Increasing Rates of Obesity, Diabetes, and Depression Prevalence Among Primary and Revision Total Joint Arthroplasty from 2002-2014

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Introduction

Total joint arthroplasty (TJA) procedures have increased in volume continuously over recent decades. Previous studies have evaluated expected future growth for primary and revision TJA procedures. There has been little discussion of the changes in the comorbidity prevalence amongst the TJA population since 2002 and how it can be expected to influence the total joint arthroplasty population in the future. This paper seeks to evaluate the recent changes in trends in diabetes mellitus, obesity, and depression among patients undergoing primary and revision TJA procedures in comparison to trends in the general United States population.

Background

Primary and revision TJA are common procedures that are expected to continue to rise in the coming years.[1] These procedures are associated with a significant cost to the health system, and in the era of bundled care, understanding and preventing potential complications and readmissions is paramount. Clinicians and hospital systems need to continue to look for ways to improve delivered care and potentially reduce these complications and readmissions. Diabetes mellitus, depression, and obesity are three common comorbidities that have seen a significant increase in prevalence in general United States population over the last two decades. Outcomes of patients with these comorbidities has been studied, but little has been studied regarding these trends in the TJA population. Understanding these trends and how they may affect future patients is critical in optimizing outcomes and care.

Diabetes mellitus (DM) is a common and increasingly prevalent comorbidity in the United States. Diabetes has important clinical effects on the musculoskeletal system, and has been shown to be an independent predictor of development of severe osteoarthritis.[2] Similarly, patients with DM have been shown to be at an increased risk to undergo primary and revision TJA.[3] Notably, the prevalence of DM has increased from 9.3% of adults in the general United States in 2002 to 11.7% in 2014.[4] Diabetes is not only associated with risk for undergoing joint replacement, but has been associated with increased rates of stiffness, prosthetic joint infection, revision arthroplasty and cost of care.[5,6] Taken together, it can be expected that more patients undergoing TJA will have diabetes and understanding these risk factors and management is critical to sustaining good outcomes.

Comparably, obesity has seen a rise through the United States and the globe, becoming an epidemic. The rate of obesity (classified as BMI > 30 kg/m^2) has risen from 30.5% in 2002 to 37.7% in 2014.[7] Obese patients have been shown to have significantly increased rates of cardiopulmonary complications, wound and implant complications and readmissions.[8-10] These rates of complications are also directly related to the degree of obesity, as patients with BMI > 40kg/m^2 have been shown to have higher rates of these complications.[8-10] Unfortunately, this trend continues to increase.

Lastly, mental health is an area of medicine that has been gaining increased attention in term of diagnosis, treatment, and surgical outcomes. In 2016 alone, 14% of adults in the United States were diagnosed with a mental illness, and 4.2% were diagnosed with a mental illness that interfered with life activities.[11] The prevalence of depression has risen significantly, from 7.1% in adults in 2002 to 8.1% in 2014.[12,13] Recent studies have demonstrated that depression is associated with a significantly higher risk of readmission following TJA, even when controlled for other chronic conditions.[14] Additionally, depression is an independent predictor of increased cost of stay and post-operative complications.[15]

Taken together, three common comorbidities (diabetes mellitus, obesity, depression) have been shown to be increasing in frequency in the general United States and have been associated with increased rates of complications, worse clinical outcomes, and readmissions. What is not known, is how these rates have changed in the TJA population during this time frame. This paper seeks to identify these trends in the primary and revision TJA population from 2000-2014.

Methods

The National Inpatient Sample (NIS) database was queried. This database contains a 20% sample

of all public United States hospital discharges annually. The database is built as a representative sample of all inpatients in the United States in order to simulate national trends. Patients undergoing primary total hip arthroplasty (THA), primary total knee arthroplasty (TKA), revision THA, and revision TKA were identified by ICD-9 procedure code. ICD-9 diagnosis code at time of discharge was used to identify the annual prevalence of obesity, diabetes, and depression among the TJA population.

Sampling weights provided by NIS were used to estimate national comorbidity rates. Proportional changes from 2002 to 2014 were compared using a Chi-square test. Linear regression was performed to assess trends in comorbidity prevalence over time. Data from the Centers for Disease Control and Prevention were used to compare comorbidity prevalence in the TJA population with the general United States population over the same time period.

Results

In 2002, volume of procedures for each TJA category was 339,686 for primary TKA, 194,998 for primary THA, 30,007 for revision TKA, and 37,049 for revision THA. In 2014, volume of procedures for each TJA category was 680,886 for primary TKA, 371,605 for primary THA, 63,205 for revision TKA, and 50,425 for revision THA.

From 2002-2014, the TJA population comorbidity prevalence changed significantly. Obesity, diabetes, and depression all significantly increased from 2002-2014 in both primary TJA and revision TJA categories. (Table 1)

Obesity was noted to increase significantly (p < 0.01) at all times points for all groups. (Figure 1) Primary THA (6.6% to 18%), Primary TKA (10.7 to 26.2%), Revision THA (5.3 to 16.2%), and Revision TKA (9.7 to 28%). Notably, while obesity increased in every group, at all time points obesity is below that of the general population (30.5% and 37.7% in 2002 and 2014 respectively).

Diabetes was shown to increase significantly (p < 0.01) at both time points in all groups. (Figure 2) Primary THA (9.7 % to 13.5%), Primary TKA (15% to 19.8%), Revision THA (10.5% to 15%), and Revision TKA (16.2% to 22.9%). For all groups in
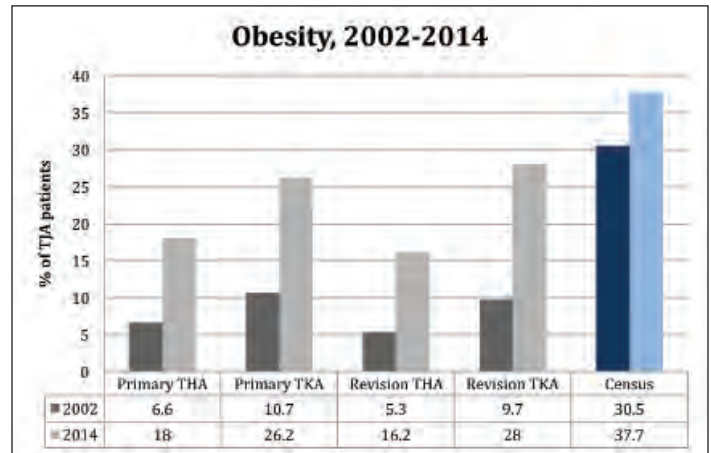

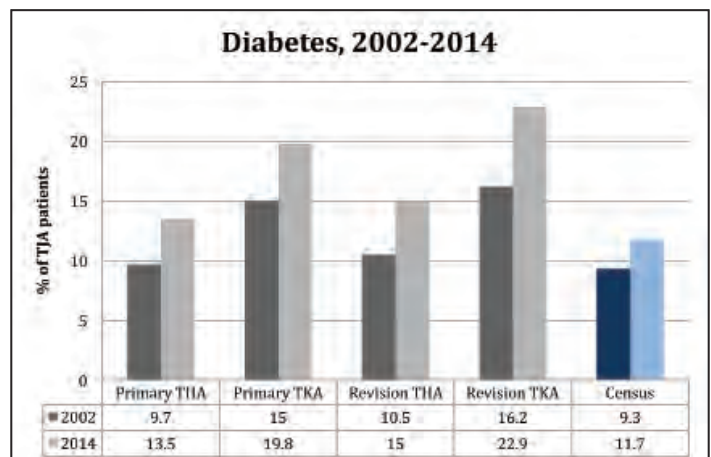**Figure 1.** Percentage of Obesity in TJA patients in 2002 and 2014.

Figure 2. Percentage of Diabetes in TJA patients in 2002 and 2014.

2002 and 2014, the prevalence in the primary and revision TJA groups is above that of the general population.

The prevalence of depression increased significantly (p < 0.01) at both time points in all groups. (Figure 3) Primary THA (4.9 to 12.6%), Primary TKA (5.7% to 14.4%), Revision THA (6.7% to 17%), and Revision TKA (6.9% to 18.8%). In 2002,

Table 1. Prevalence of Obesity, Diabetes, Depression in Primary THA, TKA and Revision THA, TKA in 2002 and 2014.

|	Primary THA Trend (p)	Primary TKA Trend (p)	Revision THA Trend (p)	Revision TKA Trend (p)
Obesity				
2002 Prevalence, % (SE)	6.6 (0.0012)	10.7 (0.0012)	5.3 (0.0025)	9.7 (0.0038)
2014 Prevalence, % (SE)	18.0 (0.0014) +0.0102 (<0.01)	26.2 (0.0012) +0.0132 (<0.01)	16.2 (0.0037) +0.0099 (<0.01)	28.0 (0.0040) +0.0159 (<0.01)
Diabetes				
2002 Prevalence, % (SE)	9.7 (0.0015)	15.0 (0.0014)	10.5 (0.0035)	16.2 (0.0047)
2014 Prevalence, % (SE)	13.5 (0.0013) +0.0037 (<0.01)	19.8 (0.0011) +0.0041 (<0.01)	15.0 (0.0036) +0.0040 (<0.01)	22.9 (0.0037) +0.0056 (<0.01)
Depression				
2002 Prevalence, % (SE)	**4.9 (0.0011)**	**5.7 (0.0009)**	**6.7 (0.0028)**	**6.9 (0.0032)**
2014 Prevalence, % (SE)	**12.6 (0.0012) +o.0066 (<0.01)**	**14.4 (0.0010) +o.0073 (<0.01)**	**17.0 (0.0037) +0.0088 (<0.01)**	**18.8 (0.0035) +0.0097 (<0.01)**
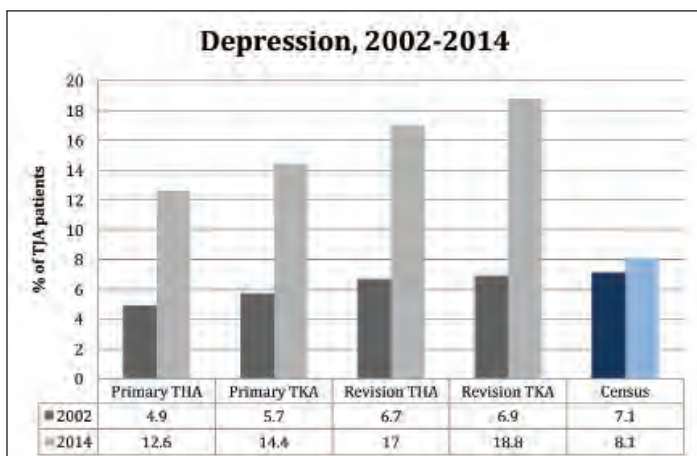
Figure 3. Percentage of Depression in TJA patients in 2002 and 2014.

depression was noted to be of a lower prevalence than the general United States population in all groups, while found to be higher as compared to the census in all groups at 2014.

Discussion

Analysis of the National Inpatient Sample database demonstrated that the prevalence of obesity, diabetes mellitus, and depression all significantly increased (p < 0.01) in the primary and revision TJA groups from 2002 to 2014. The prevalence of depression and diabetes were both higher than that of the United States population as a whole for both the primary and revision groups at all time points. However, the recorded prevalence of obesity was below that of general population in all groups in both 2002 and 2014. There are several key takeaways from these findings discussed below.

Obesity, diabetes, and depression are all significantly associated with post-operative complications, worse outcomes, and unplanned readmissions.[2, 6, 8, 9, 14, 15] All three comorbities significantly increased in prevalence from 2002 to 2014 in both the primary and revision TJA groups. The current trends of these comorbidities in the general population suggest that this increase in prevalence can be expected to continue in the near term. Long term trends are uncertain. This has important implications for clinicians and health systems alike. Hospitals are financially incentivized by Medicare, Medicaid and insurance companies to encourage efficient care coordination and reduce hospital readmissions. This database demonstrated a significant increase in known risk factors for complications and unplanned readmissions. In order to provide efficient cost effective care, hospital systems and clinicians need to address these issues pre-operatively via collaborative management with primary care and mental health providers. In the era of bundled care, addressing known risk factors such as obesity, diabetes, and depression in an organized fashion is paramount to prevent poor outcomes and increased costs. Further studies are needed to address specific controllable variables including the influence of hemoglobin A_{1c}, perioperative hyperglycemia, preoperative psychosomatic interventions and evaluations, and obesity interventions.

This study's limitations are related to the dataset and the retrospective nature of the study. As noted above, the diagnosis of obesity is below that of the general population at all time points in this database review, contrary to prior studies.[8, 9] Administrative databases have known issues when coding-based data is utilized, specifically when related to obesity.[16] This is again highlighted in this study, as a relative increase in coding frequency will overestimate the true trend of the variable of interest. At the root of this study is reimbursement, as hospitals and physicians are not reimbursed for an ICD-9 diagnosis of obesity following TJA at the current time. Thus, there is no incentive to properly code this data, and thus the specific proportions reported here are likely underestimates, based only on the coded rates of these comorbidities. Understanding and interpreting retrospective database sets with caution is important in order to draw accurate conclusions.

In summary, this retrospective review demonstrates a total joint arthroplasty population that has an increasing prevalence of obesity, diabetes and depression, in parallel with the general population. The overall United States general population demonstrates increasing prevalence of diabetes, obesity, and depression with trends that do not look to be decreasing in the near future. Understanding these trends and their implications for patient care and outcomes is critical in providing cost effective care.

References

1. **Kurtz S, Ong K, Lau E, Mowat F, Halpern M.** Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg Am.* 2007;89(4):780-5.

2. **Schett G, Kleyer A, Perricone C, Sahinbegovic E, Iagnocco A, Zwerina J, et al.** Diabetes is an independent predictor for severe osteoarthritis: results from a longitudinal cohort study. *Diabetes Care.* 2013;36(2):403-9.

3. **King KB, Findley TW, Williams AE, Bucknell AL.** Veterans with diabetes receive arthroplasty more frequently and at a younger age. *Clinical Orthopaedics and Related Research®.* 2013;471(9):3049-54.

4. **Caspard H, Jabbour S, Hammar N, Fenici P, Sheehan JJ, Kosiborod M.** Recent trends in the prevalence of type 2 diabetes and the association with abdominal obesity lead to growing health disparities in the USA: An analysis of the NHANES surveys from 1999 to 2014. Diabetes, *Obesity and Metabolism.* 2018;20(3):667-71.

5. **Hogan C, Bucknell AL, King KB.** The effect of diabetes mellitus on total joint arthroplasty outcomes. *Jbjs Reviews.* 2016;4(2).

6. **Shohat N, Muhsen K, Gilat R, Rondon AJ, Chen AF, Parvizi J.** Inadequate Glycemic Control Is Associated with Increased Surgical Site Infection in Total Joint Arthroplasty: A Systematic Review and Meta-analysis. *The Journal of Arthroplasty.* 2018.

7. **Ogden CL CM, Fryar CD, Flegal KM.** Prevalence of obesity among adults and youth: United States, 2011–2014. NCHS data brief, no 219. Hyattsville, MD: National Center for Health Statistics. 2015.

8. **Wagner ER, Kamath AF, Fruth K, Harmsen WS, Berry DJ.** Effect of body mass index on reoperation and complications after total knee arthroplasty. *JBJS.* 2016;98(24):2052-60.

9. **Wagner ER, Kamath AF, Fruth KM, Harmsen WS, Berry DJ.** Effect of body mass index on complications and reoperations after total hip arthroplasty. *JBJS.* 2016;98(3):169-79.

10. **Zusmanovich M, Kester BS, Schwarzkopf R.** Postoperative Complications of Total Joint Arthroplasty in Obese Patients Stratified by BMI. *The Journal of Arthroplasty.* 2018;33(3):856-64.

11. **Park Lee E, Lipari, R. N., Hedden, S. L., Kroutil, L. A., & Porter, J. D.** (2017, September). Receipt of services for substance use and mental health issues among adults: Results from the 2016 National Survey on Drug Use and Health. *NSDUH Data Review.*

12. **Brody DJ PL, Hughes J.** Prevalence of depression among adults aged 20 and over:

United States, 2013–2016. NCHS Data Brief. 2018;No 303(Hyattsville, MD: National Center for Health Statistics. 2018.).

13.**Wilson M. Compton MD, M.P.E. ,, Kevin P. Conway PD, Frederick S. Stinson PD, Bridget F. Grant PD.** Changes in the Prevalence of Major Depression and Comorbid Substance Use Disorders in the United States Between 1991–1992 and 2001–2002. *American Journal of Psychiatry.* 2006;163(12):2141-7.

14.**Gold HT, Slover JD, Joo L, Bosco J, Iorio R, Oh C.** Association of depression with 90-day hospital readmission after total joint arthroplasty. *The Journal of Arthroplasty.* 2016;31(11):2385-8.

15.**Rasouli MR, Menendez ME, Sayadipour A, Purtill JJ, Parvizi J.** Direct cost and complications associated with total joint arthroplasty in patients with preoperative anxiety and depression. *The Journal of Arthroplasty.* 2016;31(2):533-6.

16.**George J, Newman JM, Ramanathan D, Klika AK, Higuera CA, Barsoum WK.** Administrative Databases Can Yield False Conclusions—An Example of Obesity in Total Joint Arthroplasty. *The Journal of Arthroplasty.*32(9):S86-S90.