Retrospective Review

Prevalence of Specific Types of Pain Diagnoses in a Sample of United States Adults

Kelly Ryan Murphy, BS[1], Jing L. Han, BA[1], Siyun Yang, MS[2], Syed Mohammed Qasim Hussaini, MS[1], Aladine A. Elsamadicy, BE[1], Beth Parente, MHS[1], Jichun Xie, PhD[2], Promila Pagadala, PhD[1], and Shivanand P. Lad, MD, PhD[1]

From: [1]Duke University Medical Center, Department of Neurosurgery, Durham, NC; [2]Duke University Medical Center, Department of Biostatistics, Durham, NC

Address Correspondence: Shivanand P. Lad, MD, PhD Department of Neurosurgery Duke University Medical Center, Box 3807 Durham, NC 27710 E-mail: nandan.lad@duke.edu

Disclaimer: SPL has received fees for serving as a speaker and consultant for Medtronic Inc., Boston Scientific, and St. Jude Medical. He serves as the Director of the Duke Neuro-outcomes Center which has received research funding from NIH KM1 CA 156687, Medtronic Inc. and St. Jude Medical. The remaining authors report no conflicts of interest or financial disclosures.
Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 06-02-2016
Revised manuscript received: 08-13-2016
Accepted for publication: 08-22-2016

Free full manuscript: www.painphysicianjournal.com

Background: Patients with pain conditions place significant demands on health care services globally. Health economists have reported the annual economic cost of pain in the United States as high as $635 billion. A common challenge in treating patients suffering from chronic pain conditions is accurate diagnosis and treatment.

Objective: The aim of this study was to determine the modern-day prevalence of individual types of pain diagnoses in adults.

Study Design: Retrospective analysis of Truven MarketScan® Commercial and Medicare Supplemental database.

Setting: United States patient population with pain diagnoses from 2000 to 2012.

Methods: Multivariate analysis was used to determine the individual prevalence of specific types of pain diagnoses over a 13-year period. We grouped the 6,575,999 patients with ICD-9 pain diagnoses into pain groupings.

Results: We determined the prevalence of pain groupings as back pain (74.7%), chronic pain (10.4%), complex regional pain syndrome (1.2%), degenerative spine disease (63.6%), limb pain (50.0%), neuritis/radiculitis (52.8%), and post-laminectomy syndrome (14.8%).

Limitations: Retrospective and non-randomized study with a patient cohort that is weighted towards recent years and commercial insurance. Coding discrepancies that are recorded and collected for patients.

Conclusions: The demographic differences and similarities within the subgroups highlight that pain diagnoses should be considered as separate, but related entities. The present study helps us to better understand the frequency of specific pain diagnoses, and directs future studies to appropriately focus on pain diagnoses based on prevalence. This will allow increased understanding of the variation in pain diagnoses and prevent over-generalization in studies examining pain patients to more accurately reflect the varied subtypes and their economic impact.
Duke University Institutional Review Board Protocol: 00053624

Key words: Pain diagnoses, CRPS, neuritis, radiculitis, limb pain, degenerative spine disease, back pain, chronic pain, post-laminectomy pain, prevalence, MarketScan

Pain Physician 2017; 20:E257-E268

Patients with pain conditions place significant demands on health care services globally with millions of American adults affected. Prior studies have estimated the total impact of medical care and lost economic productivity on the US economy to be $635 billion (1-5). The FDA has implored the scientific community to find new and improved approaches to diagnosing and treating chronic

pain (6). A common challenge in treating patients suffering from chronic pain conditions is accurate diagnosis and treatment (7,8). The responsibility of proper pain diagnosis and treatment rests on the clinical and scientific community to perform studies that acknowledge the heterogeneity, overlap, and differences among the many varied subgroups of pain patients.

Many prior studies have examined the prevalence of pain (3,5,9-21). Typically, demographic associations have highlighted the age and gender differences based on pain type and incidence (3,9-11,17-19,22,23). Other studies focus on differences between race and economic profiles in both prevalence and management (24,25). Across many studies, the prevalence of pain over time appears to be rising (1,3). Whether such trends reflect the actual increase in pain among patients or changes in coding practice is not clear (17,26-28). There appears to be a paucity of studies examining the prevalence of specific types of pain diagnoses based on pain codes over a longitudinal scale.

The primary objective of this study was to determine how the prevalence of specific types of pain diagnoses have changed over a recent 13-year period. We hypothesized that the prevalence of pain diagnoses has been increasing over time, and proposed that most pain patients carry multiple pain diagnoses. Furthermore, we sought to determine whether specific demographic factors were associated more commonly with specific types of pain diagnoses.

Methods

Data Source

We utilized the Truven Reuters MarketScan® Database, containing information on more than 100 million unique patients in the United States since 1995. This database contains fully integrated patient-level data, including inpatient, outpatient, drug, and lab information from commercial, Medicare Supplemental, and Medicaid populations. We performed a 13-year retrospective review of specific types of pain diagnoses in United States adults from the years 2000 – 2012.

Patient Population

International Classification of Diseases, Ninth Revision (ICD-9), codes were used to select patients with chronic pain and segmented into specific types of pain diagnoses. Using these codes, 6,575,999 patients were identified with the following pain diagnoses: back pain, chronic pain, complex regional pain syndrome, degenerative spine disease, limb pain, neuritis/radiculitis, and post-laminectomy syndrome. Patients ≥ 18 years of age with at least one ICD-9 pain code were included in the analysis (Supplementary Table 1). They were counted multiple times if they had multiple chronic pain diagnoses.

Statistical Analysis

The descriptive variables were shown using means, median with standard deviation (SD), whereas the categorical variables were represented with counts (n) and percentages (%). Kruskal Wallis test was used for group difference in continuous outcomes and Chi-square test was used for group difference in categorical outcomes. We determined the probability of having each of the diagnostic subgroups over a 13-year period using multivariate logistic regression analyses. Covariates included age, gender, region, insurance status, employment status, and year. Regional and employment status data was only available for Medicare and commercially insured patients. Using an adjusted logistic model, we computed odds ratios (ORs) with 95% confidence intervals (CI) to analyze differences within the 7 diagnostic subgroups. The patients were excluded from analysis if any of the covariates were missing, which resulted in 6,575,982 patients being included in the regression. All analyses were conducted with SAS version 9.4 (SAS Institute, Cary, NC, USA).

Results

Patient Cohort

The patient demographics are listed in Table 1. The average age at first diagnosis was 54.5 (16.5) years ($P < 0.0001$). More patients were women (58%) and 38.4% were insured through either Medicare or Medicaid. The prevalence of the 7 pain diagnoses were back pain (74.7%), chronic pain (10.4%), complex regional pain syndrome (1.2%), degenerative spine disease (63.6%), limb pain (50.0%), neuritis/radiculitis (52.8%), and post-laminectomy syndrome (14.8%) (Fig. 1). The total prevalence of pain in the population summated to 267.5%, which reflects each patient carrying a mean of 2.68 (SD: 1.34) pain diagnoses.

A quarter of the patient cohort, or 24.8%, had only one out of the 7 pain diagnoses used in this study and 28.2% carried 4 or more of the 7 diagnoses. Only 1.9% and 0.1% of the patients carried a multiple diagnosis of 6 or 7 conditions, respectively (Fig. 2). Certain

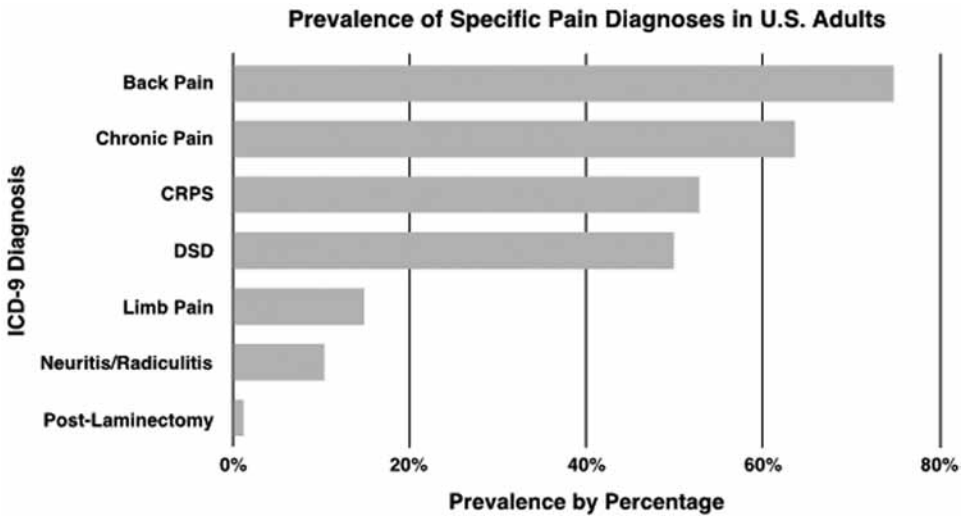

Fig. 1. *Prevalence of specific pain diagnoses in US adults.*

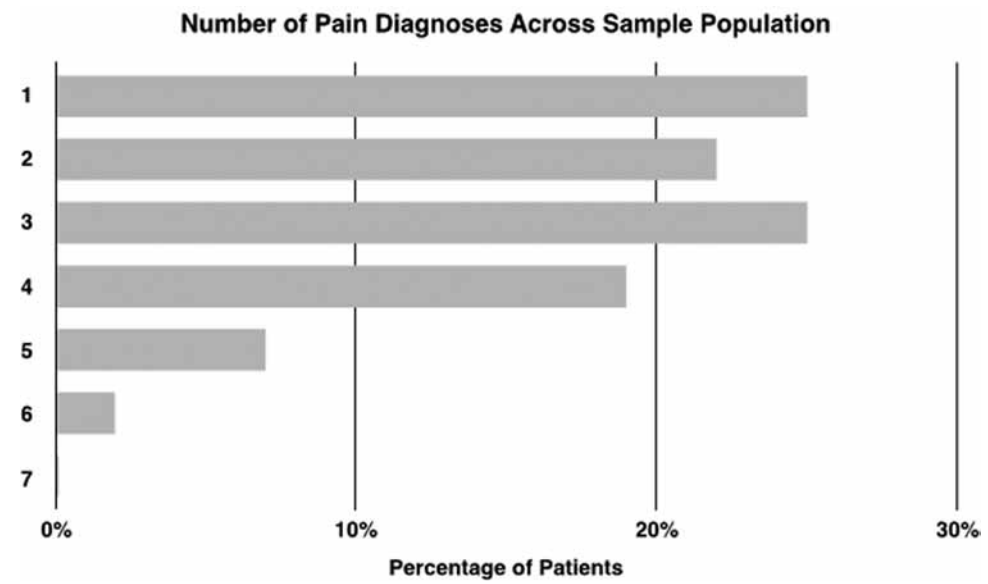

Fig. 2. *Number of pain diagnoses across sample population.*

groups had a greater proportion of multiple diagnoses. Chronic pain, complex regional pain syndrome, and post-laminectomy syndrome had a higher proportion of patients that were labeled having 4 or more diagnosis (78.9%, 77.1%, 66.6%; $P < 0.0001$). Complex regional pain syndrome had by far the largest proportion of patients with at least 7 diagnosis (9.6% vs. 0.1% average overall; $P < 0.0001$) (Table 1).

Age Differences

Youngest age at first diagnosis was seen in complex regional pain syndrome at ~51 years (SD: 13.9; $P < 0.001$). Using the adjusted model, each unit increase of age was associated with a 2% increased risk of degenerative spine disease (OR 1.02, 95% CI [1.02, 1.02]; $P < 0.001$) and 2% reduced risk of having back pain (OR 0.98, 95% CI [0.98, 0.98]; $P < 0.001$). However, age was

Table 1. *Baseline characteristics of pain.*

	Back pain (N=4912164)	Chronic pain (N=683681)	CRPS (N=79025)	DSD (N=4185232)	Limb pain (N=3289520)	Neuritis/radiculitis (N=3474698)	Post-laminectomy (N=975095)	Total (N=6575999)	*P*-value
Prevalence	74.7%	10.4%	1.2%	63.6%	50.0%	52.8%	14.8%	267.5%	
Source, N(%)									**<0.0001**
CCAE	3055787 (62.2)	364569 (53.3)	52592 (66.6)	2545205 (60.8)	1816743 (55.2)	2215133 (63.8)	596518 (61.2)	4050757 (61.6)	
MAID	627483 (12.8)	179221 (26.2)	11760 (14.9)	442744 (10.6)	521277 (15.8)	372970 (10.7)	138942 (14.2)	826338 (12.6)	
MDCR	1228894 (25.0)	139891 (20.5)	14673 (18.6)	1197283 (28.6)	951500 (28.9)	886595 (25.5)	239635 (24.6)	1698904 (25.8)	
Employment Status, N(%)									**<0.0001**
Active Full Time	963124 (19.6)	90304 (13.2)	14365 (18.2)	757869 (18.1)	558334 (17.0)	657889 (18.9)	162671 (16.7)	1278712 (19.4)	
Active Part Time/Seasonal	18951 (0.4)	1818 (0.3)	287 (0.4)	14924 (0.4)	11059 (0.3)	12834 (0.4)	3081 (0.3)	25417 (0.4)	
Early Retiree	238358 (4.9)	18576 (2.7)	3700 (4.7)	202309 (4.8)	165285 (5.0)	169143 (4.9)	44812 (4.6)	320269 (4.9)	
Medicare Eligible Retiree	612601 (12.5)	56855 (8.3)	8090 (10.2)	580822 (13.9)	474228 (14.4)	432260 (12.4)	115052 (11.8)	826208 (12.6)	
Retiree (status unknown)	141556 (2.9)	22261 (3.3)	2081 (2.6)	129007 (3.1)	107341 (3.3)	105356 (3.0)	30810 (3.2)	183655 (2.8)	
COBRA Continuee	34916 (0.7)	5261 (0.8)	978 (1.2)	31067 (0.7)	19897 (0.6)	26810 (0.8)	8668 (0.9)	43980 (0.7)	
Long Term Disability	19294 (0.4)	3867 (0.6)	763 (1.0)	17017 (0.4)	12936 (0.4)	15014 (0.4)	5833 (0.6)	23904 (0.4)	
Surviving Spouse/ Depend.	95437 (1.9)	9652 (1.4)	1008 (1.3)	86060 (2.1)	79087 (2.4)	60351 (1.7)	14114 (1.4)	130983 (2.0)	
Other/Unknown	2160444 (44.0)	295866 (43.3)	35993 (45.5)	1923413 (46.0)	1340076 (40.7)	1622071 (46.7)	451112 (46.3)	2916533 (44.4)	
Medicaid	627483 (12.8)	179221 (26.2)	11760 (14.9)	442744 (10.6)	521277 (15.8)	372970 (10.7)	138942 (14.2)	826338 (12.6)	
Gender of Patient, N(%)									**<0.0001**
Missing	12 (0.0)	3 (0.0)	0 (0.0)	10 (0.0)	12 (0.0)	5 (0.0)	0 (0.0)	17 (0.0)	
Male	2021256 (41.1)	261893 (38.3)	26164 (33.1)	1787252 (42.7)	1266543 (38.5)	1453825 (41.8)	411371 (42.2)	2771409 (42.1)	
Female	2890896 (58.9)	421785 (61.7)	52861 (66.9)	2397970 (57.3)	2022965 (61.5)	2020868 (58.2)	563724 (57.8)	3804573 (57.9)	
Year at first diagnosis, N(%)									**<0.0001**
2000	145490 (3.0)	12583 (1.8)	3321 (4.2)	123815 (3.0)	109805 (3.3)	108630 (3.1)	35171 (3.6)	167348 (2.5)	
2001	178602 (3.6)	16012 (2.3)	3555 (4.5)	148881 (3.6)	135719 (4.1)	127368 (3.7)	38868 (4.0)	211149 (3.2)	
2002	266015 (5.4)	29449 (4.3)	5482 (6.9)	220922 (5.3)	199240 (6.1)	188176 (5.4)	57829 (5.9)	319110 (4.9)	
2003	288111 (5.9)	22320 (3.3)	4822 (6.1)	237853 (5.7)	200662 (6.1)	195197 (5.6)	55220 (5.7)	362130 (5.5)	
2004	353976 (7.2)	30893 (4.5)	6441 (8.2)	299488 (7.2)	246089 (7.5)	247743 (7.1)	68290 (7.0)	444631 (6.8)	
2005	285951 (5.8)	24664 (3.6)	4618 (5.8)	236289 (5.6)	195444 (5.9)	191750 (5.5)	50932 (5.2)	374486 (5.7)	
2006	362303 (7.4)	41310 (6.0)	7436 (9.4)	307115 (7.3)	239659 (7.3)	260701 (7.5)	69916 (7.2)	462633 (7.0)	
2007	296465 (6.0)	36983 (5.4)	4911 (6.2)	243738 (5.8)	194133 (5.9)	203586 (5.9)	52952 (5.4)	393440 (6.0)	
2008	458821 (9.3)	70162 (10.3)	8262 (10.5)	405743 (9.7)	302133 (9.2)	334661 (9.6)	94802 (9.7)	611333 (9.3)	

Table 1 (cont). *Baseline characteristics of ain.*

	Back pain (N=4912164)	Chronic pain (N=683681)	CRPS (N=79025)	DSD (N=4185232)	Limb pain (N=3289520)	Neuritis/radiculitis (N=3474698)	Post-laminectomy (N=975095)	Total (N=6575999)	*P*-value
2009	312862 (6.4)	48279 (7.1)	4472 (5.7)	267298 (6.4)	204746 (6.2)	216995 (6.2)	67600 (6.9)	454566 (6.9)	
2010	1018459 (20.7)	212068 (31.0)	15522 (19.6)	886943 (21.2)	681334 (20.7)	751187 (21.6)	206073 (21.1)	1336692 (20.3)	
2011	620272 (12.6)	99264 (14.5)	7334 (9.3)	536936 (12.8)	392496 (11.9)	439186 (12.6)	119416 (12.2)	893672 (13.6)	
2012	324837 (6.6)	39694 (5.8)	2849 (3.6)	270211 (6.5)	188060 (5.7)	209518 (6.0)	58026 (6.0)	544809 (8.3)	
Age at first diagnosis									**<0.0001**
N	4912164	683681	79025	4185232	3289520	3474698	975095	6575999	
Mean (SD)	53.8 (16.2)	52.3 (15.2)	50.7 (13.9)	56.1 (15.1)	55.9 (16.4)	54.6 (14.7)	53.8 (14.7)	54.5 (16.5)	
Median	54.0	52.0	51.0	56.0	56.0	54.0	54.0	55.0	
Geographic region, N(%)									**<0.0001**
Northeast Region	652827 (13.3)	64097 (9.4)	8547 (10.8)	584315 (14.0)	441465 (13.4)	481626 (13.9)	118560 (12.2)	921700 (14.0)	
North Central Region	1201828 (24.5)	125387 (18.3)	17070 (21.6)	1010601 (24.1)	838319 (25.5)	824359 (23.7)	229880 (23.6)	1603979 (24.4)	
South Region	1654517 (33.7)	202228 (29.6)	29672 (37.5)	1468691 (35.1)	1011186 (30.7)	1251503 (36.0)	333218 (34.2)	2182274 (33.2)	
West Region	690591 (14.1)	100025 (14.6)	10733 (13.6)	600744 (14.4)	424650 (12.9)	482423 (13.9)	136526 (14.0)	922016 (14.0)	
Unknown Region	84918 (1.7)	12723 (1.9)	1243 (1.6)	78137 (1.9)	52623 (1.6)	61817 (1.8)	17969 (1.8)	119692 (1.8)	
Medicaid	627483 (12.8)	179221 (26.2)	11760 (14.9)	442744 (10.6)	521277 (15.8)	372970 (10.7)	138942 (14.2)	826338 (12.6)	
Multiple diagnosis, N(%)									**<0.0001**
1	598588 (12.2)	17626 (2.6)	2701 (3.4)	240822 (5.8)	528619 (16.1)	152211 (4.4)	92610 (9.5)	1633177 (24.8)	
2	1020980 (20.8)	44638 (6.5)	5963 (7.5)	781305 (18.7)	549194 (16.7)	444103 (12.8)	104189 (10.7)	1475186 (22.4)	
3	1458987 (29.7)	86584 (12.7)	9443 (11.9)	1362737 (32.6)	653891 (19.9)	1126913 (32.4)	129243 (13.3)	1609266 (24.5)	
4	1224524 (24.9)	171953 (25.2)	15219 (19.3)	1197409 (28.6)	992663 (30.2)	1151285 (33.1)	234591 (24.1)	1246911 (19.0)	
5	473676 (9.6)	233558 (34.2)	22064 (27.9)	468096 (11.2)	430780 (13.1)	464884 (13.4)	286537 (29.4)	475919 (7.2)	
6	127820 (2.6)	121733 (17.8)	16046 (20.3)	127274 (3.0)	126784 (3.9)	127713 (3.7)	120336 (12.3)	127951 (1.9)	
7	7589 (0.2)	7589 (1.1)	7589 (9.6)	7589 (0.2)	7589 (0.2)	7589 (0.2)	7589 (0.8)	7589 (0.1)	

MDCR, Medicare; MAID, Medicaid; CCAE, commercially available insurance; COBRA, Consolidated Omnibus Reconciliation Act of 1985
OR, odds ratio; CI, confidence interval
CRPS – complex regional pain syndrome; DSD – degenerative spine disease

Table 2. *Multivariate logistic regression.*

	Back pain	Chronic pain	CRPS	DSD	Limb pain	Neuritis/radiculitis	Post-laminectomy
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Age							
	0.98 (0.98, 0.98)*	0.99 (0.99, 0.99)*	0.98 (0.98, 0.98)*	1.02 (1.02, 1.02)*	1.01 (1.01, 1.01)*	1.00 (1.00, 1.00)*	0.99 (0.99, 0.99)*
Gender of Patient							
Female	1.11 (1.10, 1.11)*	1.03 (1.02, 1.03)*	1.35 (1.33, 1.37)*	0.85 (0.84, 0.85)*	1.29 (1.28, 1.29)*	0.93 (0.92, 0.93)*	0.90 (0.90, 0.90)*
Male	reference	reference	reference	reference	reference	reference	reference
Insurance source							
MDCR	1.09 (1.08, 1.10)*	1.17 (1.16, 1.19)	0.88 (0.85, 0.91)*	0.80 (0.79, 0.81)*	1.20 (1.19, 1.21)*	0.72 (0.71, 0.72)*	1.02 (1.01, 1.03)*
MAID	reference	reference	reference	reference	reference	reference	reference
CCAE	reference	reference	reference	reference	reference	reference	reference
Employment status							
M	1.05 (1.04, 1.06)*	4.39 (4.33, 4.44)*	1.16 (1.13, 1.20)*	0.51 (0.51, 0.51)*	1.84 (1.83, 1.86)*	0.47 (0.46, 0.47)*	1.26 (1.25, 1.27)*
Other/Unknown	0.95 (0.95, 0.96)*	1.45 (1.43, 1.46)*	1.12 (1.10, 1.15)*	1.12 (1.11, 1.12)*	0.91 (0.91, 0.92)*	1.11 (1.10, 1.11)*	1.19 (1.18, 1.20)*
Surviving Spouse/Depend.	1.16 (1.14, 1.18)*	1.20 (1.17, 1.23)*	1.06 (0.99, 1.13)*	0.88 (0.87, 0.90)*	1.18 (1.16, 1.20)*	0.79 (0.78, 0.80)*	0.87 (0.85, 0.89)*
Long Term Disability	1.09 (1.06, 1.13)*	1.83 (1.76, 1.90)*	2.10 (1.95, 2.27)*	1.09 (1.05, 1.12)*	1.05 (1.02, 1.08)#	1.05 (1.02, 1.09)#	1.66 (1.60, 1.71)*
COBRA Continuee	1.12 (1.09, 1.15)*	1.43 (1.39, 1.48)*	1.59 (1.49, 1.70)*	1.35 (1.32, 1.38)*	0.82 (0.81, 0.84)*	1.21 (1.18, 1.24)*	1.43 (1.39, 1.47)*
Retiree (status unknown)	1.13 (1.12, 1.15)*	1.31 (1.29, 1.34)*	1.08 (1.03, 1.14)#	0.91 (0.90, 0.93)*	1.25 (1.23, 1.26)*	1.04 (1.03, 1.06)*	1.14 (1.12, 1.16)*
Medicare Eligible Retiree	1.15 (1.14, 1.16)*	0.93 (0.92, 0.95)*	1.29 (1.24, 1.34)*	1.06 (1.05, 1.06)*	1.10 (1.09, 1.11)*	1.00 (0.99, 1.01)	1.04 (1.03, 1.06)*
Early Retiree	1.05 (1.04, 1.06)*	0.81 (0.80, 0.83)*	1.12 (1.08, 1.16)*	0.90 (0.89, 0.90)*	1.19 (1.18, 1.20)*	0.93 (0.92, 0.94)*	1.08 (1.07, 1.09)*
Active Part Time or Seasonal	0.98 (0.95, 1.01)	1.04 (0.99, 1.10)	1.05 (0.93, 1.18)	0.99 (0.96, 1.02)	0.98 (0.96, 1.01)	0.98 (0.96, 1.01)	0.97 (0.93, 1.01)
Active Full Time	reference	reference	reference	reference	reference	reference	reference
Multiple diagnosis (<3)							
1	39.85 (39.35, 40.36)*	12.90 (12.82, 12.98)*	8.88 (8.73, 9.03)*	33.69 (33.41, 33.98)	9.07 (9.03, 9.11)*	31.08 (30.88, 31.29)*	7.27 (7.24, 7.31)*
0	reference	reference	reference	reference	reference	reference	reference
Geographic region							
Unknown Region	1.02 (1.00, 1.03)	1.46 (1.42, 1.49)*	1.06 (1.00, 1.13)	1.05 (1.03, 1.06)*	0.85 (0.84, 0.86)*	0.90 (0.89, 0.91)*	1.13 (1.11, 1.16)*
West Region	1.19 (1.19, 1.20)*	1.61 (1.59, 1.62)*	1.21 (1.17, 1.24)*	1.04 (1.03, 1.05)*	0.83 (0.82, 0.83)*	0.93 (0.92, 0.93)*	1.12 (1.11, 1.14)*
South Region	1.17 (1.16, 1.17)*	1.21 (1.20, 1.22)*	1.24 (1.21, 1.27)*	1.16 (1.16, 1.17)*	0.84 (0.84, 0.85)*	1.13 (1.13, 1.14)*	1.10 (1.09, 1.11)*
North Central Region	1.15 (1.14, 1.15)*	1.09 (1.08, 1.11)*	1.04 (1.02, 1.07)#	0.93 (0.92, 0.93)*	1.10 (1.10, 1.11)*	0.88 (0.88, 0.89)*	1.08 (1.07, 1.09)*
Northeast Region	reference	reference	reference	reference	reference	reference	reference

MDCR, Medicare; MAID, Medicaid; CCAE, commercially available insurance; COBRA, Consolidated Omnibus Reconciliation Act of 1985
OR, odds ratio; CI, confidence interval;
*$P<0.001$, #$P < 0.005$

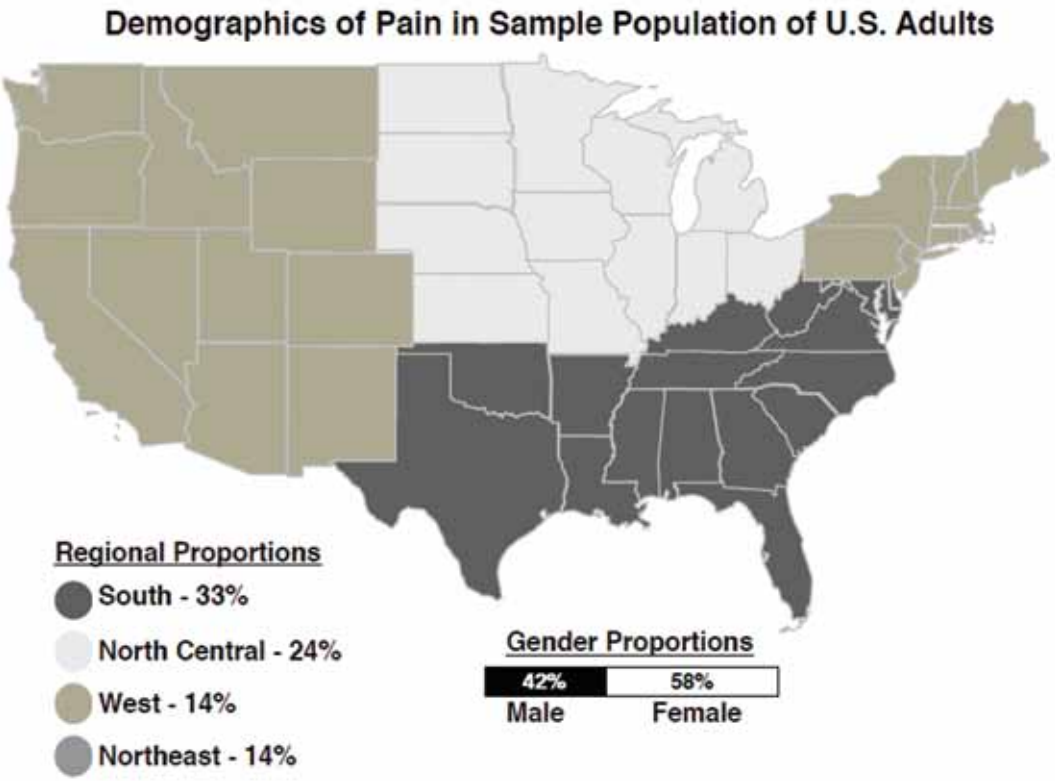

Fig. 3. *Demographic of pain in sample population of US adults.*

less predictive of pain diagnosis than some of the other covariates. Subgroup variation for gender, insurance, and region are provided below and shown in Table 2.

Gender Differences

We found 58% of all pain patients were women (Fig. 3). Women were more likely to have complex regional pain syndrome (OR 1.35, 95% CI [1.33, 1.37]; $P < 0.001$) and limb pain (OR 1.29, 95% CI [1.28, 1.29]; $P < 0.001$) compared with men. Women were also slightly more likely to have back pain compared with men (OR 1.11, 95% CI [1.10, 1.11]; $P < 0.001$), but were less likely to have degenerative spine disease (OR 0.85, 95% CI [0.84, 0.85]; $P < 0.001$) and post-laminectomy syndrome (OR 0.90, 95% CI [0.90, 0.90]; $P < 0.001$).

Regional Differences

All pain diagnoses in the sample population distributed by region: 14% west, 14% northeast, 24% north central, and 33% south (Fig. 3). Medicaid patients (12.6%) did not have regional information and data was unknown in an additional 1.8% of instances. Notable differences in the geographic distribution of pain diagnoses was found. Compared to the northeast, the odds of having chronic pain were higher in the south and west regions (ORs 1.21, 1.61; $P < 0.001$). Back pain, a group with the highest prevalence in our patient cohort, was found most notably in the west and south (ORs 1.19, 1.17; $P < 0.001$). Degenerative spine disease, the second largest group in our patient cohort, was distributed most strongly in the south, and least in the north central (ORs 1.16, 0.93; $P < 0.001$).

Employment and Insurance Differences

Pain diagnoses differed among insurance types (Fig. 4). Using the multivariate model, all comparisons were made against patients who were active full time unless otherwise specified. The odds of having complex regional pain syndrome were higher in patients with long-term disability, COBRA insurance, and Medicare

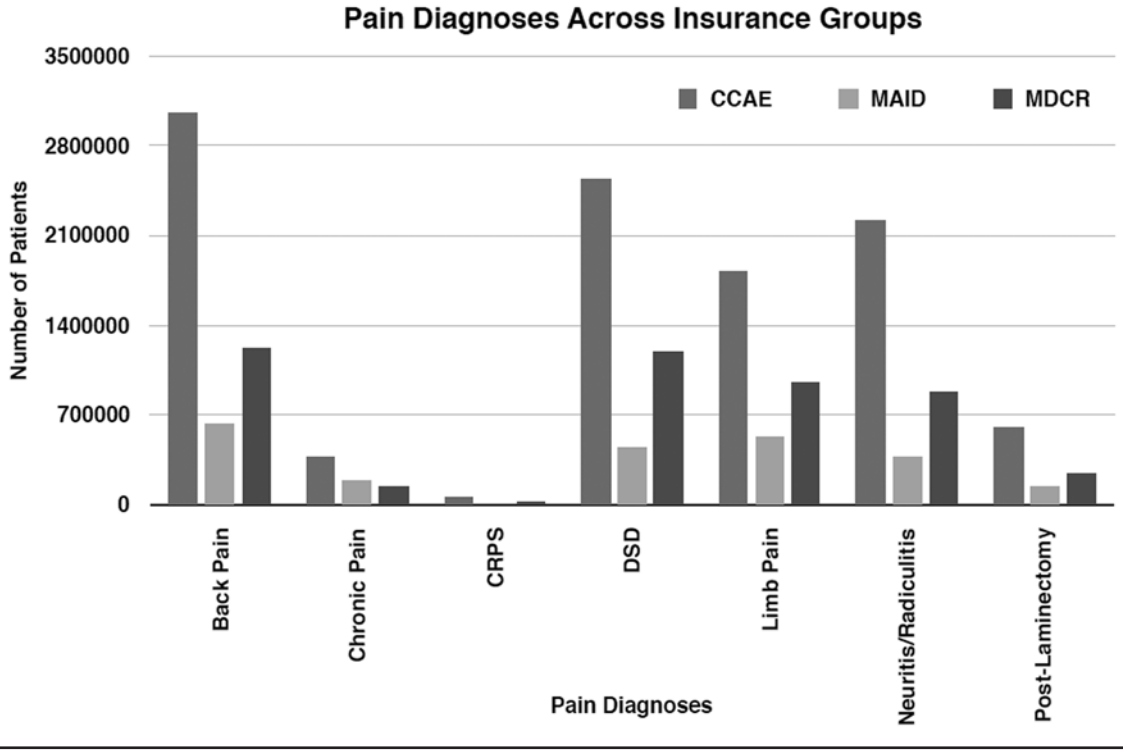

Fig. 4. *Pain diagnoses across insurance groups.*

eligible retiree patients (ORs 2.10, 1.59, 1.29 respectively; $P < 0.001$). Patients with Medicare were less likely to have complex regional pain syndrome, degenerative spine disease, and neuritis/radiculitis compared with patients with commercial insurance (ORs 0.88, 0.80, 0.72; $P < 0.001$). The odds of having limb pain were higher in Medicaid and retiree patients (ORs 1.84, 1.25; $P < 0.001$). The odds of having degenerative spine disease and neuritis/radiculitis were lower in Medicaid patients (ORs 0.51, 0.47; $P < 0.0001$). The odds of having back pain were slightly higher in surviving spouse/dependent (OR 1.16; $P < 0.001$) and the odds of having chronic pain were higher in Medicaid and long term disability patients (ORs 4.39, 1.83; $P < 0.001$).

Discussion

Chronic pain places a large burden on patients, providers, and the US health care system (2,29-32). Some experts suggest that pain, in and of itself, should constitute a disease state (31,32). The American Pain Society proposed "pain as the 5th vital sign" to elevate awareness of pain treatment among health care professionals, but evidence shows pain management has not improved in response to this initiative (27,33,34). Classifying pain becomes difficult when codes encourage specificity, but lack individuality. Based on diagnostic taxonomy, patients often have multiple overlapping diagnoses representing one issue, and others have multiple issues encompassed by one diagnosis (35). The importance of studying the differences of pain diagnoses is underscored by research that frequently compares pain diagnoses. In reality, various diagnoses of pain often significantly differ from a clinical perspective. Because of these important differences, pain diagnoses should not necessarily be considered as comparable as they have been, as this might introduce unaccounted for variation and confounding factors in the samples.

Accurately reflecting the complexity of pain proves challenging to the ICD system, however, it is important to make use of this coding in studies to make improvements to how these pain patients are treated clinically (26,35,36). The recent implementation of ICD-10 may allow more detailed pain diagnosis (36,37). Changes have underscored the importance of acknowledging

the large prevalence and wide heterogeneity of pain in the US population. However, the pain community is already calling on ICD-11 to further improve upon the classification of pain and account for nuances in pain diagnosis (28,36,38,39). Treede et al (28) has proposed 7 distinct classifications for the subset of chronic pain alone, suggesting that chronic primary pain be considered distinct from specific regional or etiologies of chronic pain.

In the present study, we show pain diagnoses in order of most to least prevalent: back pain (74.7%), degenerative spine disease (63.6%), neuritis/radiculitis (52.8%), limb pain (50.0%), post-laminectomy syndrome (14.8%), chronic pain (10.4%), and complex regional pain syndrome (1.2%). We believe this aligns with clinical experience, but more importantly, the results from this MarketScan subset align with proportions previously found in the literature. The National Health Interview Survey found that approximately 19% of adults in the US reported persistent pain in 2010 (5), which decreased to an estimated 11.2% of adults who experience daily chronic pain in 2012 (17). In a recent epidemiology meta-analysis, Henschke et al (30) reported chronic pain prevalence ranging from 10.6% to 13.5% and back pain ranging from 51% to 84%, findings that were largely supported by our prevalence percentages at 10.4% and 74.7% respectively.

Of importance, there is a marked increase in prevalence across all pain diagnoses between 2009 and 2010. Prior to 2010, disease prevalence across all diagnoses demonstrated a gradual, relatively stable incremental annual increase, with an average 3.3% prevalence increase across diagnoses from 2000 to 2009. However, between 2009 and 2010, there was an average 3-fold increase across all pain diagnoses, with the greatest increase in prevalence of complex regional pain syndrome (3.4-fold increase), neuritis/radiculitis (3.5-fold increase), and chronic pain (4.4-fold increase).

This trend reversed in the following year, with an average 33.1% decrease in prevalence across all pain diagnoses. Again, the most drastic change was seen in the chronic pain diagnosis, with a 53.2% decrease between 2010 and 2011. By 2012, disease prevalence across all diagnoses—except complex regional pain syndrome—normalized to approximate pre-2010 percentages. Henschke et al (30) reported findings of low back pain significantly increasing over time from 3.9% in 1992 to 10.2% in 2006.

These trends pose interesting questions regarding accurately diagnosing pain conditions in clinical practice. There are several possibilities that could account for this increase in disease prevalence: 1) a marked increase in disease awareness, 2) changes in coding standards vis-à-vis billing practices, 3) broad scale changes in patient health insurance policies, and 4) increased coding of multiple diagnoses for each patient. The Patient Protection and Affordable Care Act, introduced to lower the uninsured rate and expand both public and private insurance coverage, was signed into law on March 2010. It would be reasonable to posit that the increased coverage of previously uninsured populations and the expanded coverage for patients under existing policies led to an immediate increase in patient visits for pain-related diagnoses, and a subsequent rebound decline after initial implementation. It can be hypothesized that the 4-fold increase in chronic pain prevalence from 2009 to 2010, much more so than other diagnoses, is partially explained by a shift in insurance coding practices to include both a general and specific pain diagnosis at index.

It is worth discussing patients that carry multiple diagnoses. While categories classify pain patients in a clinically representative way, it is clear that there is either repeated coding and/or a fairly common occurrence of one patient developing more than one pain problem. Our results show an average of 2.68 (SD 1.34) of these 7 umbrella diagnoses per individual patient. While this study cannot delineate whether these are the same issues that were coded multiple times or distinct pain issues, it sheds light on the high prevalence of pain at both an individual and population level. This further underscores the importance of proper coding and placing research efforts on investigating pain as a unique chronic "disease" whose incidence is potentially higher than most chronic conditions based on the ability to develop separate, but similar disease diagnoses throughout one's life. Interestingly, certain groups had a greater proportion of multiple diagnoses. These included patients with chronic pain, complex regional pain syndrome, and post-laminectomy syndrome. As one significant example of this trend, 9.6% of patients with complex regional pain syndrome had a co-diagnosis with all 6 pain groups (overall group average for 7 diagnoses was 0.1%). This trend may suggest an existing lack of understanding or consistent diagnostic guidelines on some of the pain diagnoses, and underscores the importance of further research and education on the topic.

Multiple diagnoses can result from unawareness of certain conditions, which presents an opportunity

to educate the patient and the provider. The increased prevalence of complex regional pain syndrome and neuritis/radiculitis in later years may have resulted from increased disease awareness and improved recognition of more specific pain diagnoses. The explanation for the increase in chronic pain diagnosis might best be explained by redundancy in coding where a chronic pain umbrella diagnosis serves as a placeholder until a more specific diagnosis can be made, or is made by a different provider. However, in an analysis of the controversial decision of the FDA to approve Zohydro™, Manchikanti et al (40) illustrated that the FDA approval was due to the misinterpretation of the prevalence of chronic severe disabling pain, where the decision was based on the Institute of Medicine prevalence report of 100 million, a number the authors found at the time was actually only 22.6 million individuals. Furthermore, the authors demonstrated a soaring increase in opioid prescriptions, with the US consuming greater than 84% of the global oxycodone and 99% of the hydrocodone supply. Therefore, the increasing use of opioid analgesics may contribute to the increasing prevalence of pain conditions, possibly due to addiction and misuse of opioids.

Further, multiple pain diagnoses in one person have been associated with comorbid psychiatric diagnoses. The tendency to apply additional diagnoses when a single, inclusive diagnosis is more appropriate has implications for proper access to mental health resources that might treat the multiple pains better than the traditional methods of treating somatic pain (41). As this study highlights, identifying redundant pain diagnoses and trends in redundancy can help providers to hone in on the underlying issue to ensure precision of future ICD iterations and to address chronic pain as holistically as possible.

Our study also supports pain as a diagnosis that most greatly impacts middle age adults with an age at first diagnosis, consistent across all diagnoses, of approximately 55 years. We show that complex regional pain syndrome might be considered a disease of younger patients with a mean of 51 years, which corroborates clinical findings. Our findings also support previous literature that shows pain to be more common in women (57.9% vs. 42.1%), but suggests specific pain diagnoses driving this difference, specifically complex regional pain syndrome, limb pain, and back pain (22,23,42) as opposed to all instances of pain.

Variations in employment, medical insurance, and geographic distribution of pain diagnoses were also found in our study. More notably, patient populations diagnosed with chronic pain were least likely to be actively employed and most likely to carry Medicaid insurance, compared to other diagnoses. Interestingly, Medicare requires the coding of both a primary and secondary pain diagnosis for the approval of spinal cord stimulation, a procedure performed frequently for refractory pain (43). This practice of dual-coding for procedural approval might explain some of the redundancy in coding, as well as some of the differences seen in multiple pain diagnoses based on insurance. Regionally, the south had an overall higher likelihood of pain diagnoses. Other variations included the western region leading in all pain diagnoses except limb pain compared to the northeast. While some of this can potentially be attributed to the relative concentration of pain specialists or pain care centers located in the United States, one would expect that this regional trend be observed across all pain diagnoses.

While there have been several studies in the literature that have examined prevalence of pain, our study is the first to consider pain subtypes in a longitudinal manner, using a large national database cohort. The Truven MarketScan Commercial and Medicare Supplemental database is frequently used to perform cost and outcomes analysis. As a large database, individuality can be lost and as the database expands, it will be increasingly important to appropriately consider subgroups of the database. Despite the statistical power that comes with analyzing large sample sizes and the ability to track longitudinal trends, there are several limitations. Limitations to our analysis include that this study is retrospective and non-randomized, with a patient cohort that is weighted towards recent years and towards patients with commercial insurance. We attempted to address this through a multivariate analysis and adjustment of our data for patient and hospital-related factors. Similarly, other factors that may add to the breadth of discussion, such as changes to numerical pain scores, pain intensity, or quality and impact on quality of life, could not be analyzed in the dataset available for this large patient cohort. However, by determining which diagnoses carry the highest prevalence in the population, it will allow future analyses to focus on the more prevalent chronic pain diagnoses and make more specific and clinically relevant conclusions.

Despite aforementioned limitations, our study identifies a useful trend in provider practice that directly impacts patient outcomes by recognizing the prevalence of specific and overlapping pain diagnoses in the

US over a 13-year longitudinal period. Future studies will be required to understand the practice variations that make this possible, and to consider the effect of various interventions for specific pain diagnoses on health care utilization.

Conclusions

The similarities and differences found between the leading pain subgroups highlight that specific pain diagnoses should be considered separate, but related, entities. This study not only helps us to better understand the modern-day prevalence of pain diagnoses over a 13-year period, but also allows future studies to appropriately focus on specific pain diagnoses based on prevalence and demographic characteristics. Such analyses will increase our understanding of pain diagnoses, beyond the commonly examined chronic pain and back pain, and prevent over-generalization in studies examining pain patients to more accurately reflect the varied pain subtypes and their economic impact.

Supplementary Table 1. *ICD 9 codes for pain diagnosis*.

Pain Diagnosis	ICD-9 Codes
Post-laminectomy Syndrome	722.80, 722.81, 722.82, 722.83, V45.89
CRPS	337.20, 337.21, 337.22, 337.29, 354.4, 355.71
Neuritis/Radiculitis	354.8, 354.9, 355.79, 355.8, 355.9, 356.9, 720.2, 723.4, 724.3, 724.4, 729.2, 953.1, 953.2
Limb Pain	729.5
Degenerative Spine Disease	721.0, 721.3, 721.41, 721.42, 722.0, 722.10, 722.4, 722.51, 722.52, 722.6, 722.73, 722.93, 724.00, 724.01, 724.02, 737.30, 738.4
Back Pain	723.1, 724.1, 724.2, 724.5
Chronic Pain	338.0, 338.21, 338.28, 338.29, 338.4

References

1. Freburger JK, Holmes GM, Agans RP, Jackman AM, Darter JD, Wallace AS, Castel LD, Kalsbeek WD, Carey TS. The rising prevalence of chronic low back pain. *Archives of Internal Medicine* 2009; 169:251-258.
2. Gaskin DJ, Richard P. The economic costs of pain in the United States. *The Journal of Pain* 2012; 13:715-724.
3. Hardt J, Jacobsen C, Goldberg J, Nickel R, Buchwald D. Prevalence of chronic pain in a representative sample in the United States. *Pain Medicine (Malden, Mass)* 2008; 9:803-812.
4. Simon LS. Relieving pain in America: A blueprint for transforming prevention, care, education, and research. *Journal of Pain & Palliative Care Pharmacotherapy* 2012; 26:197-198.
5. Kennedy J, Roll JM, Schraudner T, Murphy S, McPherson S. Prevalence of persistent pain in the U.S. adult population: New data from the 2010 national health interview survey. *The Journal of Pain* 2014; 15:979-984.
6. Califf RM, Woodcock J, Ostroff S. A proactive response to prescription opioid abuse. *N Eng J Med* 2016; 374:1480-1485.
7. Fishman SM, Young HM, Lucas Arwood E, Chou R, Herr K, Murinson BB, Watt-Watson J, Carr DB, Gordon DB, Stevens BJ, Bakerjian D, Ballantyne JC, Courtenay M, Djukic M, Koebner IJ, Mongoven JM, Paice JA, Prasad R, Singh N, Sluka KA, St Marie B, Strassels SA. Core competencies for pain management: Results of an interprofessional consensus summit. *Pain Medicine (Malden, Mass)* 2013; 14:971-981.
8. Lippe PM, Brock C, David J, Crossno R, Gitlow S. The First National Pain Medicine Summit – final summary report. *Pain Medicine (Malden, Mass)* 2010; 11:1447-1468.
9. Andersson GB. Epidemiological features of chronic low-back pain. *Lancet (London, England)* 1999; 354:581-585.
10. Bicket MC, Mao J. Chronic pain in older adults. *Anesthesiology Clinics* 2015; 33:577-590.
11. Bulls HW, Freeman EL, Anderson AJ, Robbins MT, Ness TJ, Goodin BR. Sex differences in experimental measures of pain sensitivity and endogenous pain inhibition. *Journal of Pain Research* 2015; 8:311-320.
12. Gallagher RM, Verma S, Mossey J. Chronic pain. Sources of late-life pain and risk factors for disability. *Geriatrics* 2000; 55:40-44, 47.
13. Jackson T, Thomas S, Stabile V, Han X, Shotwell M, McQueen K. Prevalence of chronic pain in low-income and middle-income countries: A systematic review and meta-analysis. *Lancet (London, England)* 2015; 385:S10.
14. Lamerato LE, Dryer RD, Wolff GG, Hegeman-Dingle R, Mardekian J, Park PW, Zlateva G. Prevalence of chronic pain in a large integrated healthcare delivery system in the U.S.A. *Pain Practice* 2015; doi: 10.1111/papr.12334 [Epub ahead of print].
15. Manchikanti L, Singh V, Datta S, Co-

hen SP, Hirsch JA. Comprehensive review of epidemiology, scope, and impact of spinal pain. *Pain Physician* 2009; 12:E35-E70.

16. Mansfield KE, Sim J, Jordan JL, Jordan KP. A systematic review and meta-analysis of the prevalence of chronic widespread pain in the general population. *Pain* 2015; 157:55-64.
17. Nahin RL. Estimates of pain prevalence and severity in adults: United States, 2012. *The Journal of Pain* 2015; 16:769-780.
18. Rustoen T, Wahl AK, Hanestad BR, Lerdal A, Paul S, Miaskowski C. Age and the experience of chronic pain: Differences in health and quality of life among younger, middle-aged, and older adults. *The Clinical Journal of Pain* 2005; 21:513-523.
19. Sansone P, Pace MC, Passavanti MB, Pota V, Colella U, Aurilio C. Epidemiology and incidence of acute and chronic post-surgical pain. *Annali Italiani di Chirurgia* 2015; 86:285-292.
20. Curatolo M, Muller M, Ashraf A, Neziri AY, Streitberger K, Andersen OK, Arendt-Nielsen L. Pain hypersensitivity and spinaln hypersensitivity in chronic pain: Prevalence and associated factors. *Pain* 2015; 156:2373-2382.
21. Inoue S, Kobayashi F, Nishihara M, Arai YC, Ikemoto T, Kawai T, Inoue M, Hasegawa T, Ushida T. Chronic pain in the Japanese community – prevalence, characteristics and impact on quality of life. *PloS one* 2015; 10:e0129262.
22. Fillingim RB, King CD, Ribeiro-Dasilva MC, Rahim-Williams B, Riley JL. Sex, gender, and pain: A review of recent clinical and experimental findings. *The Journal of Pain* 2009; 10:447-485.
23. Tsang A, Von Korff M, Lee S, Alonso J, Karam E, Angermeyer MC, Borges GLG, Bromet EJ, De Girolamo G, De Graaf R. Common chronic pain conditions in developed and developing countries: Gender and age differences and comorbidity with depression-anxiety disorders. *The Journal of Pain* 2008; 9:883-891.
24. Mossey JM. Defining racial and ethnic disparities in pain management. *Clinical Orthopaedics and Related Research* 2011; 469:1859-1870.
25. Chang SC, Ma CC, Lee CT, Hsieh SW. Pharmacoepidemiology of chronic noncancer pain patients requiring chronic opioid therapy: A nationwide population-based study. *Acta Anaesthesiologica Taiwanica* 2015; 53:89-94.
26. McCarthy EP, Iezzoni LI, Davis RB, Palmer RH, Cahalane M, Hamel MB, Mukamal K, Phillips RS, Davies Jr DT. Does clinical evidence support ICD-9-CM diagnosis coding of complications? *Medical Care* 2000; 38:868-876.
27. Mularski RA, White- Chu F, Overbay D, Miller L, Asch SM, Ganzini L. Measuring pain as the 5th vital sign does not improve quality of pain management. *Journal of General Internal Medicine* 2006; 21:607-612.
28. Treede R-D, Rief W, Barke A, Aziz Q, Bennett MI, Benoliel R, Cohen M, Evers S, Finnerup NB, First MB. A classification of chronic pain for ICD-11. *Pain* 2015; 156:1003.
29. Gureje O, Von Korff M, Simon GE, Gater R. Persistent pain and well-being: A World Health Organization study in primary care. *JAMA* 1998; 280:147-151.
30. Henschke N, Kamper SJ, Maher CG. The epidemiology and economic consequences of pain. *Mayo Clinic Oroceedings* 2015; 90:139-147.
31. Smith BH, Elliott AM, Chambers WA, Smith WC, Hannaford PC, Penny K. The impact of chronic pain in the community. *Family Practice* 2001; 18:292-299.
32. Taylor AM, Phillips K, Taylor JO, Singh JA, Conaghan PG, Choy EH, Tugwell PS, Kaiser U, Strand V, Simon LS, Mease PJ. Is chronic pain a disease in its own right? Discussions from a Pre-OMERACT 2014 workshop on chronic pain. *The Journal of Rheumatology* 2015; 42:1947-1953.
33. Campbell J. Pain: The fifth vital sign. Presidential Address, American Pain Society. Los Angeles, CA, November 11, 1995.
34. Walid MS, Donahue SN, Darmohray DM, Hyer Jr LA, Robinson Jr JS. The fifth vital sign—what does it mean? *Pain Practice* 2008; 8:417-422.
35. Fillingim RB, Bruehl S, Dworkin RH, Dworkin SF, Loeser JD, Turk DC, Widerstrom-Noga E, Arnold L, Bennett R, Edwards RR. The ACTTION-American Pain Society Pain Taxonomy (AAPT): An evidence-based and multidimensional approach to classifying chronic pain conditions. *The Journal of Pain* 2014; 15:241-249.
36. Manchikanti L, Falco FJ, Hirsch JA. Necessity and implications of ICD-10: Facts and fallacies. *Pain Physician* 2011; 14:E405-E425.
37. Manchikanti L, Falco FJ, Hirsch JA. Ready or not! Here comes ICD-10. *Journal of Neurointerventional Surgery* 2013; 5:86-91.
38. Manchikanti L, Falco F, Kaye AD, Hirsch JA. The disastrous but preventable consequences of ICD-10. *Pain Physician* 2014; 17:E111.
39. Rief W, Kaasa S, Jensen R, Perrot S, Vlaeyen JW, Treede R-D, Vissers K. The need to revise pain diagnoses in ICD-11. *Pain* 2010; 149:169-170.
40. Manchikanti L, Atluri S, Candido KD, Boswell MV, Simopoulos TT, Grider JS, Falco FJE, Hirsch JA. Zohydro™ approval by food and drug administration: Controversial or frightening? *Pain Physician* 2014; 17:E437-E450.
41. Gureje O, Von Korff M, Kola L, Demyttenaere K, He Y, Posada-Villa J, Lepine JP, Angermeyer MC, Levinson D, De Girolamo G. The relation between multiple pains and mental disorders: Results from the World Mental Health Surveys. *Pain* 2008; 135:82-91.
42. Sandroni P, Benrud-Larson LM, McClelland RL, Low PA. Complex regional pain syndrome type I: Incidence and prevalence in Olmsted county, a population-based study. *Pain* 2003; 103:199-207.
43. Pope JE, Falowski SM. Coding and reimbursement for spinal cord stimulation. In: Pope JE, Falowski SM (eds). *Integrating Pain Treatment into Your Spine Practice*. Springer, Switzerland, 2016, pp 89-96.