Journal of Orthopaedic Experience & Innovation
Clinical, Economic, and Innovative Orthopaedic Experience

Pugh, Mary Jo, and Jessica Rivera. 2020. "Musculoskeletal Related Disability in Veterans of Iraq and Afghanistan." *Journal of Orthopaedic Experience & Innovation* 1 (2). https://doi.org/10.60118/001c.13660.

Research Article

Musculoskeletal Related Disability in Veterans of Iraq and Afghanistan

Mary Jo Pugh[1a], Jessica Rivera[2b]

[1] Salt Lake City Health Care System, [2] Orthopaedic Surgery, LSU Health Science Center New Orleans

Keywords: veterans' health service-connected disability musculoskeletal disability

https://doi.org/10.60118/001c.13660

Journal of Orthopaedic Experience & Innovation

Vol. 1, Issue 2, 2020

Purpose: Over 60% of Iraq and Afghanistan veterans access Veterans Administration (VA) health care after military service. The purpose of this research is to describe the types of musculoskeletal service-connected disabilities distributed among these veterans.
Methods: A retrospective cohort of 383,757 Iraq and Afghanistan veterans were searched for service-connected disability determinations using the Veterans Services Network Corporate Master File (VETSNET). Service-connected disabilities were grouped according to the types of diagnoses represented.
Results: Of 383,757 included veterans, 347,643 (90.6%) had at least one musculoskeletal-related service-connected disability. The most common group of musculoskeletal disabilities was conditions of the spine, affecting 241, 636 (69.5%) veterans, limitations in the knee/leg motion (46.6%) and acute and chronic disorders (30.2%). The median number of musculoskeletal conditions contributing to the service connected disability per veteran was 2.8 ± 1.3 conditions. Post-Traumatic Stress Disorder was the most common primary service connected disability for both men and women.
Discussion: Musculoskeletal conditions as a source of service connected disability affects 90% of veterans from Iraq and Afghanistan. While the primary source of service connected disability is most often not musculoskeletal related, the overall burden of musculoskeletal conditions is very high with an average of 2.8 musculoskeletal conditions per veteran contributing to their disability.

INTRODUCTION

Over the course of military operations in Afghanistan and Iraq since 2001, over 52,000 United States (US) service members have been wounded in action (Defense Casualty Health Statistics 2016). Several accounts in the military literature describe these wounds (Owens et al. 2007, 2008; Belmont et al. 2013), recognizing that extremity injuries are the most common and are often characterized by high energy, explosion mechanisms (Owens et al. 2007, 2008; Belmont et al. 2013; Doucet et al. 2011). The consequence is a heavy burden of musculoskeletal related disability. Short term results characterizing disability recognized by the military physical evaluation board (PEB) process indicates that extremity injuries lead to 70% of military disqualifying disabilities and approximately one-third of injured service members are removed from military service due to these disabilities (Cross et al. 2011). Prominent sources of limb morbidity that affects disability and return to military duty include nerve injury, post traumatic arthritis, and muscle loss (Rivera, Glebus, and Cho 2014; Rivera et al. 2012; Corona et al. 2015).

a South Texas Veterans Health Care System, San Antonio, Texas; VA Salt Lake City Health Care System, Salt Lake City, Utah

Conflicts of Interest Statement for this author

b Louisiana State University Health Science Center Department of Orthopaedic Surgery, New Orleans, LA; US Army Institute of Surgical Research and San Antonio Military Medical Center Department of Orthopaedic Surgery, Joint Base San Antonio, Texas

LSUHSC Dept Orthopaedic Surgery
1542 Tulane Ave
New Orleans, LA 70112
Email: jrive5@lsuhsc.edu

Conflicts of Interest Statement for this author

Visit the Open Payments Data Page for this author

The Epidemiology Program of the VA's Office of Public Health reports that 61% of eligible veterans who served in Iraq or Afghanistan have accessed VA health care since their military separations (Department of Veterans Affairs 2015). Musculoskeletal conditions are the most frequents diagnoses treated in this population based on International Classification of Disease, version 9 (ICD-9) codes. After active duty military service is completed, new veterans who choose to seek care in the Veterans Administration (VA) health system undergo an evaluation for military service connected disability. Similar to the military evaluation board, the VA service connected disability process relies on the VA Schedule for Rating Disabilities (VASRD) to categorize conditions based on the body system affected and identify severity of the condition (*38 Code of Federal Regulations, Book C, Schedule for Rating Disabilities*, n.d.). The evaluation for service connected disability carries implications for long term disability compensation, VA health care access, and other VA related benefits.

Considering a 60% rate of transition into VA healthcare for Iraq and Afghanistan veterans, the common nature of musculoskeletal diagnoses treated at the VA, and the known high rate of musculoskeletal related disabilities following deployment related injury, it is intuitive that much of service connected disability in this population is musculoskeletal related. Because service connected disability can result in compensation and other benefit payments, the cost of musculoskeletal service connected disability extends beyond the treatment costs of musculoskeletal diagnoses. The purpose of this research is to describe the types of musculoskeletal service connected disabilities distributed among Iraq and Afghanistan veterans who have matriculated to the VA health care system and to postulate the population based implication of these disabilities on the veteran population as a whole.

METHODS

This study was approved for conduct by the Institutional Review Boards of the University of Texas Health Science Center at San Antonio and the Edith Nourse Rogers VA Medical Center. This is a retrospective cohort study of veterans who received a disability determination for service-connected disability by the Veterans Benefit Administration (VBA) before February 25, 2015 using the Veterans Services Network Corporate Master File (VETSNET). This population included individuals deployed in support of Post-9/11 conflicts, and who were identified as such in the Operations Enduring Freedom/Operation Iraqi Freedom/ Operation New Dawn Roster file (OEF/OIF/OND Roster from VA Environmental Epidemiology Service). Individuals were included if they received care at the VA during fiscal year 2014 and had received a determination for service connection by February 2015.

The VETSNET data was searched for all veterans with a VASRD corresponding to a service connected disability of the musculoskeletal system, including the spine, and the peripheral nervous system. Individual musculoskeletal VASRD codes were grouped according to type of represented disability into acute, subacute, or chronic inflammatory conditions (e.g., osteoarthritis), prosthetic replacement of joints, amputations of the upper extremity and lower extremity, limitations of motion for each joint, spine diagnoses, muscle injuries or dysfunction, and peripheral nerve disorders including paralysis (loss of function) and nerve related pain (neuritis or neuralgia). Conditions of the skull, rib, coccyx, and musculoskeletal neoplasms were excluded. Frequencies for each group of condition were calculated for male and female veterans separately and for the total included population.

For any given veteran, more than one service connected disability can be determined if the veteran has multiple morbid issues. In this case, the designated VASRD codes that describe the disability are ranked based on the most disabling condition first (primary) and the least disabling condition last, up to nine conditions. The frequency which any musculoskeletal condition was designated as the primary source of service connected disability was determined. Because veterans with a musculoskeletal service connected disability can also have conditions designated that are not related to the musculoskeletal system, the most common non-musculoskeletal conditions are also described. The specific diagnoses assigned as primary disability were ranked in order of frequency for male and female veterans .

Demographic characteristics included in this study were obtained from the OEF/OIF/OND roster file supplemented by VA inpatient and outpatient data DoD demographic data; individuals with missing demographic data were excluded. Age was analyzed as a continuous variable. Sex was defined as male or female. Service component was classified as Active Duty, National Guard, or Reserves. The results should be stratified by service. Rank was classified as Enlisted, Officer, or Warrant Officer with combined ranks within these categories. Race/ethnicity was defined as White, Black, Hispanic, Other/unknown. All analyses were performed using Stata 14.1/IC (College Station, TX).

RESULTS

The total VETSNET population with documented care in fiscal year 2014 and with service connection adjudication by February 2015 included 383,757 individuals. 347,643 (90.6%) veterans had at least one musculoskeletal related service connected disability. Among these, 303,410 (87.3%) were males with an average age of 38.1 ± 9.8 years (range 20-77 years, median 35 years). Table 1 includes remaining demographics for the musculoskeletal cohort.

The most common group of musculoskeletal related service connected disabilities was conditions of the spine, affecting 241, 636 (69.5%) veterans, followed by limitations in the knee/leg motion (46.6%) and acute and chronic disorders (30.2%). The median number of musculoskeletal conditions contributing to the service connected disability per veteran was 2.8 ± 1.3 conditions. Amputations, including single digit amputations, comprised 1.2% of service connected disabilities. Table 2 lists the frequencies and per-

Table 1: Demographics of veterans with musculoskeletal service connected disability (n = 347,643)

	Male (n), %	*Female (n), %*	*Total*
Sex	303,410 (87.3%)	44,233 (12.7%)	
Age (Mean ± SD)	38.2 ± 9.9 years	37.5 ± 9.3 years	38.1 ± 9.8 years
Service Component			
Active Duty	208, 514 (68.7%)	31,559 (71.3%)	240,073 (69.1%)
National Guard	61,603 (20.3%)	6,228 (14.1%)	67,831 (19.5%)
Reserves	33,293 (11.0%)	6,446 (14.6%)	39,739 (11.4%)
Rank			
Enlisted	284,221 (93.7%)	40,497 (91.6%)	324,718 (93.4%)
Officer	15,974 (5.3%)	3,408 (7.7%)	19,382 (5.6%)
Warrant Officer	3,215 (1.0%)	328 (0.7%)	3,543 (1.0%)
Race/Ethnicity			
White	198,922 (65.6%)	21,269 (48.1%)	220,191 (65.3%)
Black	52,265 (17.2%)	15,145 (34.2%)	67,410 (19.4%)
Hispanic	36,702 (12.1%)	5,238 (11.8%)	41,940 (12.1%)
Other/Unknown	15,521 (5.1%)	2,581 (5.8%)	18,102 (5.2%)

Table 2: Number and Percentage of Veterans with Groups of Service Connected Disabilities among Veterans with at least one Musculoskeletal Service Connected Disability (n=347,643)

	Male (n), %	*Female (n), %*	*Total (n), %*
Acute/Chronic	92,541 (30.5%)	12,338 (27.9%)	104, 879 (30.2%)
Degenerative Arthritis	20,789 (6.9%)	2,431 (5.5%)	23,229 (6.7%)
Traumatic Arthritis	19,091 (6.3%)	2,092 (4.7%)	21,183 (6.1%)
Amputations	3,858 (1.3%)	213 (0.5%)	4,071 (1.2%)
Loss of Motion(all)	231,423 (76.3%)	32,901 (74.4%)	264,324 (76.0%)
Shoulder/Arm Motion	63,285 (20.9%)	6,119 (13.8%)	69,404 (20.0%)
Elbow/Forearm Motion	18,082 (6.0%)	1,638 (3.7%)	19,720 (5.7%)
Wrist/Hand Motion	46,288 (15.3%)	5,912 (13.4%)	52,200 (15.0%)
Hip/Thigh Motion	24,120 (7.9%)	6,889 (15.6%)	31,009 (8.9%)
Knee/Leg Motion	142, 633 (47.0%)	19,404 (43.9%)	162,037 (46.6%)
Foot/Ankle Motion	80,138 (26.4%)	11,455 (25.9%)	91,593 (26.4%)
Muscle Injury (all)	7,679 (2.5%)	581 (1.3%)	8,260 (2.4%)
Nerve Paralysis	62,800 (20.1%)	9,469 (21.4%)	72,269 (20.8%)
Nerve Related Pain	19,539 (6.4%)	2,680 (6.1%)	22,219 (6.4%)
Spine/Back	211,485 (69.7%)	30,151 (68.2%)	241,636 (69.5%)

centage of veterans with each group of service connected disabilities.

The primary source of service connected disability was a musculoskeletal diagnosis for o 21.8% of veterans. Among the top ten diagnoses contributing to the primary disability for both sexes were lumbosacral or cervical strain, degenerative arthritis (DA) of the spine, and limitation of flexion of the knee. Post-Traumatic Stress Disorder (PTSD) was the most common specific diagnosis resulting in primary service connected disability for both men and women even though musculoskeletal conditions examined as groups of conditions were overall the most common contributor to

Table 3: Ten most common specific VASRD codes for the primary service connected disability for males and females with musculoskeletal disability (n = 347,643)

Female (n = 44,233)		*Males (n = 303,410)*	
PTSD	124,554(41.1%)	PTSD	13,025(29.5%)
Sleep Apnea	31,445 (10.4%)	Major Depressive Disorder	4,053 (9.2%)
Tinnitus	12,697 (4.2%)	Migraine	2,502 (5.7%)
Lumbosacral/Cervical Strain	11,409 (3.8%)	Anxiety Disorder	2,077 (4.7%)
Major Depressive Disorder	9,434 (3.4%)	Lumbosacral/Cervical Strain	2,002 (4.5%)
Anxiety Disorder	7,907 (2.6%)	Sleep Apnea	1,354 (3.1%)
DA of the Spine	6,596 (2.2%)	Adjustment Disorder	1,190 (2.7%)
Migraine	6,160 (2.0%)	Tinnitus	1,030 (2.3%)
Limitation of Flexion/Knee	4,776 (1.6%)	DA of the Spine	836 (1.9%)
Residual Effects of TBI	4,561 (1.5%)	Limitation of Flexion/Knee	786 (1.8%)

VASRD: Veterans Administration Schedule for Rating Disabilities; PTSD: Post-Traumatic Stress Disorder; DA: degenerative arthritis; TBI: Traumatic Brain Injury

cumulative disability. Table 3 contains the most common primary service connected diagnosis per sex among individuals with one or more musculoskeletal disabilities.

DISCUSSION

Musculoskeletal conditions as a source of service connected disability affects 90% of veterans of Iraq and Afghanistan. While the primary source of service connected disability is most often not musculoskeletal related, the overall burden of musculoskeletal conditions is still very high with an average of 2.8 musculoskeletal conditions per veteran contributing to their disability. Combined conditions of the back and knee are the most common musculoskeletal disabilities. Mental health conditions, most prominently PTSD, are the most common primary source of service connected disability despite the high frequency of musculoskeletal conditions.

A similar disability determination process is utilized by the military to determine if an ill or injured service member is medically able to perform his or her duties. VASRD codes in this setting are used to describe "unfitting" or service disqualifying conditions rather than service connected disabilities. Cross et al. (2011) published on the most common unfitting conditions in OIF and OEF veterans following combat injury where 70% of all unfitting conditions were due to musculoskeletal disorders. In this report, degenerative arthritis was the most common condition that resulted in medical discharge from military service following combat injury. Unlike the report by Cross et al. (2011), Patzkowski et al. (2012), published medical discharge data for all Army personnel during prior to military engagements in 2001 and at a second timepoint in 2009, including both individuals with and without combat/deployment related injury. This report also indicates the prominence of degenerative disorders, mainly arthritis and back conditions, as unfitting conditions. Both reports using military data also include psychiatric disorders, including PTSD, among the top ten most common unfitting conditions, but do not demonstrate these conditions as being the top force subtractor. It is interesting that the conditions the lead to medical discharge from the military are not more closely matched to the conditions identified by the VA as the most highly rated service connected disabilities, even though discharge from the military and matriculation into the VA health care system are close time points temporally.

Back and spine disorders affected nearly 70% of this cohort and two specific spine/back related VASRD codes were in the top most common conditions for both males and females. This is consistent with prior reports both in the military/veteran population and the civilian population. Spine injuries are common in combat, having occurred in 14% of soldiers who are medically retired (Blair et al. 2012; Rivera et al. 2014). However, a majority of spine conditions are not attributable to a specific injury or are pre-existing prior to deployment (Rivera et al. 2012, 2014). In the civilian population, over 70% of the work force reports experiencing at least one episode of back pain during a life-time; and 25% of the entire population endorses back pain at any given time (Chou et al. 2007). Back pain contributed to at least 16% of workmen's compensation claims, but accounts for over twice this percentage of workmen's compensation payouts (Bernard, n.d.). Two percent of the US workforce each year receives compensation for work days lost due to back pain (Chou et al. 2007). These data corroborate the known burden of back/spine disorders in morbidity and compensation among the larger veterans population. While specific diagnoses of lumbosacral or cervical strain and degenerative arthritis of the spine where not commonly the primary (first) source of disability in this cohort, multiple different spine related diagnoses contributed to a majority of the veterans' service connected disability determinations.

Arthritis is the most frequent reason that combat veterans are medically discharged from the military (Cross et al. 2011; Rivera et al. 2012) and among the most common conditions treated at Veterans Affairs (VA) health care facilities (Bernard, n.d.). Even in times of peace, arthritis remains one of the most common reasons that service members are medically discharged or separated from the military (Patzkowski et al. 2012). In this OIF/OEF/OND veterans population, the specific disability designations for degenerative arthritis and traumatic arthritis did not comprise

what one might expect considering national population estimates of arthritis diagnoses. However, prior work using DoD medical discharge data suggests that individuals with disability codes for limitations in motion more often than not have arthritis as the underlying cause of the motion limitation (Rivera et al. 2012). While this data cannot confirm based on physician diagnosed or radiographic arthritis if this is the case for these veterans, the clinical implication is substantial if disability assigned to limitation in joint motion does correspond to arthritis. In this cohort, the overlap between individuals with an arthritis specific VASRD code and a limitation in motion code is only 6%. As such the impact of joint disorders on the larger veteran population likely spurs from these disabilities combined.

Functional impairment following musculoskeletal injury contributes substantially to decrease in motion caused by stiffness and perceived muscle dysfunction (Vela and Denegar 2010). This cohort demonstrates a tremendous burden of motion limitations. As above, joint motion limitation often is due to underlying degeneration of the joint. Motion limitations in this cohort were distributed across the skeleton with motion limitations about the knee being the most common. Disability about the knee is common following combat and non-combat knee injury is a known contributor to knee arthritis leading to joint arthroplasty in military personnel (Rivera et al. 2012; Murtha et al. 2017). Together this suggests that degeneration of the knee both due to aging and post traumatic conditions is likely an important clinical factor in this population. Additionally, perceived muscle dysfunction can also cause functional impairment. Muscle injury is a known cause of medical discharge from active duty service which typically causes disability that worsens with time (Corona et al. 2015; Rivera and Corona 2016). This cohort had a relatively low frequency of muscle specific service connected disabilities; but muscle dysfunction could still be present and contributing to limitations in motion. Another potential source of perceived muscle dysfunction is nerve injury. Consistent with prior reports from the DoD, nerve related loss of function (paralysis) is not an insignificant source of disability (Cross et al. 2011; Rivera, Glebus, and Cho 2014). Taken together, the status of the joint cartilage, the skeletal muscle, and the motor nerves can all contribute morbidity of motion limitation and individually contribute to a cumulative limb disability.

The primary source of service connected disability in this cohort was most often the specific diagnosis of PTSD. In fact, within the top ten specific diagnoses found to be the primary service connected disability, mental health diagnoses are four of the top ten primary disorders for male veterans and five of the top ten for female veterans. Significant attention in the media and medical literature has been paid to combat related amputations, PTSD, and TBI as "signature injuries" from OEF, OIF and OND. While universally service disqualifying per military retention regulations, amputations represent a relatively very small proportion of service connected disabilities within the entire veteran population. In contrast, PTSD contributes to 16% of wounded service members' medical discharge from active duty service but was by far the most common primary service connected disability (Cross et al. 2011). PTSD was much more impactful on service connected disability than the residuals of TBI, both components of the OEF/OIF/OND polytrauma clinical triad (Pugh et al. 2014). The prominence of PTSD in this cohort should also draw additional attention to the burden of mental health disorders on this population. Major depressive disorder and anxiety disorders are also among the top ten primary service connected disabilities for both men and women. The population impact of mental health conditions alone must, then, be substantial. However, this impact is amplified by prior findings that mental health conditions can compound long term morbidity from musculoskeletal related injuries.

The limitations to this study are several. First, the outcomes presented herein are based on counts of VASRD codes which are then grouped along with similar VASRD codes. The VASRD system is unique to the military and veterans' health care settings and may not extrapolate well to civilian outcomes. VASRD coding may also subject to variability based on each individual veteran's respective examiner. Based on the regulations dictating how the VASRD designations are applied, examiner inter-rater reliability should be reasonable, but this cannot be confirmed with these present data. Similarly, the specific diagnoses that correspond to the VASRD codes are not available. For example, prior work suggests that VASRD codes for limitations in motion often correspond to the diagnosis of arthritis (Rivera et al. 2012); however this can only be speculated using the codes only in this analysis. As such, the clinical implications of some conditions may be under- or over-estimated based on the interpretation of a veteran's VASRD profile. While determining how military deployment affects long term disability is of interest, these data are not able to delineate between service connected disabilities that are also deployment connected. Finally, the VA designation for service connected disabilities has specific compensation implications for the veteran, but does not necessarily reflect the demand of specific health service.

In conclusion, musculoskeletal conditions are prevalent in the OEF/OIF/OND veteran population and contribute to service connected disability in a majority. This analysis highlights the importance of back/spine conditions, arthritis and limitations to motion, and cumulative conditions that may result from a single limb injury due to multiple tissue injuries. However, mental health disorders predominated the service connected disability in this cohort as the primary source of disability. The VA health care system and civilian health care systems that absorb veterans should be aware of the high burden of musculoskeletal disability and comorbid mental health conditions.

DECLARATION OF INTERESTS

The authors have no financial conflicts of interest to report pertaining to this work.

The opinions or assertions contained here are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the

Army, the Department of Defense, or the United States Government.

REFERENCES

38 Code of Federal Regulations, Book C, Schedule for Rating Disabilities. n.d.

Belmont, Philip J. Jr, Brendan J. McCriskin, Mark S. Hsiao, Robert Burks, Kenneth J. Nelson, and Andrew J. Schoenfeld. 2013. "The Nature and Incidence of Musculoskeletal Combat Wounds in Iraq and Afghanistan (2005-2009)." *Journal of Orthopaedic Trauma* 27 (5): e107–13. https://doi.org/10.1097/bot.0b013e3182703188.

Bernard, B.P. n.d. "Musculoskeletal Disorders and Workplace Factors: A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back." NIOSH Publication 97-141. Centers for Disease Control and Prevention. http://www.cdc.gov/niosh/docs/97-141.

Blair, James A, Jeanne C Patzkowski, Andrew J Schoenfeld, Jessica D Cross Rivera, Eric S Grenier, Ronald A Lehman Jr., and Joseph R Hsu. 2012. "Spinal Column Injuries Among Americans in the Global War on Terrorism." *The Journal of Bone and Joint Surgery-American Volume* 94 (18): 1–9. https://doi.org/10.2106/jbjs.k.00502.

Chou, Roger, Amir Qaseem, Vincenza Snow, Donald Casey, J. Thomas Cross Jr., Paul Shekelle, Douglas K. Owens, Clinical Efficacy Assessment Subcommittee of the American College of Physicians, American College of Physicians, and American Pain Society Low Back Pain Guidelines Panel. 2007. "Diagnosis and Treatment of Low Back Pain: A Joint Clinical Practice Guideline from the American College of Physicians and the American Pain Society." *Annals of Internal Medicine* 147 (7): 478–91. https://doi.org/10.7326/0003-4819-147-7-200710020-00006.

Corona, Benjamin T., Jessica C. Rivera, Johnny G. Owens, Joseph C. Wenke, and Christopher R. Rathbone. 2015. "Volumetric Muscle Loss Leads to Permanent Disability Following Extremity Trauma." *Journal of Rehabilitation Research and Development* 52 (7): 785–92. https://doi.org/10.1682/jrrd.2014.07.0165.

Cross, Jessica D., James R. Ficke, Joseph R. Hsu, Brendan D. Masini, and Joseph C. Wenke. 2011. "Battlefield Orthopaedic Injuries Cause the Majority of Long-Term Disabilities." *American Academy of Orthopaedic Surgeon* 19 (Supplement 1): S1–7. https://doi.org/10.5435/00124635-201102001-00002.

Defense Casualty Health Statistics. 2016. "U.S.Military Casualties - OCO Casualty Summary by Casualty Types." https://www.dmdc.osd.mil/dcas/pages/report_sum_reason.xhtml.

Department of Veterans Affairs. 2015. "Analysis of VA Health Care Utilization among Operation Enduring Freedom (OEF), Operation Iraqi Freedom (OIF), and Operation New Dawn (OND) Veterans." http://www.publichealth.va.gov/epidemiology/reports/oefoifond/health-care-utilization/index.asp.

Doucet, Jay J., Michael R. Galarneau, Bruce M. Potenza, Vishal Bansal, Jeanne G. Lee, Alexandra K. Schwartz, Amber L. Dougherty, et al. 2011. "Combat Versus Civilian Open Tibia Fractures: The Effect of Blast Mechanism on Limb Salvage." *The Journal of Trauma: Injury, Infection, and Critical Care* 70 (5): 1241–47. https://doi.org/10.1097/ta.0b013e3182095b52.

Murtha, Andrew S., Anthony E. Johnson, Joseph A. Buckwalter, and Jessica C. Rivera. 2017. "Total Knee Arthroplasty for Posttraumatic Osteoarthritis in Military Personnel under Age 50." *Journal of Orthopaedic Research* 35 (3): 677–81. https://doi.org/10.1002/jor.23290.

Owens, Brett D, John F Jr Kragh, Joseph Macaitis, Steven J Svoboda, and Joseph C Wenke. 2007. "Characterization of Extremity Wounds in Operation Iraqi Freedom and Operation Enduring Freedom." *Journal of Orthopaedic Trauma* 21 (4): 254–57. https://doi.org/10.1097/bot.0b013e31802f78fb.

Owens, Brett D., John F. Jr Kragh, Joseph C. Wenke, Joseph Macaitis, Charles E. Wade, and John B. Holcomb. 2008. "Combat Wounds in Operation Iraqi Freedom and Operation Enduring Freedom." *The Journal of Trauma: Injury, Infection, and Critical Care* 64 (2): 295–99. https://doi.org/10.1097/ta.0b013e318163b875.

Patzkowski, Jeanne C., Jessica C. Rivera, James R. Ficke, and Joseph C. Wenke. 2012. "The Changing Face of Disability in the US Army: The Operation Enduring Freedom and Operation Iraqi Freedom Effect." *Journal of the American Academy of Orthopaedic Surgeons* 20 (Supplement 1): S23–30. https://doi.org/10.5435/jaaos-20-08-s23.

Pugh, Mary Jo, Erin P. Finley, Laurel A. Copeland, Chen-Pin Wang, Polly H. Noel, Megan E. Amuan, Helen M. Parsons, Margaret Wells, Barbara Elizondo, and Jacqueline A. Pugh. 2014. "Complex Comorbidity Clusters in OEF/OIF Veterans: The Poly Trauma Clinical Triad and Beyond." *Medical Care* 52 (2): 172–81. https://doi.org/10.1097/mlr.0000000000000059.

Rivera, Jessica C., Edward R. Anderson, Joel W. Jenne, and Raymond F. Topp. 2014. "Spine-Related Disability Following Combat Injury." *Journal of Surgical Orthopaedic Advances* 23 (3): 136–39. https://doi.org/10.3113/jsoa.2014.0136.

Rivera, Jessica C., and B.T. Corona. 2016. "Muscle-Related Disability Following Combat Injury Increases with Time." *The Medical Journal, US Army Medical Center of Excellence* Jan-Mar:30–34.

Rivera, Jessica C., G. P. Glebus, and M. S. Cho. 2014. "Disability Following Combat-Sustained Nerve Injury of the Upper Limb." *The Bone & Joint Journal* 96-B (2): 254–58. https://doi.org/10.1302/0301-620x.96b2.31798.

Rivera, Jessica C., Joseph C. Wenke, Joseph A. Buckwalter, James R. Ficke, and Anthony E. Johnson. 2012. "Posttraumatic Osteoarthritis Caused by Battlefield Injuries: The Primary Source of Disability in Warriors." *Journal of the American Academy of Orthopaedic Surgeons* 20 (Supplement 1): S64–69. https://doi.org/10.5435/jaaos-20-08-s64.

Vela, Luzita I., and Craig Denegar. 2010. "Transient Disablement in the Physically Active With Musculoskeletal Injuries, Part I: A Descriptive Model." *Journal of Athletic Training* 45 (6): 615–29. https://doi.org/10.4085/1062-6050-45.6.615.