement per 1,000 Medicare enrollees		Knee replacement per 1,000 Medicare enrollees		Shoulder replacement per 1,000 Medicare enrollees	
			2000-01	2005-06	2000-01	2005-06	2000-01	2005-06
1	Birmingham	AL	2.5	3.2	5.6	8.5	0.6	0.7
2	Dothan	AL	2.8	2.7	6.8	8.3	0.6	1.2
5	Huntsville	AL	1.9	2.8	5.7	9.8	0.5	0.7
6	Mobile	AL	2.6	3.5	6.6	9.1	0.7	1.0
7	Montgomery	AL	2.5	3.3	4.8	7.8		0.8
9	Tuscaloosa	AL	2.9	3.7	5.5	7.1		
10	Anchorage	AK	3.6	3.6	5.7	9.3		0.9
11	Mesa	AZ	4.4	4.6	8.3	10.4	0.6	0.6
12	Phoenix	AZ	3.9	4.2	6.4	8.3	0.6	0.7
14	Sun City	AZ	4.0	5.5	8.5	10.7		0.9
15	Tucson	AZ	4.3	4.2	6.0	8.6	0.7	1.2
16	Fort Smith	AR	1.6	2.6	5.1	7.3		1.0
18	Jonesboro	AR	2.2	3.2	4.8	8.4		
19	Little Rock	AR	3.3	3.3	6.4	9.9	0.5	1.0
21	Springdale	AR	2.8	4.5	5.5	7.3		
22	Texarkana	AR	2.8	2.4	5.4	8.6		1.5
23	Orange County	CA	3.7	3.9	5.1	7.3	0.5	0.4
25	Bakersfield	CA	3.2	2.8	4.6	7.5		
31	Chico	CA	3.4	5.2	6.4	9.5		0.8
33	Contra Costa County	CA	3.8	4.6	3.9	6.4		0.9
43	Fresno	CA	2.9	3.6	5.9	8.3	0.7	0.7
56	Los Angeles	CA	2.7	2.7	3.9	5.6	0.4	0.5
58	Modesto	CA	4.0	3.9	6.6	8.2		0.9
62	Napa	CA	5.1	5.8	5.9	8.8		0.9
65	Alameda County	CA	3.5	3.5	4.2	7.7	0.7	0.4
69	Palm Springs/Rancho Mirage	CA	5.1	6.1	8.2	10.2		1.1
73	Redding	CA	4.3	3.2	6.9	9.2		1.1
77	Sacramento	CA	3.2	4.0	5.6	7.2	0.4	0.5
78	Salinas	CA	5.7	4.7	5.0	8.7		1.3
79	San Bernardino	CA	2.7	3.1	5.2	7.8	0.5	0.6
80	San Diego	CA	3.1	3.6	5.3	7.2	0.4	0.6
81	San Francisco	CA	2.6	3.3	3.6	6.0	0.4	0.5
82	San Jose	CA	2.5	2.9	3.7	5.5		0.3
83	San Luis Obispo	CA	3.8	6.7	6.5	9.9		
85	San Mateo County	CA	4.7	4.1	3.6	6.9		0.9
86	Santa Barbara	CA	4.6	4.5	6.2	9.2		0.8
87	Santa Cruz	CA	3.8	3.9	3.6	8.6		
89	Santa Rosa	CA	3.8	6.1	5.3	9.0		1.4
91	Stockton	CA	2.8	3.1	4.8	7.4		
96	Ventura	CA	4.0	4.5	5.9	8.1		0.5
101	Boulder	CO	6.7	5.3	4.2	9.2		2.6
102	Colorado Springs	CO	4.2	5.4	7.9	11.7	0.8	2.1
103	Denver	CO	5.3	4.6	6.8	11.1	0.5	1.3

HRR number	HRR name	State	Hip replacement per 1,000 Medicare enrollees		Knee replacement per 1,000 Medicare enrollees		Shoulder replacement per 1,000 Medicare enrollees	
			2000-01	2005-06	2000-01	2005-06	2000-01	2005-06
104	Fort Collins	CO	4.2	5.8	5.9	11.3	1.8	1.6
105	Grand Junction	CO	4.2	5.3	6.2	10.4		2.4
106	Greeley	CO	4.7	4.9	6.3	14.2	1.0	1.4
107	Pueblo	CO	5.1	4.4	5.4	12.5		
109	Bridgeport	CT	3.5	4.4	3.9	6.7		0.7
110	Hartford	CT	3.6	4.1	4.9	7.2	0.3	0.7
111	New Haven	CT	3.4	4.8	4.4	7.1	0.5	0.6
112	Wilmington	DE	4.0	4.7	6.2	9.2	0.4	0.9
113	Washington	DC	3.2	3.9	5.5	8.6	0.5	0.9
115	Bradenton	FL	4.8	3.8	6.0	8.3		2.0
116	Clearwater	FL	4.1	3.9	6.2	9.3	0.5	0.7
118	Fort Lauderdale	FL	4.5	4.5	5.5	7.4	0.5	0.7
119	Fort Myers	FL	5.3	6.1	8.0	12.1	0.7	1.1
120	Gainesville	FL	3.0	3.0	5.9	7.7		0.8
122	Hudson	FL	3.8	3.9	6.9	8.3		0.6
123	Jacksonville	FL	3.5	3.4	6.1	8.0	0.5	0.7
124	Lakeland	FL	3.4	3.1	5.7	9.7	0.9	
127	Miami	FL	2.4	2.6	3.6	5.2	0.4	0.4
129	Ocala	FL	3.7	4.2	6.1	9.4	0.4	1.0
130	Orlando	FL	3.5	4.0	6.3	9.0	0.5	0.9
131	Ormond Beach	FL	4.0	4.8	6.0	9.6		0.9
133	Panama City	FL	2.6	2.9	5.0	8.3		1.1
134	Pensacola	FL	2.4	3.9	6.6	9.9	0.7	0.9
137	Sarasota	FL	4.9	5.6	6.7	9.2	0.6	0.7
139	St. Petersburg	FL	2.7	4.0	5.1	8.1	0.8	0.9
140	Tallahassee	FL	3.1	2.7	5.4	7.8	0.9	0.8
141	Tampa	FL	3.0	3.7	6.0	9.4	0.7	0.8
142	Albany	GA	3.2	4.7	7.6	9.8		
144	Atlanta	GA	2.9	3.4	5.4	7.4	0.5	0.8
145	Augusta	GA	3.1	3.3	6.5	8.1	0.5	0.8
146	Columbus	GA	2.6	2.9	7.4	10.8		1.2
147	Macon	GA	2.7	3.2	6.9	8.1	0.6	0.7
148	Rome	GA	2.2	2.3	5.5	7.9		
149	Savannah	GA	3.7	4.4	6.3	9.1	0.5	1.2
150	Honolulu	HI	1.5	1.9	2.5	4.1		0.4
151	Boise	ID	5.8	5.9	8.2	11.9	1.0	1.7
152	Idaho Falls	ID	5.3	5.4	9.5	12.5		
154	Aurora	IL	4.1	3.5	5.9	7.8		1.7
155	Blue Island	IL	4.6	4.8	5.7	8.4		0.6
156	Chicago	IL	2.9	3.4	4.3	6.6	0.4	0.6
158	Elgin	IL	4.9	4.7	8.1	11.0		1.2
161	Evanston	IL	5.3	5.9	6.3	8.9	0.5	0.7
163	Hinsdale	IL	4.1	4.5	5.9	9.6		0.9
164	Joliet	IL	4.3	4.4	8.0	11.2	0.6	0.6

HRR number	HRR name	State	Hip replacement per 1,000 Medicare enrollees		Knee replacement per 1,000 Medicare enrollees		Shoulder replacement per 1,000 Medicare enrollees	
			2000-01	2005-06	2000-01	2005-06	2000-01	2005-06
166	Melrose Park	IL	4.0	5.3	6.8	10.0	0.4	0.6
170	Peoria	IL	4.1	4.5	7.9	11.3	0.3	1.0
171	Rockford	IL	5.1	5.0	7.3	10.1	0.4	1.1
172	Springfield	IL	3.8	4.0	7.2	11.3	0.8	0.7
173	Urbana	IL	3.5	4.1	5.7	10.3	0.7	0.7
175	Bloomington	IL	3.7	6.8	8.7	11.5		
179	Evansville	IN	2.9	3.7	7.0	10.0	0.6	0.7
180	Fort Wayne	IN	3.6	5.6	7.1	10.8	0.6	1.2
181	Gary	IN	3.6	4.2	7.0	8.3		0.7
183	Indianapolis	IN	3.6	4.3	6.1	9.3	0.6	0.9
184	Lafayette	IN	3.3	5.9	5.3	10.0		
185	Muncie	IN	4.7	3.6	5.6	8.8		
186	Munster	IN	3.6	4.1	5.1	8.6		
187	South Bend	IN	4.1	4.2	7.8	10.2	0.6	1.3
188	Terre Haute	IN	2.5	4.5	5.2	10.2		
190	Cedar Rapids	IA	5.0	3.5	9.1	11.6		
191	Davenport	IA	4.8	4.8	9.9	12.6	0.5	0.9
192	Des Moines	IA	5.0	4.0	8.3	12.1	0.6	1.0
193	Dubuque	IA	3.4	5.7	7.1	13.3		
194	Iowa City	IA	4.7	5.7	9.7	10.3		0.9
195	Mason City	IA	5.9	6.5	8.9	10.8		
196	Sioux City	IA	6.3	7.1	10.5	11.9	0.7	1.1
197	Waterloo	IA	6.1	4.1	8.6	10.2		
200	Topeka	KS	5.1	5.0	9.9	13.4	0.9	1.0
201	Wichita	KS	4.4	4.7	9.1	11.9	0.6	0.8
203	Covington	KY	3.1	4.2	4.4	6.7		0.8
204	Lexington	KY	2.3	2.8	3.5	6.0	0.2	0.5
205	Louisville	KY	3.0	3.8	5.5	8.6	0.4	0.5
207	Owensboro	KY	1.9	3.2	4.4	8.1		
208	Paducah	KY	2.7	4.1	5.3	8.8		0.6
209	Alexandria	LA	1.2	2.4	5.9	9.2		
210	Baton Rouge	LA	2.5	2.5	4.7	8.5		0.8
212	Houma	LA	1.8	2.1	5.2	8.2		
213	Lafayette	LA	2.3	2.7	5.1	8.5		0.8
214	Lake Charles	LA	2.4	2.9	5.2	10.2		1.2
216	Metairie	LA	1.7	2.3	4.8	5.7		0.8
217	Monroe	LA	3.3	2.8	5.3	11.4		
218	New Orleans	LA	2.4	2.5	5.7	6.0		
219	Shreveport	LA	2.9	3.5	5.6	9.3	0.5	0.7
220	Slidell	LA	2.5	3.1	4.5	5.7		
221	Bangor	ME	3.6	4.1	5.9	8.2		0.7
222	Portland	ME	3.8	4.1	6.7	7.6	0.6	1.0
223	Baltimore	MD	3.4	4.3	7.1	10.4	0.6	1.1
225	Salisbury	MD	3.7	4.0	5.3	10.0	0.5	0.9

HRR number	HRR name	State	Hip replacement per 1,000 Medicare enrollees		Knee replacement per 1,000 Medicare enrollees		Shoulder replacement per 1,000 Medicare enrollees	
			2000-01	2005-06	2000-01	2005-06	2000-01	2005-06
226	Takoma Park	MD	3.7	4.2	6.4	8.2	0.6	0.7
227	Boston	MA	3.2	4.3	4.7	7.5	0.4	0.6
230	Springfield	MA	3.1	3.7	5.0	7.3		0.5
231	Worcester	MA	2.7	3.6	4.1	6.6		
232	Ann Arbor	MI	4.4	4.7	7.2	9.7	0.4	1.0
233	Dearborn	MI	3.3	3.7	6.0	10.7		0.9
234	Detroit	MI	3.9	4.1	5.5	10.1	0.4	0.9
235	Flint	MI	4.7	4.4	6.6	10.0		1.4
236	Grand Rapids	MI	4.4	5.5	8.0	10.9	0.7	1.1
238	Kalamazoo	MI	4.5	5.0	7.4	12.1	0.8	1.1
239	Lansing	MI	5.8	6.2	6.7	12.5	0.7	1.2
240	Marquette	MI	3.6	3.8	7.1	10.1		1.2
242	Muskegon	MI	5.8	5.4	8.1	11.9		
243	Petoskey	MI	4.6	6.3	7.1	10.7		1.4
244	Pontiac	MI	3.9	5.6	6.0	10.7		1.1
245	Royal Oak	MI	3.9	4.8	6.4	10.0	0.7	1.0
246	Saginaw	MI	4.8	5.2	8.3	12.5	1.0	1.0
248	St. Joseph	MI	5.3	4.7	7.1	9.6		
249	Traverse City	MI	3.5	4.7	7.6	10.7		
250	Duluth	MN	5.8	5.5	7.8	10.8	1.0	1.7
251	Minneapolis	MN	4.5	5.7	7.7	11.7	0.7	1.1
253	Rochester	MN	3.8	6.4	7.2	11.5		1.1
254	St. Cloud	MN	5.2	6.5	8.6	12.3		
256	St. Paul	MN	4.7	6.7	7.9	12.9	0.7	1.5
257	Gulfport	MS	2.7	4.3	4.9	8.5		1.5
258	Hattiesburg	MS	3.0	2.9	6.5	10.2		
259	Jackson	MS	2.6	2.7	5.6	7.6	0.5	1.0
260	Meridian	MS	2.7	2.4	5.8	9.2		
261	Oxford	MS	2.3	3.1	4.5	5.5		
262	Tupelo	MS	2.3	2.9	5.7	7.6		0.8
263	Cape Girardeau	MO	3.0	2.9	6.8	7.8		0.9
264	Columbia	MO	3.8	4.7	8.0	11.4	0.5	0.6
267	Joplin	MO	3.0	3.4	7.4	10.0		
268	Kansas City	MO	3.5	4.1	7.4	10.2	0.5	0.7
270	Springfield	MO	2.8	3.1	6.2	8.8	0.4	1.1
273	St. Louis	MO	3.4	3.9	6.7	9.5	0.7	0.9
274	Billings	MT	5.2	6.3	7.4	11.2	1.0	1.4
275	Great Falls	MT	4.1	5.0	5.8	12.9	1.3	1.7
276	Missoula	MT	4.7	5.5	6.8	11.5		1.2
277	Lincoln	NE	4.6	5.1	10.1	15.7	0.8	1.4
278	Omaha	NE	4.4	4.6	9.1	12.7	0.9	1.1
279	Las Vegas	NV	3.8	3.6	4.5	7.0	0.6	0.5
280	Reno	NV	3.9	4.3	5.0	8.3	0.6	1.0
281	Lebanon	NH	4.5	4.9	5.2	8.7		0.5

HRR number	HRR name	State	Hip replacement per 1,000 Medicare enrollees		Knee replacement per 1,000 Medicare enrollees		Shoulder replacement per 1,000 Medicare enrollees	
			2000-01	2005-06	2000-01	2005-06	2000-01	2005-06
282	Manchester	NH	3.5	4.2	5.9	7.5	0.5	0.6
283	Camden	NJ	3.1	3.6	4.6	7.7	0.4	0.5
284	Hackensack	NJ	2.1	3.3	3.6	5.2	0.4	0.5
285	Morristown	NJ	3.1	5.0	4.1	6.2		0.5
288	New Brunswick	NJ	2.7	4.0	4.4	6.1		0.3
289	Newark	NJ	2.8	2.4	3.6	4.9	0.3	
291	Paterson	NJ	2.7	3.1	3.1	4.4		
292	Ridgewood	NJ	3.2	4.0	3.3	5.3		
293	Albuquerque	NM	2.5	3.1	4.6	6.5	0.5	0.6
295	Albany	NY	3.5	4.4	5.0	7.9	0.4	0.7
296	Binghamton	NY	3.3	4.8	5.2	8.1		0.6
297	Bronx	NY	2.0	2.3	3.1	4.1		
299	Buffalo	NY	3.7	4.0	5.0	8.0	0.3	0.7
300	Elmira	NY	3.4	4.0	5.1	8.5		0.6
301	East Long Island	NY	3.0	3.5	3.5	5.6	0.2	0.4
303	Manhattan	NY	2.4	2.8	2.9	4.0	0.3	0.4
304	Rochester	NY	4.4	4.5	6.1	8.5	0.4	0.7
307	Syracuse	NY	4.5	4.5	5.0	8.6	0.2	0.3
308	White Plains	NY	3.5	5.0	3.9	6.8	0.3	0.7
309	Asheville	NC	4.1	4.2	5.0	8.2	0.4	0.8
311	Charlotte	NC	2.9	3.4	5.8	8.4	0.4	1.0
312	Durham	NC	3.0	3.7	5.4	8.3	0.4	1.0
313	Greensboro	NC	3.1	3.3	5.4	7.1	0.5	0.8
314	Greenville	NC	3.6	3.2	6.7	7.7	0.7	0.7
315	Hickory	NC	2.1	3.2	5.3	8.7		1.4
318	Raleigh	NC	3.5	3.3	5.8	9.0	0.4	1.1
319	Wilmington	NC	2.9	3.9	4.8	8.7		0.9
320	Winston-Salem	NC	3.3	3.2	4.2	7.2		0.7
321	Bismarck	ND	3.4	5.8	9.3	13.6	0.9	1.4
322	Fargo/Moorhead MN	ND	4.4	5.6	8.6	12.5	0.6	1.0
323	Grand Forks	ND	5.9	6.3	8.6	11.3		
324	Minot	ND	4.8	4.9	7.3	10.1		
325	Akron	OH	3.7	3.9	6.9	10.6	0.4	0.7
326	Canton	OH	3.3	3.7	6.9	9.9	0.5	0.7
327	Cincinnati	OH	3.3	3.7	5.2	9.9	0.3	0.9
328	Cleveland	OH	3.5	4.5	6.1	9.5	0.5	0.8
329	Columbus	OH	3.9	4.2	5.9	9.3	0.3	1.0
330	Dayton	OH	4.0	4.7	6.4	10.7	0.3	0.8
331	Elyria	OH	3.1	4.5	10.5	12.5		1.2
332	Kettering	OH	4.1	3.9	6.3	9.6		0.7
334	Toledo	OH	4.2	4.8	8.7	10.8	0.7	1.3
335	Youngstown	OH	3.9	4.4	6.5	9.8	0.5	0.8
336	Lawton	OK	3.4	2.2	5.1	10.3		
339	Oklahoma City	OK	3.0	3.7	7.4	9.8	0.5	0.9

HRR number	HRR name	State	Hip replacement per 1,000 Medicare enrollees		Knee replacement per 1,000 Medicare enrollees		Shoulder replacement per 1,000 Medicare enrollees	
			2000-01	2005-06	2000-01	2005-06	2000-01	2005-06
340	Tulsa	OK	2.9	3.4	6.6	10.5	0.4	0.6
341	Bend	OR	5.0	5.5	8.4	9.5		1.7
342	Eugene	OR	3.6	4.4	5.1	8.1		0.6
343	Medford	OR	4.3	4.9	6.2	8.0	0.6	1.3
344	Portland	OR	3.7	4.7	6.4	8.3	0.4	0.8
345	Salem	OR	4.4	6.5	3.7	6.9		
346	Allentown	PA	3.1	3.6	5.4	9.5	0.4	0.7
347	Altoona	PA	2.3	4.2	6.6	8.1		
350	Danville	PA	3.9	3.8	6.4	10.1	0.7	0.9
351	Erie	PA	4.1	4.1	6.5	9.7	0.5	0.8
352	Harrisburg	PA	3.5	3.6	7.1	10.3	0.5	0.9
354	Johnstown	PA	2.9	3.6	6.3	9.3		
355	Lancaster	PA	3.5	5.6	5.7	10.2		0.8
356	Philadelphia	PA	3.2	3.9	5.0	7.7	0.5	0.7
357	Pittsburgh	PA	3.3	4.1	6.6	8.8	0.4	0.5
358	Reading	PA	3.1	3.7	6.8	10.2	0.4	0.4
359	Sayre	PA	3.7	5.5	6.6	8.6		1.2
360	Scranton	PA	2.7	3.2	5.8	9.7	0.6	0.7
362	Wilkes-Barre	PA	2.2	1.9	4.1	9.1		
363	York	PA	3.4	3.0	5.0	8.8		0.8
364	Providence	RI	2.9	3.4	5.0	6.7	0.5	0.6
365	Charleston	SC	3.2	3.7	6.1	10.1	0.6	1.1
366	Columbia	SC	2.9	3.5	6.1	9.1	0.6	0.7
367	Florence	SC	2.7	3.0	4.4	7.7		
368	Greenville	SC	2.6	3.0	6.1	10.1	0.6	1.2
369	Spartanburg	SC	2.5	4.3	5.5	9.7		0.7
370	Rapid City	SD	4.2	6.0	7.7	10.4		1.1
371	Sioux Falls	SD	4.7	6.2	9.1	14.3	0.7	0.9
373	Chattanooga	TN	3.1	2.8	7.7	8.8	0.6	0.6
374	Jackson	TN	2.4	2.4	4.2	7.6		1.0
375	Johnson City	TN	2.8	3.4	5.0	7.6		1.1
376	Kingsport	TN	3.0	2.6	3.1	4.9		
377	Knoxville	TN	3.0	3.4	4.6	6.8	0.6	0.7
379	Memphis	TN	3.0	3.0	4.9	6.8	0.5	0.5
380	Nashville	TN	3.0	3.6	5.1	8.3	0.5	1.0
382	Abilene	TX	2.8	3.1	7.1	9.4		1.2
383	Amarillo	TX	3.6	3.8	9.8	11.8	0.8	1.3
385	Austin	TX	2.5	4.0	6.4	9.8	0.4	1.2
386	Beaumont	TX	1.7	1.9	5.9	8.3		0.7
388	Bryan	TX	2.5	1.8	6.0	7.7		
390	Corpus Christi	TX	2.2	1.9	6.3	7.8		0.7
391	Dallas	TX	2.8	3.3	5.8	9.2	0.4	0.9
393	El Paso	TX	2.5	2.5	5.9	7.8	0.4	0.6
394	Fort Worth	TX	3.2	3.4	6.3	9.8	0.4	0.8

HRR number	HRR name	State	Hip replacement per 1,000 Medicare enrollees		Knee replacement per 1,000 Medicare enrollees		Shoulder replacement per 1,000 Medicare enrollees	
			2000-01	2005-06	2000-01	2005-06	2000-01	2005-06
396	Harlingen	TX	2.1	1.9	6.3	11.2		1.1
397	Houston	TX	2.5	3.0	5.4	8.5	0.4	0.8
399	Longview	TX	3.2	3.6	6.4	10.8		
400	Lubbock	TX	3.2	4.6	10.1	12.3	0.6	0.9
402	McAllen	TX	2.0	2.0	8.6	10.2		0.6
406	Odessa	TX	2.6	2.8	7.9	10.1		1.0
411	San Angelo	TX	1.5	2.6	6.4	12.8		
412	San Antonio	TX	2.1	2.5	6.1	8.9	0.5	0.6
413	Temple	TX	2.1	3.5	5.8	8.7		
416	Tyler	TX	2.6	3.6	5.6	9.0	0.5	1.2
417	Victoria	TX	3.1	2.4	9.0	8.8		
418	Waco	TX	2.0	3.0	6.6	10.2		
420	Wichita Falls	TX	2.8	3.1	7.0	10.3		1.2
421	Ogden	UT	4.6	7.2	8.7	13.3		0.9
422	Provo	UT	5.2	6.0	9.3	11.3		3.0
423	Salt Lake City	UT	5.1	5.4	8.3	12.1	0.8	1.5
424	Burlington	VT	4.0	5.3	5.1	7.3	0.5	0.6
426	Arlington	VA	4.4	4.2	4.4	7.9	0.2	0.7
427	Charlottesville	VA	5.3	3.7	7.2	7.4	0.6	0.8
428	Lynchburg	VA	2.9	3.8	4.2	9.3		
429	Newport News	VA	3.5	3.8	5.6	9.3	0.6	1.3
430	Norfolk	VA	3.1	3.5	5.2	9.3	0.5	1.0
431	Richmond	VA	3.6	4.2	5.9	8.3	0.9	1.0
432	Roanoke	VA	3.5	3.6	5.6	8.5	0.4	0.8
435	Winchester	VA	2.5	4.2	6.9	9.6		0.7
437	Everett	WA	4.5	4.8	5.4	8.3		1.0
438	Olympia	WA	4.3	4.5	4.5	10.5		0.8
439	Seattle	WA	4.2	5.3	5.7	8.5	0.6	1.0
440	Spokane	WA	5.6	5.7	7.2	11.2	0.6	0.9
441	Tacoma	WA	5.6	4.8	5.2	9.0	1.3	0.8
442	Yakima	WA	4.5	3.6	5.2	9.9		1.1
443	Charleston	WV	2.3	2.8	4.4	7.1	0.2	0.8
444	Huntington	WV	2.7	2.8	4.3	8.4		0.6
445	Morgantown	WV	3.2	2.7	6.6	7.9		0.7
446	Appleton	WI	4.7	4.9	7.9	11.0	0.8	0.9
447	Green Bay	WI	4.0	5.2	9.1	12.8	0.5	0.9
448	La Crosse	WI	3.7	4.3	6.8	13.4		1.2
449	Madison	WI	4.7	5.0	7.7	11.1	0.3	0.7
450	Marshfield	WI	4.2	5.3	8.2	12.2	0.6	1.5
451	Milwaukee	WI	4.2	5.0	7.1	10.8	0.6	1.0
452	Neenah	WI	4.6	6.3	10.4	10.0	0.9	
456	Wausau	WI	3.7	6.3	8.8	10.1		1.6
457	Casper	WY	4.0	4.4	7.4	12.9		1.5
999	**United States**	**US**	**3.5**	**4.0**	**6.0**	**8.8**	**0.5**	**0.8**

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The Dartmouth Atlas Project is funded by a broad coalition of funders, led by the **Robert Wood Johnson Foundation**.

Other major sources of funding include the **National Institute of Aging, California Healthcare Foundation, United Healthcare Foundation,** and the **WellPoint Foundation.**

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