Pain Medicine

Pain Medicine 2012; 13: 498–506
Wiley Periodicals, Inc.

SPINE SECTION

Original Research Article

Multivariable Analyses of the Relationships Between Age, Gender, and Body Mass Index and the Source of Chronic Low Back Pain

Michael J. DePalma, MD,* Jessica M. Ketchum, PhD,† and Thomas R. Saullo, MD‡

*Virginia Spine Research Institute, Inc, and Virginia iSpine Physicians, PC, Richmond, Virginia;

†Department of Biostatistics, Virginia Commonwealth University, Richmond, Virginia;

‡Spine and Scoliosis Specialists, Greensboro, North Carolina, USA

Reprint requests to: Michael J. DePalma, MD, Virginia Spine Research Institute, Inc, 9020 Stony Point Parkway, Suite 140, Richmond, VA 23235, USA. Tel: 804-330-0303; Fax: 804-327-1677; E-mail: depalmamj8@yahoo.com.

Co-investigator on clinical trials for Mesoblast, St. Jude Medical, Spinal Restoration; monies were paid directly to institution.

Abstract

Objective. To examine the combined relationships between age, gender, and body mass index (BMI) and the specific source of chronic low back pain.

Design. Retrospective chart review.

Setting. University spine center.

Patients. Charts from 378 cases from 358 consecutive patients were reviewed and 157 independent cases from 153 patients who underwent definitive diagnostic injections were analyzed.

Interventions. Discography, dual diagnostic facet joint blocks, sacroiliac joint injections, anesthetic interspinous ligaments/opposing spinous processes/posterior fusion hardware injections, percutaneous augmentation.

Outcome Measures. Chronic low back pain source was the primary outcome variable. Predictor variables included age at initial presentation, gender, and BMI.

Results. Age, gender, and BMI were each significantly associated with the source of chronic low back pain, after controlling for the effects of each other. Increases in age were associated with significant decreases in the odds of internal disc disruption (IDD) vs facet joint pain (FJP), sacroiliac joint pain (SIJP), and other sources and decreases in the odds of FJP and SIJP vs other sources. Being female was associated with significant increases in the odds of SIJP vs IDD, FJP, and other sources. Increased BMI was associated with significant increases in the odds of FJP vs SIJP.

Conclusions. These findings suggest a significant relationship among gender, age, and BMI and structural causes of chronic low back pain. Lumbar IDD is more prevalent in young males while FJP is more prevalent in females with increased BMI. Female gender and low BMI are associated with SIJP.

Key Words. Low Back Pain; Chronic Pain; Disparities-Gender; Facet Joint; Intervertebral Disc; Interventional; Lumbar; Sacroiliac Joint; Zygoapophyseal Joint; Body Mass Index

Introduction

Internal disc disruption (IDD) is the most common source of chronic low back pain (CLBP) followed by facet joint pain (FJP) and sacroiliac joint pain (SIJP) [1–4]. Schwarzer's initial prevalence estimate for lumbar IDD (39%) was reported from a CLBP group comprised of 61% male subjects [2]. Female gender has been shown to correlate with SIJP by some investigators [5,6] but not others [3,7]. Similarly, FJP has been suggested to occur more frequently in female CLBP subjects [4], yet FJP has also been documented in young, male adult CLBP patients [8]. Gender has been shown to not influence CLBP patient's report of exact or similar LBP during discography [2].

Age has previously been shown to correlate with the source of CLBP in adult subjects [1]. IDD tends to occur more routinely in younger CLBP patients while prevalence

of FJP and SIJP increases with age [1,4,9]. Controlling for the effect of age would allow more definitive assessment of gender on sources of CLBP and vice versa. However, such a study has yet to be published.

Body mass index (BMI) has been shown to correspond in a dose-dependent manner with disc degeneration [10]. Samartzsis et al. performed a cross-sectional analysis of 2,252 Chinese citizens and reported a positive relationship between BMI and disc degeneration (DD). BMI was shown to be positively associated with DD severity, number of DD levels, and herniation score after adjusting for subject age and workload [10]. Although this is the largest population-based study to systematically assess lumbar DD and BMI, the relationship between BMI and the specific structural source of CLBP has yet to be explored. Irwin et al. found no association between proven SIJP and BMI [9]. Yet, Heuch et al. observed increasing prevalence of nonspecific CLBP in individuals with high BMI regardless of gender [11].

The purpose of the present study was to explore the effects of age, gender, and BMI on the specific source of CLBP, collectively, in order to assess for a link between a combination of these variables and the structural etiology of CLBP. Because each of these variables may either mediate or moderate the relationship between the other variables and CLBP, a multivariable model that considers these variables in conjunction with each other may better illuminate the effects they have on the specific source of the patient's CLBP.

Methods

Participants

After Institutional Review Board approval, 378 consecutive charts from 358 CLBP patients presenting between November 2007 and December 2008 were reviewed. Patients were evaluated at a community-based academic interventional spine care practice after being referred by community and university physicians from many subspecialties. Enrolled cases were patients with CLBP unresponsive to physical therapy, analgesics, and/or anti-inflammatory medications.

Eighteen patients presented with more than one case during the period the charts were reviewed; 16 patients with two cases and two patients with three cases, for a total of 38 cases. Seven of the 18 patients presented with multiple cases at the same point in time (six with two cases and one with three cases) and the remaining 11 presented at different points in time (10 with two cases and one with three). The seven cases with multiple cases at the same point in time were excluded as these sources could not be reasonably considered to be independent events. Of the remaining 363 cases from 351 patients, 157 cases underwent diagnostic injections and 206 did not due to clinical improvement in their symptoms. These patients were excluded from the analysis. Thus, the sample used for analysis consists of 157 cases from 153 patients who underwent definitive diagnostic spinal injections to identify the source of their CLBP in order to implement more definitive treatment.

Measures

To determine the source of CLBP, each patient underwent provocation lumbar discography, dual diagnostic medial branch blocks with local comparative anesthetics, intra-articular diagnostic SIJ injections (SIJB), injection of anesthetic into putatively painful interspinous ligaments/opposing spinous processes/posterior fusion hardware, or percutaneous augmentation depending on the clinical presentation [1]. Some subjects underwent multiple diagnostic injections until the source of their LBP was identified. If the initial diagnostic injection was negative, the next most likely structure in the diagnostic algorithm was interrogated. However, once a source of the subject's LBP was identified, subsequent diagnostic injections were not performed. This interventional spine care diagnostic algorithm was consistently applied to all consecutive CLBP patients evaluated by the lead author and has previously been published [1].

Positive discography was defined as concordant/partial concordant LBP (>6/10) at low pressure (<50 psi over opening pressure) due to ≥Grade III annular tears [12–14]. Diagnostic blockade of FJ, SIJ, or other structures was deemed positive if the patient's index pain was relieved by ≥75% after injection of each anesthetic [15–17]. In the case of fusion hardware blockade, minimal relief (<75%) after the placebo injection was required to constitute a positive block. Insufficiency fractures were deemed the source of LBP if the patient's clinical symptoms were significantly reduced after percutaneous augmentation [18–23].

Based on the results of diagnostic injections or LBP reduction after percutaneous augmentation, subjects were classified as having IDD, FJP, SIJP, or other sources of LBP (fusion hardware mediated soft tissue pain, Baastrup's disease, or vertebral or sacral insufficiency fractures). The classification of this source of CLBP was the primary outcome variable of interest in this study. The predictor variables considered for this analysis were available from the patient's charts and include age at initial presentation, gender, height, and weight. BMI was calculated from the height and weight measurements.

Statistical Analyses

Initially, the prevalence of each source was estimated in this population by computing the proportion of patients with each diagnosed source presenting with CLBP out of all diagnosed patients. The mean age, proportion of males/females, and mean BMI for each of the diagnostic groups were estimated and compared statistically between the IDD, FJP, SIJP, and other source groups using analysis of variance and chi-square tests.

Table 1 Prevalence of source of chronic low back pain

	Count	Prevalence	95% CI
Intervertebral disc (IDD)	68	43.3	(35.8, 51.1)
Lumbar facet joint(s) (FJP)	49	31.2	(24.5, 38.8)
Sacroiliac joint(s) (SIJP)	28	17.8	(12.6, 24.6)
Other	12	7.6	(4.4, 12.9)
Pelvic insufficiency fracture	2	1.3	(0.4, 4.5)
Vertebral insufficiency fracture	4	2.5	(1.0, 6.4)
Interspinous ligament pain	2	1.3	(0.4, 4.5)
Other posterior element	4	2.5	(1.0, 6.4)

CI = confidence interval.

Next, the bivariate relationship between each of the predictors (age, gender, and BMI) and the probability of the sources of CLBP (IDD, FJP, SIJP, or other) was estimated with multinomial logistic regression analyses assuming a generalized logit link function. The three predictor variables were then simultaneously modeled with a single multinomial logistic regression model to explore the adjusted relationship between the predictors and the source of CLBP. Pairwise interaction effects among the three variables were tested to determine if the effect of one predictor on the source of CLBP depends on (i.e., is modified by) another predictor. Odds ratios and 95% confidence intervals (CIs) were used to describe the relationship between the predictor variables and the source of CLBP. The significance level for all tests was 5%. SAS v.9.2 (Copyright © 2002–2008 by SAS Institute Inc., Cary, NC, USA) was used for all data analyses and Microsoft ® Office Excel ® 2007 was used for all graphics.

Results

Cases of CLBP were primarily female (67%), presented at an average age of 54 years (standard deviation [SD] = 16.1), and had a median duration of LBP of 12 months (interquartile range [IQR] = 6 to 36). The estimated prevalence of each source of CLBP in this population is summarized in Table 1.

Patient characteristics are summarized by source of LBP in Table 2. The mean age was significantly different among the source groups (F [3, 153] = 27.5, $P < 0.001$). IDD cases were significantly younger than FJP, SIJP, and other source groups, and FJP cases were significantly younger than other sources. Mean age was not significantly different between FJP and SIJP, or between SIJP and other sources. The percent of female cases was significantly different among the source groups ($\chi^2 = 12.7$, df = 3, $P = 0.005$). SIJP cases had significantly greater percentages of females than IDD or other cases of CLBP. The percent female was not significantly different between FJP and SIJP, or between other and IDD, FJP, or SIJP sources. The mean BMI was significantly different among the source groups (F [3, 151] = 4.9, $P = 0.003$). FJP cases had significantly higher BMI than SIJP cases. There were not significant differences in mean BMI between IDD and FJP, SIJP, or other sources, or between other sources and IDD or SIJP.

The probability of the sources of CLBP was modeled as a function of each predictor variable, without adjusting for other characteristics. Each predictor was significantly associated with the source of CLBP: age ($P < 0.001$), gender ($P = 0.005$), and BMI ($P = 0.001$). A multivariable generalized logistic regression model indicated that age (chi-square = 37.5, df = 3, $P < 0.001$), gender (chi-square = 10.8, df = 3, $P = 0.013$), and BMI (chi-square = 9.5, df = 3, $P = 0.024$) were each associated with the source of CLBP, after controlling for the effects of each other. There was no evidence of significant pairwise interaction effects between age and gender ($P = 0.73$), age and BMI ($P = 0.40$), or gender and BMI ($P = 0.29$).

The unadjusted and adjusted odds ratios comparing the sources for a 5-year increase in age, for females vs males, and for a 5 kg/m^2 increase in BMI are summarized in Table 3. Increases in age were associated with significant decreases in the adjusted odds of IDD vs FJP, SIJP, and other sources and decreases in the adjusted odds of FJP and SIJP vs other sources, after controlling for gender and BMI. Being female was associated with significant

Table 2 Patient characteristic by source of low back pain

	Overall	IDD	FJP	SIJP	Other
Female, count (percent)	103 (65.6)	38 (55.9)	34 (69.4)	25 (89.3)	6 (50.0)
Age, mean (SD)	54.1 (16.1)	43.7 (10.4)	59.8 (12.8)	62.3 (17.5)	70.8 (16.4)
Duration, median (IQR)	12 (6 to 36)	12 (6 to 33)	17 (7 to 36)	12 (3 to 60)	10.5 (2 to 33)
Height, mean (SD)	66.5 (4.5)	68.1 (3.8)	65.2 (4.4)	64.6 (3.6)	68.2 (6.6)
Weight, mean (SD)	194.9 (48.5)	206.3 (47.5)	199.3 (47.2)	161.2 (38.5)	188.6 (49.3)
BMI, mean (SD)	31.0 (7.7)	31.4 (7.2)	33.4 (8.9)	27.0 (5.8)	28.1 (4.2)

FJP = facet joint pain; IDD = intervertebral disc; IQR = interquartile range; SD = standard deviation; SIJP = sacroiliac joint pain.

Table 3 Unadjusted and adjusted odds ratios

	Unadjusted		Adjusted	
	Odds Ratio	95% CI	Odds Ratio	95% CI
Age, 5-year increase				
IDD vs FJA	0.908	(0.876, 0.942)	0.592	(0.488, 0.718)
IDD vs SIJ	0.897	(0.860, 0.935)	0.604	(0.488, 0.746)
IDD vs other	0.465	(0.350, 0.618)	0.437	(0.317, 0.603)
FJA vs SIJ	0.987	(0.955, 1.020)	1.020	(0.855, 1.216)
FJA vs other	0.752	(0.589, 0.959)	0.739	(0.557, 0.980)
SIJ vs other	0.802	(0.621, 1.035)	0.724	(0.538, 0.976)
Gender, female vs male				
IDD vs FJA	0.559	(0.258, 1.211)	0.588	(0.235, 1.474)
IDD vs SIJ	0.152	(0.042, 0.552)	0.133	(0.033, 0.539)
IDD vs other	1.267	(0.371, 4.328)	1.702	(0.358, 8.082)
FJA vs SIJ	0.272	(0.071, 1.042)	0.226	(0.056, 0.908)
FJA vs other	2.267	(0.627, 8.188)	2.895	(0.672, 12.479)
SIJ vs other	8.333	(1.604, 43.288)	12.794	(2.149, 76.162)
BMI, 5-unit increase				
IDD vs FJA	0.852	(0.673, 1.080)	0.813	(0.602, 1.097)
IDD vs SIJ	1.685	(1.138, 2.495)	1.518	(1.004, 2.296)
IDD vs other	1.431	(0.867, 2.360)	1.043	(0.589, 1.847)
FJA vs SIJ	1.977	(1.315, 2.972)	1.867	(1.249, 2.791)
FJA vs other	1.679	(1.007, 2.797)	1.283	(0.746, 2.207)
SIJ vs other	0.849	(0.478, 1.509)	0.687	(0.373, 1.268)

CI = confidence interval; FJP = facet joint pain; SIJP = sacroiliac joint pain; IDD = intervertebral disc; SIJ = sacroiliac joint.

increases in the adjusted odds of SIJP vs IDD, FJP, and other sources, after controlling for age and BMI. Increased BMI was associated with significant increases in the adjusted odds of FJP vs SIJP, after controlling for age and gender. The adjusted predicted probability of each specific source of CLBP and the associated 95% CIs are summarized by age (20, 35, 50, 65, and 80 years) and BMI (18.5, 25, 30, and 35), for males and females in Tables 4 and 5, respectively, and plotted in Figure 1.

Discussion

In summary, all three variables, age, gender, and BMI were significantly associated with the source of CLBP. For young adults (ages 20 or 35 years), IDD was the most likely source of CLBP (70–98%), regardless of gender or BMI. For patients approximately 50 years in age, IDD was the most likely source (40–65%), except for females with low BMI, 18.5 kg/m^2, for whom SIJP was more likely (49%). FJP was the most likely source of CLBP for male patients who were approximately 65 years in age (30–54%), regardless of BMI, whereas for female patients who were 65 years, FJP was most likely (46–57%) when BMI was 30 or 35 kg/m^2 and SIJP was most likely (46–64%) when BMI was 18.5 or 25 kg/m^2. Male patients who were 80 years old had other sources as the most likely source of CLBP (47–53%) when BMI was 18.5, 25, or 30 kg/m^2, and FJP as the most likely source (49%) when BMI was 35 kg/m^2. Female patients who were 80 years old had SIJP as the most likely source (45–62%) when BMI was 18.5 or 25 kg/m^2 and FJP as the most likely source (47–58%) when BMI was 30 or 35 kg/m^2.

These findings suggest that decreased age and being male was associated with an increased probability of lumbar IDD as the source of CLBP for adult patients. FJP was more frequently associated with increased age and increased BMI. Older age, decreased BMI and being female was associated with SIJP. This is the first publication to assess the combined relationship of age, gender, and BMI on the source of CLBP in consecutive patients undergoing definitive diagnostic spinal injections and further research supporting these relationships are warranted.

Irwin et al. previously reported an association between increased age and SIJP but no association between SIJP and gender and no difference in BMI between SIJP and non-SIJP [9]. However, these investigators did not perform a multivariable analysis to control for multiple variables while assessing just one. Furthermore, the CLBP cohort studied by Irwin et al. was described as SIJP or not. So the association of BMI with SIJP and other specific sources (IDD or FJP) could not be examined.

Table 4 Predicted probabilities of sources of CLBP for males by age and BMI

		IDD		FJP		SIJP		Other		Most Likely
Age	BMI	Prob.	95% CI	Prob.	95% CI	Prob.	95% CI	Prob.	95% CI	Source
20	18.5	0.979	(0.948, 1.000)	0.011	(0.000, 0.029)	0.009	(0.000, 0.028)	0.001	(0.000, 0.003)	IDD
	25	0.980	(0.952, 1.000)	0.015	(0.000, 0.036)	0.005	(0.000, 0.016)	0.001	(0.000, 0.002)	IDD
	30	0.978	(0.949, 1.000)	0.018	(0.000, 0.043)	0.003	(0.000, 0.010)	0.001	(0.000, 0.002)	IDD
	35	0.975	(0.942 1.000)	0.022	(0.000, 0.053)	0.002	(0.000, 0.007)	0.001	(0.000, 0.002)	IDD
35	18.5	0.906	(0.806, 1.000)	0.050	(0.000, 0.108)	0.038	(0.000, 0.101)	0.007	(0.000, 0.023)	IDD
	25	0.906	(0.825, 0.988)	0.065	(0.002, 0.128)	0.022	(0.000, 0.055)	0.006	(0.000, 0.019)	IDD
	30	0.900	(0.818, 0.982)	0.080	(0.009, 0.150)	0.015	(0.000, 0.036)	0.006	(0.000, 0.017)	IDD
	35	0.888	(0.795, 0.982)	0.097	(0.012, 0.182)	0.009	(0.000, 0.024)	0.006	(0.000, 0.016)	IDD
50	18.5	0.648	(0.428, 0.867)	0.171	(0.036, 0.307)	0.125	(0.000, 0.281)	0.056	(0.000, 0.150)	IDD
	25	0.649	(0.486, 0.812)	0.225	(0.095, 0.354)	0.073	(0.000, 0.157)	0.053	(0.000, 0.121)	IDD
	30	0.634	(0.484, 0.784)	0.270	(0.138, 0.402)	0.047	(0.000, 0.102)	0.050	(0.000, 0.107)	IDD
	35	0.607	(0.440, 0.774)	0.318	(0.164, 0.472)	0.029	(0.000, 0.068)	0.046	(0.000, 0.103)	IDD
65	18.5	0.239	(0.044, 0.434)	0.305	(0.101, 0.508)	0.209	(0.000, 0.438)	0.248	(0.000, 0.510)	FJP
	25	0.240	(0.085, 0.396)	0.401	(0.218, 0.584)	0.122	(0.000, 0.254)	0.236	(0.053, 0.419)	FJP
	30	0.231	(0.088, 0.374)	0.474	(0.293, 0.655)	0.077	(0.000, 0.167)	0.218	(0.049, 0.386)	FJP
	35	0.215	(0.068, 0.362)	0.543	(0.341, 0.746)	0.047	(0.000, 0.110)	0.194	(0.003, 0.386)	FJP
80	18.5	0.042	(0.000, 0.104)	0.261	(0.014, 0.508)	0.169	(0.000, 0.397)	0.527	(0.153, 0.902)	Other
	25	0.043	(0.000, 0.099)	0.348	(0.086, 0.610)	0.100	(0.000, 0.232)	0.509	(0.000, 0.096)	Other
	30	0.042	(0.000, 0.096)	0.418	(0.117, 0.719)	0.064	(0.000, 0.155)	0.476	(0.131, 0.821)	Other
	35	0.040	(0.000, 0.094)	0.487	(0.118, 0.857)	0.040	(0.000, 0.105)	0.433	(0.026, 0.839)	FJP

CI = confidence interval; FJP = facet joint pain; IDD = intervertebral disc; SIJP = sacroiliac joint pain.

Table 5 Predicted probabilities of sources of CLBP for females by age and BMI

		IDD		FJP		SIJP		Other		Most Likely
Age	BMI	Prob.	95% CI	Prob.	95% CI	Prob.	95% CI	Prob.	95% CI	Source
20	18.5	0.918	(0.800, 1.000)	0.018	(0.000, 0.047)	0.064	(0.000, 0.171)	<0.001	(0.000, 0.002)	IDD
	25	0.938	(0.863, 1.000)	0.024	(0.000, 0.057)	0.038	(0.000, 0.095)	<0.001	(0.000, 0.001)	IDD
	30	0.945	(0.883, 1.000)	0.029	(0.000, 0.068)	0.025	(0.000, 0.062)	<0.001	(0.000, 0.001)	IDD
	35	0.947	(0.887, 1.000)	0.036	(0.000, 0.082)	0.017	(0.000, 0.042)	<0.001	(0.000, 0.001)	IDD
35	18.5	0.707	(0.462, 0.950)	0.066	(0.000, 0.142)	0.225	(0.000, 0.455)	0.003	(0.000, 0.012)	IDD
	25	0.763	(0.609, 0.916)	0.093	(0.009, 0.177)	0.141	(0.017, 0.265)	0.003	(0.000, 0.011)	IDD
	30	0.784	(0.658, 0.910)	0.118	(0.028, 0.208)	0.095	(0.013, 0.178)	0.003	(0.000, 0.010)	IDD
	35	0.788	(0.663, 0.913)	0.146	(0.043, 0.248)	0.063	(0.002, 0.125)	0.003	(0.000, 0.009)	IDD
50	18.5	0.339	(0.115, 0.564)	0.153	(0.023, 0.283)	0.491	(0.235, 0.747)	0.017	(0.000, 0.054)	SIJP
	25	0.404	(0.243, 0.564)	0.238	(0.108, 0.368)	0.339	(0.184, 0.494)	0.019	(0.000, 0.052)	IDD
	30	0.430	(0.295, 0.565)	0.312	(0.187, 0.436)	0.238	(0.125, 0.351)	0.020	(0.000, 0.050)	IDD
	35	0.435	(0.299, 0.571)	0.387	(0.257, 0.518)	0.159	(0.056, 0.261)	0.019	(0.000, 0.048)	IDD
65	18.5	0.097	(0.000, 0.197)	0.210	(0.057, 0.362)	0.635	(0.424, 0.846)	0.059	(0.000, 0.148)	SIJP
	25	0.121	(0.026, 0.217)	0.345	(0.209, 0.481)	0.464	(0.318, 0.610)	0.070	(0.000, 0.144)	SIJP
	30	0.132	(0.039, 0.225)	0.462	(0.333, 0.591)	0.333	(0.209, 0.457)	0.073	(0.006, 0.140)	FJP
	35	0.134	(0.040, 0.228)	0.574	(0.431, 0.717)	0.222	(0.092, 0.352)	0.071	(0.000, 0.144)	FJP
80	18.5	0.021	(0.000, 0.051)	0.215	(0.047, 0.383)	0.615	(0.373, 0.857)	0.150	(0.000, 0.329)	SIJP
	25	0.026	(0.000, 0.059)	0.351	(0.177, 0.525)	0.446	(0.256, 0.636)	0.177	(0.032, 0.322)	SIJP
	30	0.028	(0.000, 0.062)	0.469	(0.284, 0.654)	0.319	(0.145, 0.493)	0.184	(0.037, 0.332)	FJP
	35	0.028	(0.000, 0.063)	0.582	(0.371, 0.793)	0.212	(0.044, 0.380)	0.178	(0.000, 0.359)	FJP

CI = confidence interval; FJP = facet joint pain; IDD = intervertebral disc; SIJP = sacroiliac joint pain.

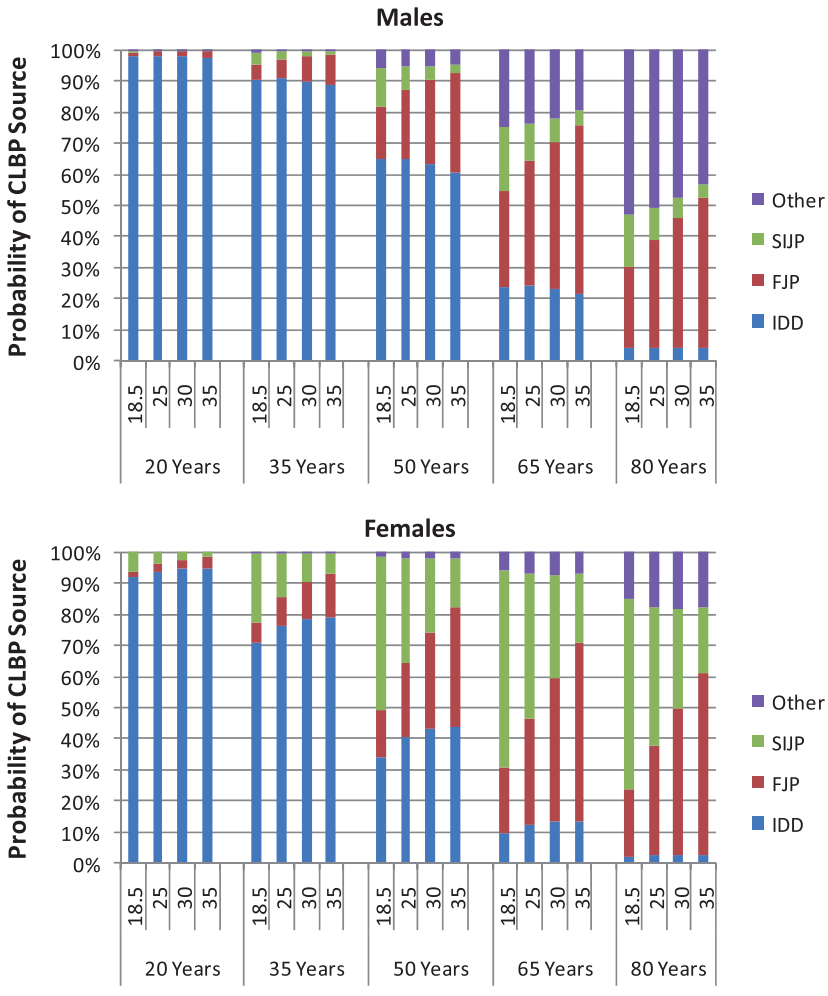

Figure 1 Probability of CLBP sources by age and BMI for males and females.

Potential explanations for an association between SIJP and female gender and lower BMI include pregnancy-related changes to the SIJ [24–28], different biomechanical behavior of the SIJ between genders [24,29,30], and displacement of weight line anterior to the pelvis in lower BMI subjects. Specific examples of pregnancy-related factors such as poor pelvic floor musculature conditioning, intra-articular bleeding during birthing process, and hormonal induced joint laxity may explain why we observed a significant relationship between female gender and SIJP.

Degenerative spinal changes are more prevalent with age [31–33]. Inherent in this process is loss of disc height and increased load borne by the posterior elements [34]. Consequently, FJP may become more prevalent in older age groups given these biomechanical changes and load transfer within the aged lumbosacral spine. Perhaps, the influence of BMI in the female gender supports this relationship. Increased BMI in women with LBP apparently increases lumbar lordosis [35]. Load on the facet joints increases with upright posture especially in the setting of disc degeneration [34,36–38]. Although lumbar hyperextension as an isolated physical exam maneuver does not provoke pain in injection proven FJP CLBP [39], the previously mentioned biomechanical features are descriptive of the patient cohort likely to experience FJP.

Perhaps most interesting was our observation of a lack of association between BMI and IDD in chronic LBP patients. This finding is not entirely compliant with previous reports insinuating a positive association between BMI and disc degeneration evidenced by lumbar spine magnetic resonance imaging (MRI) [10]. A simple and quick explanation is that disc degeneration on MRI cannot detect IDD [40] and is therefore an unreliable screening tool for IDD [41]. BMI evidently correlates with the presence of MRI morphologic changes of disc degeneration but, based on our results, it does not appear to relate with painful discs meeting criteria for IDD. The association between male gender and IDD may reflect genetic predisposition [42], propensity for gender differences in lifting activities, or selection bias inherent in a retrospective review. For example, we did not specifically address and control for smoking and occupational workload such as repetitive lifting.

Ultimately, one could argue that we erroneously calculated the prevalence estimate for lumbar IDD, FJP, and SIJP. Each patient we analyzed underwent definitive diagnostic procedures until we reached confirmation of the source of that patient's LBP. If a patient was initially evaluated with diagnostic FJ and/or SIJ blocks that were negative, that patient underwent discography to verify the presence of IDD and vice versa. Only patients whose clinical status improved with proper care did not undergo diagnostic procedures. Application of meticulous technique and strict adherence to supported operational criteria for discography [14] will minimize false positive rates to acceptably low levels [13] allowing accurate detection of IDD [2,14,43,44]. Similarly, sufficiently performed diagnostic FJ blocks and SIJ injections are associated with acceptable false positive rates. We have previously reported our results using this approach [1].

Still, our retrospective methodology is limited by inherent selection bias. Stated differently, the sequence of the diagnostic injections may prejudice subjects to responding to their first diagnostic injection. Medial branch and sacroiliac joint blocks may be more prone to this error than controlled provocation discography. The optimal scenario would be to expose all study subjects to all diagnostic injections in a randomized order. Such a study is impractical and would not be accepted by patients. Under these circumstances, our data is a best possible estimate. Strengthening our stance are Schwarzer's findings of multiple positive injections occurring in ≤3% of a reasonably large cohort of subjects undergoing two or three of our diagnostic injections [3,45]. On these grounds, our presented data could be viewed as possessing an acceptably low 3% error margin.

Lastly, if our findings were skewed by false positives, we would have likely observed different prevalence data less congruent with previous reports. By virtue of the fact that most previously reported prevalence estimates for each diagnostic group (IDD, FJP, SIJP) fall within our CIs for each group, our findings are likely fairly accurate [3,45].

Conclusions

Our preliminary findings suggest there is a significant relationship among gender, age, and BMI and structural causes (IDD, FJP, SIJP) of chronic LBP. Lumbar IDD is more prevalent in young males while FJP is more prevalent in females with increased BMI. Female gender and low BMI are associated with SIJP.

References

1 DePalma MJ, Ketchum JM, Saullo TR. What is the source of chronic low back pain and does age play a role? Pain Med 2011;12(2):224–33.

2 Schwarzer AC, Aprill CN, Derby R, et al. The prevalence and clinical features of internal disc disruption in patients with chronic low back pain. Spine 1995;20(17):1878–81.

3 Schwarzer AC, Aprill CN, Bogduk N. The sacroiliac joint in chronic low back pain. Spine 1995;20:31–7.

4 Schwarzer AC, Wang SC, Bogduk N, McNaught PJ, Lauren R. Prevalence and clinical features of lumbar z joint pain: A study in an Australian population w/chronic low back pain. Ann Rheum Dis 1995;54:100–6.

5 Cohen SP. Sacroiliac joint pain: A comprehensive review of anatomy, diagnosis, and treatment. Anesth Analg 2005;101:1440–53.

6 Liliang P, Lu K, Weng H, et al. The therapeutic efficacy of sacroiliac joint blocks with triamcinolone acetonide in the treatment of sacroiliac joint dysfunction without spondyloarthropathy. Spine 2009;34(9):896–900.

7 Maigne JY, Aivaliklis A, Fabrice P. Results of sacroiliac joint double block and value of sacroiliac pain provocation tests in 54 patients with low back pain. Spine 1996;21(16):1889–92.

8 Schwarzer AC, Aprill CN, Derby R, et al. Clinical features of patients with pain stemming from the lumbar zygapophysial joints. Is the lumbar facet syndrome a clinical entity? Spine 1994;19(10):1132–7.

9 Irwin RW, Watson T, Minick RP, Ambrosius WT. Age, body mass index, and gender differences in sacroiliac joint pathology. Am J Phys Med Rehabil 2007;86: 37–44.

10 Samartzis D, Karppinen J, Luk KDK, Cheung KMC. Body mass index and its association with disc degeneration of the lumbar spine in adults. Presented at the 2010 Annual Meeting of the American Academy of Orthopaedic Surgeons. March 9–13. New Orleans. 2010.

11 Heuch I, Hagen K, Heuch I, et al. The impact of body mass index on the prevalence of low back pain. The HUNT study. Spine 2010;35(7):764–8.

12 Derby R, Kim BJ, Chen Y, Seo KS, Lee SH. The relation between annular disruption on computed tomography scan and pressure-controlled discography. Arch Phys Med Rehabil 2005;86(8):1534–8.

13 Wolfer LR, Derby R, Lee JE, et al. Systematic review of lumbar provocation discography in asymptomatic subjects with a meta-analysis of false-positive rates. Pain Physician 2008;11:513–38.

14 Bogduk N. Lumbar disc stimulation (provocation discography). In: Bogduk N, ed. Practice Guidelines. Spinal Diagnostic and Treatment Procedures. San

Francisco, CA: International Spinal Intervention Society; 2004:20–46.

15 Bogduk N, Holmes S. Controlled zygapophysial joint blocks: The travesty of cost-effectiveness. Pain Med 2000;1:25–34.

16 Manchikanti L, Pampati V, Fellows B, Bakhit CE. The diagnostic validity and therapeutic value of lumbar facet joint nerve blocks with or without adjuvant agents. Curr Rev Pain 2000;4:337–44.

17 Slipman CW, Issac Z. The role of diagnostic selective nerve root blocks in the management of spinal pain. Pain Physician 2001;4(3):214–26.

18 Jensen ME, Evans AJ, Mathis JM, et al. Percutaneosu polymethylmethacrylate vertebroplasty in the treatment of osteoporotic vertebral compression fractures: Technical aspects. AJNR Am J Neuroradiol 1997;18: 1897–904.

19 Evans AJ, Jensen ME, Kip KE, et al. Vertebral compression fractures: pain reduction and improvement in functional mobility after percutaneous polymethylmethacrylate vertebroplasty. A retrospective report of 245 cases. Radiology 2003;226(2):366–72.

20 Grados F, Depriester C, Cayrolle G, et al. Long-term observations of vertebral osteoporotic fractures treated by percutaneous vertebroplasty. Rheumatology (Oxford) 2000;39(12):1410–4.

21 Barr JD, Barr MS, Lemley TJ, et al. Percutaneous vertebroplasty for pain relief and spinal stabilization. Spine 2000;25(8):923–8.

22 Frey ME, DePalma MJ, Cifu DX, et al. Percutaneous sacroplasty for osteoporotic sacral insufficiency fractures: A prospective, multicenter, observational pilot study. Spine J 2008;8(2):367–73.

23 Frey M, DePalma MJ, Cifu DX, Bhagia SM, Daitch J. Efficacy and safety of percutaneous sacroplasty for painful osteoporotic sacral insufficiency fractures. A prospective, multicenter trial. Spine 2007;32(15): 1635–40.

24 Dietrichs E. Anatomy of the pelvic joints—A review. Scand J Rheumatol 1991;88(suppl):4–6.

25 Damen LB, Muzaffer H, Guler-Uysal F, et al. The prognostic value of asymmetric laxity of the sacroiliac joints in pregnancy-related pelvic pain. Spine 2002;27: 2820–4.

26 Papageorgiou T, Duchatel F. Sacro-iliitis associated with pregnancy: Case report and review of the literature. BJOG 2002;109:355–6.

27 Cusi MF. Paradigm for assessment and treatment of SIJ mechanical dysfunction. J Bodyw Mov Ther 2010;14(2):152–61; Epub January 25, 2010.

28 Albert H, Godskesen M, Westergaard J. Evaluation of clinical tests used in classification procedures in pregnancy-related pelvic joint pain. Eur Spine J 2000;9(2):161–6.

29 Ross J. Is the sacroiliac joint mobile and how should it be treated? Br J Sports Med 2000;34:226.

30 O'Sullivan PB, Beales DJ. Diagnosis and classification of pelvic girdle pain disorders—Part 1: A mechanism based approach within a biopsychosocial framework. Man Ther 2007;12(2):86–97.

31 Hitselberger WE, Witten RM. Abnormal myelograms in asymptomatic patients. J Neurosurg 1968;28:204–6.

32 Jensen MC, Brant-Zawadzki MN, Obuchowski N, et al. Magnetic resonance imaging of the lumbar spine in people without back pain. N Engl J Med 1994;331(2):69–73.

33 Boden SD, Davis DO, Dina TS, et al. Abnormal magnetic-resonance scans of the lumbar spine in asymptomatic subjects: A prospective investigation. J Bone Joint Surg Am 1990;72-A(3):403–8.

34 Pollitine P, Dolan P, Tobias JH, et al. Intervertebral disc degeneration can lead to "stress-shielding" of the anterior vertebral body. A cause of osteoporotic vertebral fracture? Spine 2004;29:774–82.

35 Guo JM, Zhang GQ, Alimu J. Effect of BMI and WHR on lumbar lordosis and sacrum slant angle in middle and elderly women. China J Orthop Trauma 2008;21(1):30–1.

36 Sowa G. Conservative management of low back pain, part II: Facet-mediated pain. Dis Mon 2005;51(1): 18–33.

37 Yang KH, King AI. Mechanism of facet load transmission as a hypothesis for low-back pain. Spine 1984;9:557–65.

38 Nachemson A. Lumbar intradiscal pressure. Acta Orthop Scand 1960;43(suppl):1–104.

39 Revel M, Poiraudeau S, Auleley GR, et al. Capacity of the clinical picture to characterize low back pain relieved by facet joint anesthesia: Proposed criteria to identify patients with painful facet joints. Spine 1998;23(18):1972–6.

40 Kang CH, Kim YH, Lee SH, et al. Can magnetic resonance imaging accurately predict concordant pain

provocation during provocative disc injection? Skeletal Radiol 2009;38(9):877–85.

41 Zhou Y, Abdi S. Diagnosis and minimally invasive treatment of lumbar discogenic pain—A review of the literature. Clin J Pain 2006;22:468–81.

42 Ala-Kokka L. Genetic risk factors for lumbar disc disease. Ann Med 2002;34(1):42–7.

43 Moneta GB, Videman T, Kaivanto K, et al. Reported pain during lumbar discography as a function of anular ruptures and disc degeneration. A re-analysis of 833 discograms. Spine 1994;19(17):1968–74.

44 Walsh T, Weinstein J, Spratt KF, et al. The question of discography revisited. A controlled prospective study of normal volunteers to determine the false positive rate. J Bone Joint Surg Am 1990;72:1081–8.

45 Schwarzer AC, Aprill CN, Derby R, et al. The relative contributions of the disc and zygapophyseal joint in chronic low back pain. Spine 1994;19(7): 801–6.