	22 studios u	voro upod to colo	asymptomatic populations.	optimatos of a u	ariety of asymptomatic pathological fi	bias (volunteered). Interpretation subject to interrater variability in standardization of nomenclature and reading. Study includes "older" studies which might have variability in current best practices and image review.	
QUALITY	33 studies were used to calculate age-normative estimates of a variety of asymptomatic pathological findings in the spine. Between studies, one must consider interrater reliability of imaging review. Herzog et al, 2017* highlights the great extent of interrater reliability in reading diagnostic imaging between centers, education, and occupation. That being said, there is potential a lot of variety between studies on the reading and diagnosing of imaging. However, having a larger amount of studies for each pathology should level these findings to a more realistic average. See discussion/limitation for specific strengths and limitations within the study. Overall, as this is a large literature review with systematic analysis and statistics, it is a higher quality category of evidence. *(Herzog R, Elgort DR, Flanders AE, et al. Variability in diagnostic error rates of 10 MRI centers performing lumbar spine MRI examinations on the same patient within a 3-week period. <i>Spine J</i> . 2017;17(4):554-561, doi:10.1016/i.spinee.2016.11.009)						
Title/Author/Year	Number of Subjects/ Studies	Inclusion/Exc lusion	Description of Intervention/Da ta Synthesis	Outcome Measures/ timeframe	Results	Limitations/Discussion	
MRI Findings of Disc Degeneration are More Prevalent in Adults with Low Back Pain than in Asymptomatic Controls: A Systematic Review and Meta- Analysis. <sup>2</sup> Brinjikji W, Diehn FE, Jarvik JG, et al. 2015 <sup>2</sup>	Initial search 280 studies narrowed to 14 final studies with ~3000 subjects This study looked at possible difference s in imaging findings among painful and non- painful population	Inclusion: English, report the prevalence of degenerative findings through different ages, painful or asymptomatic populations, ages 15-50 included in study Exclusion: studies not relevant to topic	For each included study (14) sample sizes and prevalence rates for common imaging findings were pulled out. These included: central spinal canal stenosis, disc degeneration, annular fissure, high intensity zones, disc bulge, protrusion, extrusion, modic changes, spondylolisthesi s, and spondylolysis.	Meta analysis was performed on 2x2 tables from each study. the I <sup>2</sup> statistic was used to express inconsistency aside from chance. >50% indicates heterogeneity of odds. These were also cofounded by age to further refine heterogeneity Odds ratio (OR) was	14 studies were included that met inclusion and exclusion criteria. Certain imaging findings were more prevalent in painful populations <50 years of age. The following findings use a 95% confidence interval. In decreasing order of odds ratio, they include - disc bulge (OR: 7.54 $P$ =.01), - spondylolysis (OR: 5.06, $P$ <.01) - disc extrusion (OR: 4.38, $P$ <.01) - modic 1 changes (OR: 4.01 P=.04 - disc protrusion (OR: 2.65 $P$ =.03) - disc degeneration (OR: 2.24 P=.01 Additional imaging findings not associated with pain include - modic changes (OR: 1.62 $P$ =.43), - cent. canal stenosis (OR: 20.58, P<.32) - high intensity zones (OR: 2.10,	This study serves to look at findings in those <50 years of age. Further analysis of those over 50 years might be helpful to compare to asymptomatic populations and findings. With this study being a comparison study between those with and without pain, the findings of certain pathologies being linked to pain should be considered as possible candidates for low back pain, but not proven. These findings do not prove that these pathologies are pain generators, however might indicate that evidence of these findings could be explored. Previous studies have revealed that disc protrusions increase with age in asymptomatic populations. This study found that ~20% of asympomtatic patients 50 or younger had disc protrusion compared with 40% in sympomtatic group. Disc extrusion. This study also highlights the	

	s under 50 years old imaging findings			calculated and values were compared.	<ul> <li>P&lt;.17) <ul> <li>annular fissure (OR: 1.79, P=.06)</li> <li>spondylolisthesis (OR: 1.59, P=.20)</li> </ul> </li> <li>Disc extrusion is rare in asympomtatic patients (0-4%) and higher in symptomatic populations (5-10%)</li> <li>Disc degeneration might be more highly prevalent in young symptomatic populations, found in &gt;30% of asympomatic &lt;50 years age, and &gt;50% of symptomatic individuals &lt;50 years of age.</li> </ul>	heightened prevalence of disc bulge in sympomtatic vs asymptomatic populations. This may be more significant in younger populations (the link to sympomtatic individuals) as the number increases to >90% in asympomtatic older adults. This study highlights the continued controversy surrounding link between annular fissure and pain. While some studies did show higher prevalence of annular fissure in symptomatic populations, the largest study in this analysis looked at >500 individuals 18- 21 and demonstrated no association		
QUALITY	All included studies were rated with "high quality" via the New Castle-Ottawa Scale. They all demonstrated a high degree of comparability and had similar findings at baseline. The review indicates that 3 studies might be at risk for selection bias based upon studying elite athletes. It appears in some ways like the study was trying to justify findings towards findings in those without pain. This is possibly due to some bias that the reviewers/authors might have had to disprove any correlation between pathologic findings and pain. ( <i>e.g</i> in the discussion about annular fissures). As this study is a systematic review and meta-analysis with a large amount of studies, it is a higher quality piece of literature. See discussion/limitation for specific strengths and limitations within the study							
Title/Author/Year	Number	Inclusion/Exc	Description of	Outcomo	Desults			
	of Subjects/ Studies	lusion	Intervention/Da ta Synthesis	Measures/ timeframe	Results	Limitations/Discussion		
The probability of spontaneous regression of lumbar herniated disc: a systematic review. <sup>3</sup> Chiu CC, Chuang TY, Chang KH,	of Subjects/ Studies 31 initial studies, narrowed to 9 studies for review	Iusion Inclusion – patients with lumbar disc herniation and have 2 imaging evaluations of the lumbar spine. See	Total cases of each pathology were divided utilizing criteria by combined task forces of North American spine society, American	Measures/ timeframe Probability of complete resolution was calculated. In order to do so, there needed to be at least 2 effective studies. If only	ResultsThe rate of spontaneous regression was found to be highest in more severe levels of herniations (eg sequestration vs bulging)Rate of regression probability: Sequestration: 96% (52/54)	Limitations/DiscussionPrevious studies have revealed cases of disc herniation reduced from 35-100% in 3 to 40 months. The high variety of previous research is likely based on different types of herniation classification and lack of specification on partial vs complete resolution.		
The probability of spontaneous regression of lumbar herniated disc: a systematic review. <sup>3</sup> Chiu CC, Chuang TY, Chang KH, Wu CH, Lin PW, Hsu WY. 2015 <sup>3</sup>	of Subjects/ Studies 31 initial studies, narrowed to 9 studies for review 361 cases of lumbar herniation	lusion Inclusion – patients with lumbar disc herniation and have 2 imaging evaluations of the lumbar spine. See more study inclusion criteria in "Quality" section below.	Total cases of each pathology were divided utilizing criteria by combined task forces of North American spine society, American Society of spine radiology, and American society of neuroradiology. All selected	Measures/ timeframe Probability of complete resolution was calculated. In order to do so, there needed to be at least 2 effective studies. If only available in one, data in probability analysis was excluded.	ResultsThe rate of spontaneous regression was found to be highest in more severe levels of herniations (eg sequestration vs bulging)Rate of regression probability: Sequestration: 96% (52/54)Extrusion: 70% (108/154)Protrusion: 41% (38/93)Bulging: 13% (8/60)	Limitations/Discussion         Previous studies have revealed         cases of disc herniation reduced         from 35-100% in 3 to 40 months.         The high variety of previous         research is likely based on         different types of herniation         classification and lack of         specification on partial vs complete         resolution.         Authors of this review attempt to         provide more specific data on         probabilities of disc regression and         complete resolution among the         various types of herniation.		

		infection, tumor, spondylolisthe sis, or stenosis. Exclusion of patients who received chymopapain injections due to possible enzymatic nucleolysis of disc.	selected classification system, approved by two authors. This comprised of bulging (60 cases), protrusion(93 cases), extrusion (154 cases), and sequestration (54 cases).	calculated by presence of the pathology resolving (at least partially) e a fr f c c c c c c c c c c c c c c c c c	orrelation between rate of reg nd herniation type/morpholog urther analysis of more sever athology (sequestration and xtrusion) revealed a 77% reg s opposed to a 30% regressi or less severe pathology, mal dds 7.8x higher than bulging rotruding discs. omplete disc resolution was 3% for sequestrated discs co o 15% of extruded discs. (0% rotruded and 11% bulging wi complete resolution).	gression of gy. i ire (( re () ression r on rate r sing the or t about f about f th t	occurred within on year, however could be as early as 2 or 3 months in multiple studies. One study (Takada) revealed that sequestrations were more prone to regress than less severe pathologies. Throughout the literature used, there was a variety of different interventions, including bed rest, analgesiscs, NSAIDS, exercise, epidural and physical therapy. While this information would be helpful to the physical therapist, the authors state that intervention analysis was not the goal of this study, but rather the behavior and history of the herniated disc.
QUALITY	As this was a systematic review and combined analysis with a large amount of studies, the quality of this type of literature is on the higher end. Specific studies were graded based off of 6 criteria developed by authors, as there was no previous set criteria for this specific evaluative finding. Adhering to this set criteria allowed for studies to be somewhat homogenous. This included 1)prospective design, 2) eligibility criteria, 3) blind assessment of imaging outcome, 4) clear disc regression criteria, 5) acceptable drop out rate, 6) clearly defined imag follow-up protocol. Additionally, studies were determined to be adequate if there was a good descripton of the patients' clinical signs and symptoms. High quality evidence contained 5-6 of the 6 criteria. See discussion/limitation for specific strengths and limitations within the study. Overall, 5/9 studies were high quality, 3 were moderate quality, and 1 was considered low quality with only 1-2 of the 6 criteria.						
Title/Author/Year	Number of Subjects/ Studies	Inclusion/Exc lusion	Description of Intervention/Da ta Synthesis	Outcome Measur timeframe	es/ Results	1	Limitations/Discussion
The relationship between thoracic kyphosis and age and normative values across age groups: a systematic review of healthy adults. <sup>4</sup>	34 studies (24 moderate quality and 10 high quality were used)	Relationship of thoracic kyphosis and age has not previously been systematically investigated.	Articles were determined low risk vs moderate risk for bias utilizing five domains. Studies with moderate to low risk (or	Means and precisi estimates used to calculate age- normative values p group. Standard Deviations were us to establish further ranges for normati data.	on Before this study the or established cut-off is considered "normal" ir (est in 1960). When exceeding 40°, it is co hyperkyphosis, linked fracture and overall hi we mortality. Despite curr evidence that kyphosi	current k a 20-40° r nsidred r to gher c ent c s often c	While these updated findings might be considered a new "normative" range. They still might have correlations with increased mortality and fracture risk. Some authors suggest using a cut- off of 50 instead of 40° however 35% of individuals in this
Zappala M, Lightbourne S,	n=7633	Keyword Search through MEDLINE, EMBASE,	high quality) were used in the review.	Groups utilized previously in litera were set up: <40 years, 40-60 years	used as a normative of used as a normative of but might not be an ad "normative" value.	cut-off f courate f	systematic review exceeded 50°. No patients however surpassed 60° so using a range of 20-60° as a normative cut off range might be more accurate based upon the

		PATHO	LOGICAL FIND	INGS OF THE SF	VINE: EVIDENCE TABLE	MCCLELLEN 5
Heneghan NR 2021 <sup>4</sup>		PsycINFO, Ovid, AMED, Index of Chiropractic, CINAHL through April 2020.	Mean kyphosis and age were used in correlation analysis. (Pearson's OR spearman's correlation coefficient was computed) then investiaged using the Komogorov- Smirnov test.	<ul> <li>&gt;60 years, &lt;50 years and &gt; 50 years.</li> <li>Independent two-tail t-test utilized for two group compatisons (&gt;50) and one-way anova for multiple group comparison (&lt;40, 40-60, &gt;60).</li> <li>Other factors were analyzed such as gender and ethnic group differences.</li> </ul>	<ul> <li>s, Ranges were &gt;40° below 60 years in 58% of cases, and 75% in those above 60 years which puts the current cut off for "normality" at question.</li> <li>35% of patients surpassed 50°.</li> <li>Ranges never exceeded 60°</li> <li>Europeans and North Americans showed significantly higher amounts of kyphosis than Asians.</li> </ul>	findings of this study. This review has a relatively small number of studies with some not even subdividing their findings into age groups. However, the included studies were moderate to high quality, contributing to the strength of this review. Additionally low quality measurements of kyphosis were excluded based upon poor information inclusion. Asians showed significantly less kyphosis than Europeans and North Americans which might indicate a genetic component or correlations with bone mineral density . Further factors that could play into thoracic curvature should be explored (i.e sports, activity levels, sociocultural backgrounds, technology)
QUALITY 10 high quality studies and 24 mode a relatively large amount of studies, this review at low to moderate risk of			4 moderate quality s tudies, making it a h e risk of bias or goo	studies were included higher quality piece of d/high quality. See dis	in this systematic review. This study literature. The studies included were cussion/limitation for specific strengt	is a systematic review consisting of moderate to high quality placing hs and limitations within the study.
Title/Author/Year	Number of Subjects/ Studies	Inclusion/Exc lusion	Description of Intervention/Da ta Synthesis	Outcome Measures/ timeframe	Results	Limitations/Discussion
Normative magnetic resonance imaging data of age-related changes in cervical disc morphology. <sup>5</sup> Machino M, Ito K, Ando K,	1211 (about 100 males and 100 females in each decade of life from 20 to 79.	Inclusion: healthy subjects Exclusion: Neurological symptoms, neck pain, history of brain or spinal surgery, current pregnancy,	Individuals underwent cervical MRI to determine height of disc in center of sagittal images (6 levels, C2-3 to C7-T1). Disc degeneration was defined according to <i>Modified</i>	Individuals were recruited via surveys and hospital-based advertisements. One MR image was obtained for reviewers to analyze. Additionally, individuals filled out information	Intervertebral disc anteroposterior diameters: increased with increasing age. Smaller in females. Intervertebral Disc Height: decreased with increasing age except at C2-3 and C7-T1. Age- related change most prominent at C5-6 level. Vertebral Body Height: decreased slightly with increasing	This study serves to establish any existing correlation between cervical disc degeneration and disc height as well as establish age-related normative changes with sex-specific differences for each section of the cervical spine using MRI. Key Findings: Cervical disc degeneration level increased with every decade, however Level IV was not identified in 20s and 30s.

MCCIFILEN 6

#### Kobavashi K. Pfirrmann Degeneration occurred most neurological regarding age, age. Heights lower in F>M. Nakashima Hm diseasde. classification weight, height, severely at C5-6 follwed by C6-7. sex, and other Kato F et al. claustrophobic system, and Cervical disc degernation level baseline individuals. identified by 2 increased with every decade, The indicators of disc other spinal surgeons. characteristics. however Level IV was not degeneration of even younger contraindicatio identified in 20s and 30s. and more prevalent than ns to MRI. suggested in Masumoto et al. Statistical Degeneration occurred most 2021<sup>5</sup> analysis was severely at C5-6 follwed by C6-7. used to identify This study is very useful for differences individuals who might present to between groups physical therapy with specific and between concerns about more vertebral levels. degeneration at one level vs another. One strength is that the individuals were screened and excluded for current neck pain, so at the time of imaging, these individuals were asymptomatic. However, the study does not indicate if they had any previous neck pain. This study includes a large sample size within each decade of life. Risk of bias in sampling method and imaging analysis exist, as only 2 spinal QUALITY surgeons reviewed imaging and were informed of purpose of the study. This is one of the first studies that establishes normative data in currently asymptomatic individuals with neck pain. More studies to with random sampling and blinded reviewing should be initiated to establish additional pathological information about the cervical spine. See discussion/limitation for specific strengths and limitations within the study. Title/Author/Year Inclusion/Exc Outcome Limitations/Discussion Number **Description of** Results of lusion Intervention/Da Measures/ Subjects/ ta Synthesis timeframe Studies latrogenic Inclusion: 1+ Claims were Disability duration 37% non-specific LBP and 79.9% The study concludes by stating of radicular cases received early that early MRI has a strong consequences of compensated identified by post-MRI was body part and imaging ≤30 days. No-MRI groups iatrogenic effect in acute LBP, early magnetic lost time and measured and Retrospec revealed 68-72% lower amounts of resonance at least 1 year diagnosis codes compared using regardless of presence of tive cohort imaging in acute, of job tenure. in a one year Cox proportional disability lengths depending on radiculopathy. studv hazards model to work-related. Cases period (2006) type of back pain. performed excluded if from a workers disabling low back compare between on Strengths include randomization pain.6 lumbar MRI compensation groups. randomlv In general, early MRI groups of workers compensation claims was obtained insurer. (regardless of radicular vs nonselected representative of a broad range of >39 days after (described in a 1000 specific LBP) had much lower Total costs post-Webster BS. locations. onset of pain. prior study). This Bauer AZ. Choi Y. MRI were cases of rates of going off disability. included Cifuentes M. workers measured. substantially higher medical Limitations in the clinical data individuals from costs,(12-13K higher), than non-Pransky GS. compensa Exclusion: Multivariate linear gathering exist as authors identify 45 different tion claims cases were regression models MRI groups. that notes were not always clear states. in the excluded with measured the $2013^{6}$ in which cases might be non-United red flags, extent of costs Subgroup correction/analysis was specific and radicular. The

	States 555 individual cases in final analysis	history of chronic or recurrent LBP, prior surgery, concomitant injuries, non- lumbar MRI, or limited clinical information. Final number was 555 cases.	1000 claims were randomly selected, oversampling for potential radiculopathy cases based on ICD codes. This ensured that there would be a significant amount of radicular cases that did not have early MRI for analysis.	between groups as well as comparing for different variants such as those who had early-imaging but still had low lengths of disability.	made for individuals with lower disability who received early MRI and still had 7-8K higher medical costs.	positive thing in this case was that there was not a large difference between non-specific and radicular but more in the presence or lack of early imaging. Additionally, case to case, limitations exist in the ability to adjust for case-specific interventions and education. To truly see the sole effects of early imaging on disability length and cost of treatment, a controlled trial would need to be initiated.
QUALITY	This was a retrospective cohort study, which points to its limitations in quality of evidence. Overall, this is a moderate quality evidence study with moderate risk of bias. Strengths include randomization of sampling and intentionality in quantity selection to incorporate adequate amounts of each diagnosis. Additionally, subgroup analysis was performed to further address bias in initial statistical analysis. See discussion/limitation for specific strengths and limitations within the study.					

#### **References:**

- 1. Brinjikji W, Luetmer PH, Comstock B, et al. Systematic literature review of imaging features of spinal degeneration in asymptomatic populations. *AJNR Am J Neuroradiol*. 2015;36(4):811-816. doi:10.3174/ajnr.A4173
- Brinjikji W, Diehn FE, Jarvik JG, et al. MRI Findings of Disc Degeneration are More Prevalent in Adults with Low Back Pain than in Asymptomatic Controls: A Systematic Review and Meta-Analysis. *AJNR Am J Neuroradiol.* 2015;36(12):2394-2399. doi:10.3174/ajnr.A4498
- Zappalá M, Lightbourne S, Heneghan NR. The relationship between thoracic kyphosis and age, and normative values across age groups: a systematic review of healthy adults. *J Orthop Surg Res.* 2021;16(1):447. Published 2021 Jul 9. doi:10.1186/s13018-021-02592-2
- 4. Chiu CC, Chuang TY, Chang KH, Wu CH, Lin PW, Hsu WY. The probability of spontaneous regression of lumbar herniated disc: a systematic review. Clin Rehabil. 2015;29(2):184-195. doi:10.1177/0269215514540919
- 5. Machino M, Ito K, Ando K, et al. Normative Magnetic Resonance Imaging Data of Age-Related Degenerative Changes in Cervical Disc Morphology. *World Neurosurg.* 2021;152:e502-e511. doi:10.1016/j.wneu.2021.05.123
- 6. Webster BS, Bauer AZ, Choi Y, Cifuentes M, Pransky GS. latrogenic consequences of early magnetic resonance imaging in acute, work-related, disabling low back pain. *Spine (Phila Pa 1976)*. 2013;38(22):1939-1946. doi:10.1097/BRS.0b013e3182a42eb6