Spine (Phila Pa 1976). Author manuscript; available in PMC 2011 July 15.

Published in final edited form as:
Spine (Phila Pa 1976). 2011 January 15; 36(2): 160–169. doi:10.1097/BRS.0b013e3181cd9adb.

POTENTIAL OF MRI FINDINGS TO REFINE CASE DEFINITION FOR MECHANICAL LOW BACK PAIN IN EPIDEMIOLOGICAL STUDIES: A SYSTEMATIC REVIEW

Dr. Alison Endean, MBChB, MRCP, **Professor Keith T Palmer, DM, MA, MSc, FRCP, FFOM**, and **Professor David Coggon, MA PhD DM FRCP FFOM FFPH FMedSci**
MRC Epidemiology Resource Centre, University of Southampton, Southampton, UK

Abstract

Study design—Systematic review and meta-analysis

Objective—To assess how confidently LBP can be attributed to abnormalities on MRI, and thereby explore the potential value of MRI abnormalities in refining case definition for mechanical low back pain (LBP) in epidemiological research.

Summary of background data—Most epidemiological studies of mechanical LBP have defined cases only by reported symptoms, but it is possible that the potency of causes differs according to whether or not there is demonstrable underlying spinal pathology.

Methods—We reviewed the published literature on MRI abnormalities, looking for data on the repeatability of their assessment, their prevalence in people free from LBP, and their association with LBP. Where data were sufficient, we calculated a summary estimate of prevalence in people without LBP and a meta-estimate of the odds ratio for the association with LBP. A formula was then applied to estimate the corresponding prevalence rate ratio (PRR), assuming three possible prevalence rates for LBP in the general population.

Results—Data were most extensive for disc protrusion, nerve root displacement/compression, disc degeneration and high intensity zone (HIZ), all of which could be assessed repeatably. All were associated with LBP, meta-estimates of odds ratios ranging from 2.3 (nerve root displacement/compression) to 3.6 (disc protrusion). However, even for disc protrusion, estimates of the corresponding PRRs were mostly less than two.

Conclusion—MRI findings of disc protrusion, nerve root displacement/compression, disc degeneration and HIZ are all associated with LBP, but individually, none of these abnormalities provides a strong indication that LBP is attributable to underlying pathology. This limits their value in refining epidemiological case definitions for LBP.

Keywords

MRI; pathology; repeatability; diagnosis; classification; epidemiology

Introduction

"Mechanical" low back pain (LBP) is a major cause of illness and disability, especially in people of working age. By definition, it excludes pain resulting from neoplasia, fracture or

Correspondence to: Professor David Coggon, MRC Epidemiology Resource centre, Southampton General Hospital, Southampton, SO16 6YD, UK, Tel: # 44 2380 777624, Fax: # 44 2380 704021, dnc@mrc.soton.ac.uk.

Europe PMC Funders Author Manuscripts

inflammatory arthropathy, or that is referred from anatomical sites outside the spine, and in most cases there is no clearly demonstrable underlying pathology. Thus, in the absence of more objective diagnostic criteria, most epidemiological studies of mechanical LBP have defined cases simply on the basis of reported symptoms. With this approach, various risk factors have been established, including physical activities that stress the spine[1] and psychological attributes such as low mood and tendency to somatise[2];[3].

However, when defined by symptoms alone mechanical LBP may not be aetiologically homogeneous. Although the pathogenesis is generally unclear, structural abnormalities of the spine do account for the symptom in some cases. It could be, for example, that for LBP associated with identifiable underlying spinal pathology, physical risk factors are relatively more important, while psychological risk factors have less impact.

Magnetic resonance imaging (MRI) has opened up new possibilities for refined diagnostic classification of mechanical LBP in epidemiological research. Various abnormalities can be identified on spinal MRI, including disc herniation, nerve root impingement, disc degeneration and high intensity zone/annular tear. However, before any of these abnormalities is used in case definition, evidence is needed that it can be measured repeatably, and that it is importantly related to the pathogenesis of symptoms and not simply an incidental finding. If an MRI abnormality accounted for LBP in only a minority of the cases who displayed it, then its value in defining a subset of cases with distinct pathogenesis, and perhaps differing aetiology, would be limited.

In this context, the most relevant index of association between an MRI abnormality and LBP is the attributable fraction among cases (AF_{cases}), defined as (PRR-1)/PRR, where PRR is the ratio of LBP prevalence between people with and without the MRI finding in the general population. For example, if the AF_{cases} were greater than 0.5 (i.e. the PRR were greater than 2) then more than half of LBP cases with the abnormality could be ascribed to it (or to a pathological process for which it was a marker).

PRR and AF_{cases} can be estimated directly from cross-sectional surveys in representative samples from the general population in which the prevalence of LBP is assessed in relation to MRI findings. However, studies that sample differentially from patients with and without LBP can only characterise associations with MRI abnormalities by prevalence odds ratios (PORs), and not by PRRs. To obtain an estimate of PRR from the corresponding POR, additional information is needed. This can be done, for example, if the prevalence of LBP in the general population (PrLBP) and the prevalence of the MRI abnormality in people without LBP (PrMRI) are known. As demonstrated in Appendix 1, the relationship is described by the formula:

$$PRR = \frac{POR\,[PrLBP + (POR.PrMRI + 1 - PrMRI)\,(1 - PrLBP)]}{POR.PrLBP + (POR.PrMRI + 1 - PrMRI)\,(1 - PrLBP)}$$

To assess how confidently LBP can be attributed to abnormalities when present on MRI, and thereby explore the potential value of MRI abnormalities in case definition for mechanical LBP in epidemiological research, we carried out a systematic literature review, focusing principally on the repeatability of their assessment, their prevalence in asymptomatic individuals and the odds ratio for their association with LBP. Assuming various prevalence rates for LBP in the general population, we then applied the above formulae to estimate the PRR and AF_{cases} for each of the MRI abnormalities.

Method

To identify potentially relevant papers, we searched the EMBASE (1996 to August 2008) and MEDLINE (1950 to August 2008) databases, using the algorithm set out in Appendix 2. After elimination of duplicates, we checked titles and abstracts, and discarded reports that clearly did not fall within the scope of our review. Full text copies of the remaining references were scrutinised, and relevant data were abstracted into tables. In addition, we checked the reference lists of these papers, looking for other pertinent publications that might have been missed. Additional material that was found in this way was again abstracted. Apart from the initial computerised search, all of the above operations were carried out independently by two of the authors (AE and DC), and any disagreements were resolved by discussion.

For each MRI abnormality, we noted the systems by which it had been classified, and any information that was reported on the repeatability of its assessment within and between observers, as characterised by kappa statistics. From those studies that provided data on the frequency of the abnormality in people who were free from LBP, we derived prevalence estimates with corresponding 95% confidence intervals (95% CIs). We then calculated a combined estimate of prevalence by summing the numbers of cases of the abnormality and the total numbers of pain-free subjects across all studies and taking their ratio.

We next focused on reports that compared the prevalence of the MRI abnormality in people with LBP and asymptomatic controls. We abstracted the numbers of subjects with and without the MRI finding among the LBP cases and controls, and thence calculated a crude odds ratio and 95% CI. Finally, where the data were sufficient, we calculated a meta-estimate of the odds ratios across all studies, applying a random or fixed effects (inverse variance) model according to whether or not there was significant heterogeneity between studies. Heterogeneity was assessed by Cochran's Q, with a p-value less than 0.10 taken to indicate significant heterogeneity. This calculation was performed with the Sharp and Sterne STATA macro (see http://bmj.bmjjournals.com/archive/7126/7126ed9.htm)

Results

After elimination of duplicates, the initial computer search identified 4851 potentially relevant papers, of which 4645 were excluded following scrutiny of the title and abstract. The full text was retrieved for the remaining 206 papers, and examination of the reference lists from these papers identified a further 14 publications that were not picked up by the computer search, but which might contain relevant information. From the total of 220 papers that were then independently read and abstracted by two investigators, 45 contained data that were directly relevant to our review.

Most of the relevant studies focused largely or completely on men and women of working age, but some also included older participants. The way in which absence of symptoms was specified varied. For example, some studies included participants who had experienced short-lived LBP, provided it had not led to absence from work or consultation with a health professional. Also, some required subjects to have been free from symptoms lifelong, and others only in the past year or currently. Where findings were presented separately for people who had been asymptomatic for differing periods, we gave preference to results for those who had been pain-free for at least 12 months.

In reports providing information on the prevalence of MRI abnormalities among people without LBP, the sizes of the study samples ranged from 10 to 273 persons. Most investigations assessed five spinal levels from L1/L2 to L5/S1, but a few examined only the lowest three or four of these levels, and two also looked at part of the thoracic spine[4;5].

Europe PMC Funders Author Manuscripts

With one exception[5], studies addressing the association of MRI abnormalities with the occurrence of LBP again focused entirely on the lumbar spine. Most compared LBP patients with a separately selected control group, but three were based on cross-sectional samples from the general population[6] or from occupational groups[7];[8].

Disc herniation

Various systems were used to classify disc herniation as seen on MRI. Most commonly, investigators distinguished all or combinations of five grades (normal, disc bulge, protrusion, extrusion and sequestration). However, some reports referred simply to "herniation" without definition, and a few distinguished a subset of protrusions that were associated with displacement or compromise of nerve roots or other spinal structures. In general, the repeatability of grading systems for disc herniation was good, with kappa statistics of 0.6 or higher for agreement within and between observers[9]-[22].

Table 1 summarises findings from studies that assessed the prevalence of disc herniation in subjects who did not have LBP. Where possible, results are presented separately for findings of protrusion or worse, and of extrusion or worse. However, where papers reported numbers of people with protrusion and with extrusion, it was not always clear whether the two categories were mutually exclusive, or whether the same individual could be classed as having both protrusion and extrusion (because they were observed at two different spinal levels). The reported prevalence of protrusion ranged from 4%[7] to 76%[20] with some indication that prevalence was lower at younger ages[23];[24]. However, most findings, including those from the four largest studies, were consistent with the pooled prevalence of 27%. Prevalence estimates for extrusion varied from 0% to 24%, with rates in the two largest studies of 6% and 7%, and a combined prevalence of 9%.

Data on the association of disc herniation with LBP were available from six studies (Table 2). Odds ratios for protrusion ranged from 1.3 to 8.8, with significant heterogeneity ($Q = 16.846$, 5 d.f., $p=0.005$). The meta-estimate for the odds ratio from a random effects model was 3.6 (95% CI 1.8-7.0). Less information was available on associations with extrusion, but in studies that looked at both grades of herniation, odds ratios for extrusion were not consistently higher or lower than for protrusion.

Nerve root impingement

Studies that examined the prevalence of nerve root impingement and its relation to LBP most commonly graded MRI appearances according to whether there was contact with a nerve root, displacement, or frank compression. The repeatability of such classification was good with kappa statistics usually in the order of 0.6 or higher for within and between observer agreement[9];[11]-[13];[18];[25]-[29].

Table 3 summarises studies that provided information on the occurrence of nerve root impingement in people who did not have LBP. Estimated prevalence rates for nerve root contact, with or without displacement, ranged from 11% to 23%, whereas those for displacement and/or compression were in the order of 2% to 5%. The combined estimate for compression alone was 3%, while that for displacement or compression was 4%.

Three studies provided information on the association of nerve root impingement with LBP (Table 4). Two investigations indicated odds ratios of 2.2 and 2.3 respectively for displacement or compression[6] and compression[7]. In the third study[20], associations, both with compression and with any level of impingement, were much stronger. The difference arose because the prevalence of nerve root compression among back pain cases was much higher than in the other two studies (54% v 6% and 8%), and it is of note that all of the cases in this study had concordant symptoms on discography.

Disc degeneration

Disc degeneration was variably defined by the presence or severity of reduced disc height and/or reduced signal intensity in T2-weighted scans. Where the repeatability of classification was assessed within or between observers, kappa or weighted kappa statistics exceeded 0.5 and often were higher than 0.7[16,18,20,27,28,30,31].

Data on the prevalence of disc degeneration in people who did not have LBP were available from 21 studies[5-8,10,16,18,20,23,24,32-42], details of which are summarised in Supplementary Table A. Prevalence estimates varied widely (from 7% to 85%) in a way that could not be explained by obvious differences in diagnostic criteria or in the age distribution and previous symptom history of participants. The combined estimate of prevalence from all studies was 54%.

Eight studies provided estimates of the association between disc degeneration and LBP[5-8,20,24,37,38], with odds ratios ranging from 1.9[38] to 8.7[5]. There was no significant heterogeneity between studies (Q = 4.929, 7 d.f., p=0.669), and the meta-estimate of the odds ratio from a fixed effects model was 2.5 (95% CI 2.0-7.4).

High intensity zone (HIZ)/annular tear

Studies classified HIZ or annular tear simply as present or absent. Repeatability within and between observers was generally good or excellent, with kappa statistics exceeding 0.5[13,16,18,27,43,44]. Estimates of the prevalence of HIZ or annular tear in people without LBP ranged from 6% to 56% (Table 5), with a combined prevalence of 28%.

Many studies have examined the relation of HIZ on MRI to pain on discography, but only two reports provided data on the association of HIZ with LBP in the absence of provocative testing. The first gave an odds ratio of 4.6 (95%CI 1.9-11.1), but this is likely to have been upwardly biased because the method of recruiting LBP patients tended to over-represent those with HIZ[45]. The other investigation indicated an odds ratio of 2.5 (95%CI 1.6-3.9)[6].

Other MRI abnormalities

Findings for other MRI abnormalities (spinal canal stenosis, Schmorl's nodes, spodylolisthesis and facet joint arthropathy) were more sparse, and are summarised in Appendix 3.

Estimates of PRR and AF_{cases}

When deriving estimates of PRR and AF_{cases} for associations between MRI abnormalities and LBP, we assumed three alternative prevalence rates for LBP in the population of interest. The highest, 67%, corresponded to the combined prevalence of LBP in the three population-based studies that contributed data on associations between MRI abnormalities and LBP[6-8]. The second, 50%, is closer to the one-year prevalence of LBP in a large, geographically representative, survey in the UK[46], and the third, 30%, approximates to several reported estimates for the one-month prevalence of LBP[47].

Data were considered sufficient to estimate PRR and AF_{cases} for disc protrusion, nerve root displacement/compression, disc degeneration, and HIZ/annular tear. For each of these abnormalities, calculations were based on the combined prevalence of the MRI finding in people who did not have LBP from all relevant studies. For disc protrusion and disc degeneration, the odds ratios for the associations with LBP were taken as the meta-estimates from relevant studies. For nerve root displacement/compression, we assumed an odds ratio of 2.3 for the association with LBP (the odds ratio of 26 from the study by Boos et al[20] was disregarded because it was based on back pain patients with concordant symptoms on

discography, who were likely to have been atypical), and for HIZ/annular tear, 2.5. Associations of the other MRI abnormalities with LBP were too weak or too uncertain to justify estimating PRRs.

Table 6 shows the estimates of PRR and AF_{cases} that were calculated with these assumptions. PRRs were substantially attenuated in comparison with the corresponding odds ratios, especially when the assumed prevalence of LBP was high. The highest PRRs were for disc protrusion, but even for a LBP prevalence of 30%, the PRR for disc protrusion was only 2.4, corresponding to an AF_{cases} of 0.58. The abnormality with the next highest PRRs (1.4 to 1.9) was disc degeneration.

Discussion

Our analysis suggests that disc protrusion is the MRI abnormality most strongly associated with LBP, followed by disc degeneration, HIZ/annular tear, and then nerve root displacement or compression. However, even for disc protrusion, estimates of AF_{cases} were mostly less than 0.5.

The methods that we employed had several limitations. The studies reviewed had not been designed to answer the specific questions in which we were interested, and they differed in the demographic characteristics of participants, the criteria by which subjects were classed as being free from symptoms, the severity of LBP in those who had it, and the diagnostic criteria for pathology on MRI. These differences may account to some extent for the heterogeneity between studies in estimates of the prevalence of MRI abnormalities and of their association with LBP. Nevertheless, it seems unlikely, that this would have caused PRRs to be substantially underestimated. For example, even with an odds ratio as high as 4.5, the PRR for disc protrusion with an assumed LBP prevalence of 50% would have been only 2.1. Similarly, estimates of PRR were not particularly sensitive to the assumed prevalence of MRI abnormalities in people without LBP. If the prevalence of LBP was assumed to be 50%, taking the prevalence of disc protrusion in asymptomatic subjects as 40% instead of 27% only increased the PRR from 1.8 to 1.9.

Nor is it likely that PRRs will have been seriously underestimated because of errors in the classification of MRI abnormalities. In the studies that assessed the repeatability of MRI diagnoses within and between observers, agreement was generally good or excellent.

The odds ratios that we estimated did not adjust for potential confounding effects of age or sex, or of other concomitant spinal pathology. However, any such confounding would be expected to inflate rather than diminish risk estimates, and again is unlikely to have caused important underestimation of PRRs or AFs_{cases}.

The major driver of the differences between odds ratios and the corresponding PRRs was the assumed prevalence of LBP in the general population. This prevalence will depend on the case definition for LBP (for example, symptoms of sufficient severity to prompt referral to a spinal clinic will be less common than those reported in response to a questionnaire, and prevalence over one month is lower than that over 12 months), and on the characteristics of the study population (for example, LBP is more common in people whose work involves frequent heavy lifting[1]). Three of the studies that contributed to our analysis were based on cross-sectional samples of the general population or occupational groups, and in these surveys, the prevalence of LBP according to our preferred definition (prevalence in the past 12 months) was relatively high[6-8]. However, two of these studies also assessed the association with MRI findings for case definitions with a lower prevalence (LBP in the past month[6] and LBP at least once a month over the past 12 months[7]). With these alternative definitions, odds ratios for the association of LBP with MRI abnormalities tended to be

lower, often quite markedly. Thus it cannot be assumed that higher PRRs would apply to more stringent definitions of LBP.

The finding that PRRs for LBP associations with disc protrusion, nerve root displacement or compression, disc degeneration and HIZ/annular tear are generally less than two casts doubt on the potential of these abnormalities to refine case definition for LBP. This is because in a case-group comprising people with LBP and a given MRI abnormality, the pain would be unrelated to the abnormality in many (generally more than half) of the cases. As a consequence, any causal associations that were specific to pain arising from the abnormality would be substantially diluted. For example, if LBP were attributable to an abnormality in half of the cases who displayed it (a PRR of 2 and AF_{cases} of 0.5), and a risk factor doubled the risk of LBP generated through the abnormality but had no impact on LBP with other pathogenesis, the expected relative risk of 2 would be diluted to 1.5 in a study that defined cases by the presence of pain combined with the MRI finding. And if the AF_{cases} were smaller – say, 0.33 – the dilution of risk would be even greater (expected relative risk 1.33).

It may be that when present in combination, some MRI findings are more predictive of LBP than when found in isolation. However, we were not able to explore this question with the data that were available. It is also possible that some of the MRI findings examined are related more closely to symptoms other than LBP. In particular, there is evidence that nerve root impingement is more strongly associated with sciatica and neurological symptoms in the lower limb than with LBP alone[27;48-50]. Of the MRI abnormalities that we examined, disc herniation, disc degeneration, HIZ/annular tear and nerve root displacement or compression seem likely to be the most useful in distinguishing a subset of LBP cases that is aetiologically distinct. However, our analysis suggests that, individually, none of these findings can be regarded as a clear indication that LBP is attributable to underlying spinal pathology. This limits the value of such abnormalities, at least individually, in refining case definitions for LBP in epidemiological studies.

Key Points

- Disc protrusion, nerve root displacement/compression, disc degeneration and high intensity zone can all be assessed repeatably on MRI.
- All of these abnormalities are associated with LBP, but with estimated prevalence rate ratios generally less than two.
- Individually, none of these abnormalities provides a clear indication that LBP is attributable to underlying pathology.
- This limits the value of MRI abnormalities in refining epidemiological case definitions for LBP.

Mini Abstract/Précis

Evidence was reviewed on associations of MRI abnormalities with low back pain (LBP), and on their prevalence in people without LBP. Various abnormalities were associated with LBP, but with prevalence rate ratios generally less than two. Thus, they do not define a subset of LBP cases with clear underlying pathology.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Appendix 1: Derivation of prevalence ratios (PRRs)

Let the joint distribution of LBP and MRI abnormality in the general population be as set out below

		LBP	
		Present	**Absent**
MRI abnormality	**Present**	a	b
	Absent	c	d

The prevalence odds ratio, POR, for the association of LBP with the MRI abnormality, is $\frac{ad}{bc}$

The prevalence of the MRI abnormality in asymptomatic people, PrMRI, is $\frac{b}{b+d}$

The prevalence of LBP in the general population, PrLBP, is

$$\frac{a+c}{a+b+c+d}$$

It follows that:

$$\frac{a}{c}=POR.\frac{b}{d} \quad (1)$$

also:

$$b\,(1-PrMRI)=d \quad PrMRI$$

$$\therefore \frac{b}{d}=\frac{PrMRI}{(1-PrMRI)}$$

and from (1) and (2):

$$\frac{a}{c}=\frac{POR.PrMRI}{(1-PrMRI)} \quad (3)$$

Thus

$$PrLBP=\frac{a+c}{a+b+c+d}$$

$$=\frac{c\left[\frac{POR.PrMRI}{(1-PrMRI)}+1\right]}{c\left[\frac{POR.PrMRI}{(1-PrMRI)}+1\right]+d\left[\frac{PrMRI}{(1-PrMRI)}+1\right]}$$

$$=\frac{c[POR.PrMRI+1-PrMRI]}{c[POR.PrMRI+1-PrMRI]+d}$$

$$d=\frac{c\,[\,POR.PrMRI+1-PrMRI]\,[\,1-PrLBP]}{PrLBP} \quad (4)$$

From (2) and (4):

$$\therefore b=\frac{PrMRI.c\,[\,POR.PrMRI+1-PrMRI]\,[\,1-PrLBP]}{[\,1-PrMRI]\,PrLBP} \quad (5)$$

The prevalence ratio for LBP in people with MRI abnormality as compared with those who do not have the abnormality (PRR) is

$$\frac{a}{a+b}\div\frac{c}{c+d}$$

$$=\frac{a}{c}\times\frac{c+d}{a+b} \qquad \text{(from(3))}$$

$$=\frac{POR.PrMRI}{(1-PrMRI)}\times\frac{c+d}{a+b}$$

From (3), (4) and (5), this can be rewritten as

$$\frac{POR.PrMRI}{(1-PrMRI)}\times\frac{c+\frac{c[POR.PrMRI+1-PrMRI][1-PrLBP]}{PrLBP}}{\frac{c.POR.PrMRI}{(1-PrMRI)}+\frac{PrMRI.c[POR.PrMRI+1-PrMRI][1-PrLBP]}{(1-PrMRI)PrLBP}}$$

$$=\frac{POR.PrMRI[\,PrLBP+(POR.PrMRI+1-PrMRI)(1-PrLBP)]}{POR.PrMRI.PrLBP+PrMRI(POR.PrMRI+1-PrMRI)(1-PrLBP)}$$

$$=\frac{POR[\,PrLBP+(POR.PrMRI+1-PrMRI)(1-PrLBP)]}{POR.PrLBP+(POR.PrMRI+1-PrMRI)(1-PrLBP)}$$

Appendix 2 Search Strategy

A search was carried out of EMBASE (1996 to August 2008) and Ovid MEDLINE (1950 to August 2008) using the following algorithm:

1. (MRI or magnetic resonance or NMR or nuclear magnetic resonance).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
2. degenerative chang$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
3. ((disc or disk) and (abnorm$ or bulge$ or degenerat$ or herniat$ or protru$ or extru $ or sequest$ or change or loss of height$ or density)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
4. (nucleus pulposus and (abnorm$ or bulge$ or degenerat$ or herniat$ or protru$ or extru$ or sequest$ or change or density)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
5. high intensity zone$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
6. ((anular or annular) and (tear$ or disrupt$ or defect$ or fissur$ or ruptur$ or abnorm$ or bulge$ or herniat$ or protru$ or extru$ or sequest$ or change)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
7. anterolisthesis.mp. [mp=title, original title, abstract, name of substance word, subject heading word]

Europe PMC Funders Author Manuscripts

8. spondylolisthesis.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
9. retrolisthesis.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
10. (pars defect$ or pars fractur$ or spondylolysis).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
11. (microfractur$ or micro fractur$ or micro-fractur$).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
12. (canal and (dimension$ or stenosis or narrow$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
13. spinal stenosis.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
14. (facet joint and (arthr$ or degenerat$ or cyst$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
15. (foramina$ and (narrowing or stenosis)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
16. ((nerve or neural or root) and (compress$ or compromise or displac$ or imping$ or indent$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
17. (thecal and (compress$ or compromise or displac$ or imping$ or indent$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
18. schmorls nodes.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
19. (modic or Modic).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
20. (end-plate or endplate or end plate).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
21. 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
22. lumbago.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
23. LBP.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
24. (back pain or back-pain or backpain).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
25. sciatic$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
26. radiculopathy.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
27. radicular pain.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
28. radicular symptoms.mp. [mp=title, original title, abstract, name of substance word, subject heading word]

Europe PMC Funders Author Manuscripts

29. leg pain or leg symptom$. mp. [mp=title, original title, abstract, name of substance word, subject heading word]
30. 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29
31. (discographic or diskographic).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
32. (discography or diskography).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
33. (discogenic or diskogenic).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
34. 31 or 32 or 33
35. natural history.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
36. prospective.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
37. predict$3.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
38. (follow up or follow-up or followup).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
39. longitudinal.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
40. 35 or 36 or 37 or 38 or 39
41. repeatability.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
42. reproducibility.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
43. reliability.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
44. (interobserver or or inter-observer).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
45. (intraobserver or intra-observer).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
46. observer variation.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
47. (interrater or inter-rater or interater).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
48. (intrarater or intra-rater).mp. [mp=title, original title, abstract, name of substance word, subject heading word]
49. 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48
50. 30 or 34 or 40 or 49
51. 1 and 21 and 50
52. 51 limited to human

Appendix 3 Other MRI abnormalities

Spinal stenosis

Spinal stenosis was most often classified simply as present or absent, or according to whether it was moderate or severe. Most studies found prevalence rates between 3% and 13% in people who had no LBP[6,16,33,36,42,51,52], but in one, the prevalence of moderate or severe changes was reported as 31%[4]. One study found an odds ratio of 1.5 (95%CI 0.8-2.9) for the association of spinal stenosis with LBP[6]. The only other investigation with relevant data was much smaller, and indicated an odds ratio of 6.7 (95%CI 1.4-33)[52].

Endplate defects and Schmorl's nodes

Schmorl's nodes and other endplate changes in the lumbar spine were reported in some 20% to 30% of subjects who were free from LBP[6,42,51]. Only one report was found of the association between such changes and the presence of LBP, and this gave an odds ratio of 0.9 (95%CI 0.6-1.4)[6].

Spondylolisthesis

Only one study assessed the association of spondylolisthesis with LBP[6]. Odds ratios for anterolisthesis and retrolisthesis were 6.1 (95%CI 0.8-47) and 1.4 (95%CI 0.1-13.2) respectively.

Facet joint arthropathy

The threshold for diagnosis of facet joint arthropathy was not well standardised between studies, and estimates of prevalence in people without LBP ranged from 3% to 76%[6,7,16,18,36,42,51,56]. Two studies gave information on the association between facet joint arthropathy and LBP, with odds ratios of 1.1 (95%CI 0.7-1.6)[6] and 4.4 (95%CI 0.9-21)[7].

Reference List

1. Lötters F, Burdorf A, Kuiper J, et al. Model for the work-relatedness of low-back pain. Scand J Work Environ Health. 2003; 29:431–40. [PubMed: 14712849]
2. Pincus T, Burton AK, Vogel S, et al. A systematic review of psychological factors as predictors of chronicity/disability in prospective cohorts of low back pain. Spine. 2002; 27:E109–20. [PubMed: 11880847]
3. Linton SJ. A review of psychological risk factors in back and neck pain. Spine. 2000; 25:1148–56. [PubMed: 10788861]
4. Haig AJ, Tong HC, Yamakawa KS, et al. Spinal stenosis, back pain, or no symptoms at all? A masked study comparing radiologic and electrodiagnostic diagnoses to the clinical impression. Arch Phys Med Rehabil. 2006; 87:897–903. [PubMed: 16813774]
5. Swärd L, Hellström M, Jacobsson B, et al. Disc degeneration and associated abnormalities of the spine in elite gymnasts. A magnetic resonance imaging study. Spine. 1991; 16:437–43. [PubMed: 1828629]
6. Kjaer P, Leboeuf-Yde C, Korsholm L, et al. Magnetic resonance imaging and low back pain in adults: a diagnostic imaging study of 40-year-old men and women. Spine. 2005; 30:1173–80. [PubMed: 15897832]
7. Savage RA, Whitehouse GH, Roberts N. The relationship between the magnetic resonance imaging appearance of the lumbar spine and low back pain, age and occupation in males. Eur Spine J. 1997; 6:106–14. [PubMed: 9209878]
8. Luoma K, Riihimaki H, Luukkonen R, et al. Low back pain in relation to lumbar disc degeneration. Spine. 2000; 25:487–92. [PubMed: 10707396]

9. van Rijn JC, Klemetsö N, Reitsma JB, et al. Observer variation in MRI evaluation of patients suspected of lumbar disk herniation. AJR. 2005; 184:299–303. [PubMed: 15615992]
10. Schenk P, Läubli T, Hodler J, et al. Magnetic resonance imaging of the lumbar spine: findings in female subjects from administrative and nursing professions. Spine. 2006; 31:2701–6. [PubMed: 17077739]
11. van Rijn JC, Klemetso N, Reitsma JB, et al. Observer variation in the evaluation of lumbar herniated discs and root compression: spiral CT compared with MRI. Br J Radiol. 2006; 79:372–7. [PubMed: 16632616]
12. Cihangiroglu M, Yildirim H, Bozgeyik Z, et al. Observer variability based on the strength of MR scanners in the assessment of lumbar degenerative disc disease. Eur J Radiol. 2004; 51:202–8. [PubMed: 15294326]
13. Vroomen PCAJ, Wilmink JT, de Krom MCTFM. Prognostic value of MRI findings in sciatica. Neuroradiology. 2002; 44:59–63. [PubMed: 11942502]
14. Borenstein DG, O'Mara JW Jr. Boden SD, et al. The value of magnetic resonance imaging of the lumbar spine to predict low-back pain in asymptomatic subjects : a seven-year follow-up study. J Bone Joint Surg. 2001; 83-A:1306–11. [PubMed: 11568190]
15. Cooley JR, Danielson CD, Schultz GD, et al. Posterior disk displacement: morphologic assessment and measurement reliability-lumbar spine. Journal of Manipulative & Physiological Therapeutics. 2001; 24:317–26. [PubMed: 11416821]
16. Jarvik JJ, Hollingworth W, Heagerty P, et al. The Longitudinal Assessment of Imaging and Disability of the Back (LAIDBack) Study: baseline data. Spine. 2001; 26:1158–66. [PubMed: 11413431]
17. Milette PC, Fontaine S, Lepanto L, et al. Differentiating lumbar disc protrusions, disc bulges, and discs with normal contour but abnormal signal intensity. Magnetic resonance imaging with discographic correlations. Spine. 1999; 24:44–53. [PubMed: 9921590]
18. Weishaupt D, Zanetti M, Hodler J, et al. MR imaging of the lumbar spine: prevalence of intervertebral disk extrusion and sequestration, nerve root compression, end plate abnormalities, and osteoarthritis of the facet joints in asymptomatic volunteers. Radiology. 1998; 209:661–6. [PubMed: 9844656]
19. Jarvik JG, Haynor DR, Koepsell TD, et al. Interreader reliability for a new classification of lumbar disk disease. Acad Radiol. 1996; 3:537–44. [PubMed: 8796714]
20. Boos N, Rieder R, Schade V, et al. 1995 Volvo Award in Clinical Sciences. The diagnostic accuracy of magnetic resonance imaging, work perception, and psychosocial factors in identifying symptomatic disc herniations. Spine. 1995; 20:2613–25. [PubMed: 8747239]
21. Brant-Zawadzki MN, Jensen MC, Obuchowski N, et al. Interobserver and intraobserver variability in interpretation of lumbar disc abnormalities. A comparison of two nomenclatures. Spine. 1995; 20:1257–63. [PubMed: 7660234]
22. Raininko R, Manninen H, Battié MC, et al. Observer variability in the assessment of disc degeneration on magnetic resonance images of the lumbar and thoracic spine. Spine. 1995; 20:1029–35. [PubMed: 7631232]
23. Salminen JJ, Erkintalo MO, Pentti J, et al. Recurrent low back pain and early disc degeneration in the young. Spine. 1999; 24:1316–21. [PubMed: 10404573]
24. Visuri T, Ulaska J, Eskelin M, et al. Narrowing of lumbar spinal canal predicts chronic low back pain more accurately than intervertebral disc degeneration: a magnetic resonance imaging study in young Finnish male conscripts. Military Medicine. 2005; 170:926–30. [PubMed: 16450819]
25. Speciale AC, Pietrobon R, Urban CW, et al. Observer variability in assessing lumbar spinal stenosis severity on magnetic resonance imaging and its relation to cross-sectional spinal canal area. Spine. 2002; 27:1082–6. [PubMed: 12004176]
26. Beattie PF, Meyers SP, Stratford P, et al. Associations between patient report of symptoms and anatomic impairment visible on lumbar magnetic resonance imaging. Spine. 2000; 25:819–28. [PubMed: 10751293]
27. Hollingworth W, Dixon AK, Todd CJ, et al. Self reported health status and magnetic resonance imaging findings in patients with low back pain. Eur Spine J. 1998; 7:369–75. [PubMed: 9840469]

28. Pfirrmann CWA, Metzdorf A, Zanetti M, et al. Magnetic resonance classification of lumbar intervertebral disc degeneration. Spine. 2001; 26:1873–8. [PubMed: 11568697]
29. Rankine JJ, Fortune DG, Hutchinson CE, et al. Pain drawings in the assessment of nerve root compression: a comparative study with lumbar spine magnetic resonance imaging. Spine. 1998; 23:1668–76. [PubMed: 9704374]
30. Mulconrey DS, Knight RQ, Bramble JD, et al. Interobserver reliability in the interpretation of diagnostic lumbar MRI and nuclear imaging. Spine J. 2006; 6:177–84. [PubMed: 16517390]
31. Sambrook PN, MacGregor AJ, Spector TD. Genetic influences on cervical and lumbar disc degeneration: a magnetic resonance imaging study in twins. Arthritis Rheum. 1999; 42:366–72. [PubMed: 10025932]
32. Beattie PF, Brooks WM, Rothstein JM, et al. Effect of lordosis on the position of the nucleus pulposus in supine subjects. A study using magnetic resonance imaging. Spine. 1994; 19:2096–102. [PubMed: 7825052]
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. 1990; 72-A:403–8. [PubMed: 2312537]
34. Carragee EJ, Tanner CM, Khurana S, et al. The rates of false-positive lumbar discography in select patients without low back symptoms. Spine. 2000; 25:1373–80. [PubMed: 10828919]
35. Chung CB, Vande Berg BC, Tavernier T, et al. End plate marrow changes in the asymptomatic lumbosacral spine: frequency, distribution and correlation with age and degenerative changes. Skeletal Radiol. 2004; 33:399–404. [PubMed: 15138721]
36. Healy JF, Healy BB, Wong WH, et al. Cervical and lumbar MRI in asymptomatic older male lifelong athletes: frequency of degenerative findings. Journal of Computer Assisted Tomography. 1996; 20:107–12. [PubMed: 8576458]
37. Paajanen H, Erkintalo M, Kuusela T, et al. Magnetic resonance study of disc degeneration in young low-back pain patients. Spine. 1989; 14:982–5. [PubMed: 2528827]
38. Paajanen H, Erkintalo M, Parkkola R, et al. Age-dependent correlation of low-back pain and lumbar disc degeneration. Arch Orthop Trauma Surg. 1997; 116:106–7. [PubMed: 9006777]
39. Ranson CA, Kerslake RW, Burnett AF, et al. Magnetic resonance imaging of the lumbar spine in asymptomatic professional fast bowlers in cricket. J Bone Joint Surg. 2005; 87-B:1111–6.
40. Stadnik TW, Lee RR, Coen HL, et al. Annular tears and disk herniation: prevalence and contrast enhancement on MR images in the absence of low back pain or sciatica. Radiology. 1998; 206:49–55. [PubMed: 9423651]
41. Powell MC, Wilson M, Szypryt P, et al. Prevalence of lumbar disc degeneration observed by magnetic resonance in symptomless women. Lancet. 1986; 2:1366–7. [PubMed: 2878228]
42. Carragee E, Alamin T, Cheng I, et al. Are first-time episodes of serious LBP associated with new MRI findings? Spine J. 2006; 6:624–35. [PubMed: 17088193]
43. Aprill C, Bogduk N. High-intensity zone: a diagnostic sign of painful lumbar disc on magnetic resonance imaging. Br J Radiol. 1992; 65:361–9. [PubMed: 1535257]
44. Smith BM, Hurwitz EL, Solsberg D, et al. Interobserver reliability of detecting lumbar intervertebral disc high-intensity zone on magnetic resonance imaging and association of high-intensity zone with pain and anular disruption. Spine. 1998; 23:2074–80. [PubMed: 9794051]
45. Carragee EJ, Paragioudakis SJ, Khurana S. 2000 Volvo Award Winner in Clinical Studies: Lumbar high-intensity zone and discography in subjects without low back problems. Spine. 2000; 25:2987–92. [PubMed: 11145809]
46. Palmer KT, Griffin MJ, Syddall HE, et al. Raynaud's phenomenon, vibration induced white finger, and difficulties in hearing. Occup Environ Med. 2002; 59:640–2. [PubMed: 12205240]
47. Clinical Standards Advisory Group. Epidemiology review: the epidemiology and cost of back pain. HMSO; London: 1994.
48. Modic MT, Obuchowski NA, Ross JS, et al. Acute low back pain and radiculopathy: MR imaging findings and their prognostic role and effect on outcome. Radiology. 2005; 237:597–604. [PubMed: 16244269]
49. Siddiqui AH, Rafique MZ, Ahmad MN, et al. Role of magnetic resonance imaging in lumbar spondylosis. JCPSP. 2005; 15:396–9. [PubMed: 16197866]

50. Summers B, Malhan K, Cassar-Pullicino V. Low back pain on passive straight leg raising: the anterior theca as a source of pain. Spine. 2005; 30:342–5. [PubMed: 15682017]
51. Jensen MC, Brant-Zawadzki MN, Obuchowski N, et al. Magnetic resonance imaging of the lumbar spine in people without back pain. N Eng J Med. 1994; 331:69–73.
52. Parkkola R, Rytökoski U, Kormano M. Magnetic resonance imaging of the discs and trunk muscles in patients with chronic low back pain and healthy control subjects. Spine. 1993; 18:830–6. [PubMed: 8316880]
53. Mikhael MA, Ciric IS, Kudrna JC, et al. Recognition of lumbar disc disease with magnetic resonance imaging. Computerized Radiol. 1985; 9:213–22.
54. Schellhas KP, Pollei SR, Gundry CR, et al. Lumbar disc high-intensity zone. Correlation of magnetic resonance imaging and discography. Spine. 1996; 21:79–86. [PubMed: 9122767]
55. Weinreb JC, Wolbarsht LB, Cohen JM, et al. Prevalence of lumbosacral intervertebral disk abnormalities on MR images in pregnant and asymptomatic nonpregnant women. Radiology. 1989; 170:125–8. [PubMed: 2521192]
56. Tong HC, Carson JT, Haig AJ, et al. Magnetic resonance imaging of the lumbar spine in asymptomatic older adults. Journal of Back & Musculoskeletal Rehabilitation. 2006; 19:67–72.

Europe PMC Funders Author Manuscripts

Europe PMC Funders Author Manuscripts

Spine (Phila Pa 1976). Author manuscript; available in PMC 2011 July 15.

Table 1

Prevalence of disc herniation in people who do not have low back pain

Reference	Population studied	Numbers of subjects (number male)	Mean age (range)	Number of discs examined per person	Grade of disc herniation	Prevalence % (95% CI)
Boden et al, 1990[33]	Volunteers with no history of LBP lasting > 24 hours or leading to absence from work, or of sciatica	67 (30)	42 (20-80)	5	Extrusion beyond confines of vertebral body resulting in displacement of epidural fat, nerve root or thecal sac	24% (14%-36%)
Boos et al, 1995[20]	Volunteers from trauma clinic who had never consulted or been absent from work because of LBP	46 (34)	36 (20-50)	5	≥ protrusion Extrusion	76% (61%-87%) 13% (5%-26%)
Chung et al, 2004[35]	Volunteers with no history of LBP or related complaints	59 (28)	42 (20-75)	5	Protrusion	20% (11%-33%)
Haig et al, 2006[4]	Volunteers with no back pain	32 (NA *)	66 (55-80)	6	Herniation	19% (7%-36%)
Healey et al, 1996[36]	Asymptomatic athletes	19 (19)	53 (41-69)	5	Central protrusion Herniation	58% (34%-80%) 21% (6%-46%)
Jarvik et al, 2001[16]	Patients with no LBP in the past 4 months that was more than mildly bothersome	148 (131)	54 (36 -71)	5	Protrusion Extrusion	32% (25%-40%) 6% (3%-11%)
Jensen et al, 1994[51]	Volunteers with no history of LBP lasting >48 hours or of lumbosacral radiculopathy	98 (50)	42 (20-80)	5	Protrusion Extrusion	27% (18%-36%) 1% (0%-6%)
Kjaer et al, 2005[6]	Volunteers from general population with no LBP in past year	128 (NA *)	40 (40-40)	5	≥ protrusion	22% (15%-30%)
Parkkola et al, 1993[52]	Volunteers from general population with no history of back pain	60 (NA *)	NA *(30-47)	3	≥ protrusion	15% (7%-27%)
Mikhael et al, 1985[53]	Normal volunteers	10 (5)	NA *(≥19-≤72)	5	Central herniation	10% (0%-45%)
Salminen et al, 1999[23]	Schoolchildren with no history of LBP	19 (NA *)	18 (18-18)	5	Protrusion	16% (3%-40%)
Savage et al, 1997[7]	Volunteers from 5 occupations with no LBP in past year	70	NA *(≥20-≤58)	5	Protrusion	4% (1%-12%)
Schellhas et al, 1995[54]	Volunteers with no history of LBP or radicular pain	17 (NA *)	30 (22-54)	5	Herniation	0% (0%-20%)
Stadnik et al, 1998[40]	Volunteers referred for head and neck imaging with no LBP or sciatica in past 6 months	36 (20)	42 (17-71)	3	Protrusion Extrusion	33% (19%-51%) 0% (0%-10%)
Visuri et al, 2005[24]	Male conscripts who had never had LBP	90 (90)	20 (18-26)	5	Protrusion Extrusion with nerve root or dural contact and spinal or root canal compromise	12% (6%-21%) 14% (8%-23%)
Weinreb et al, 1989[55]	Asymptomatic non-pregnant volunteers	41 (0)	30 (19-40)	3	Herniation extending beyond margins of vertebral endplates with displacement of epidural fat, nerve root or thecal sac	10% (3%-23%)
Weishaupt et al, 1998[18]	Volunteers referred for non-spinal imaging who had never consulted or been absent from work because of LBP	60 (30)	35 (20-50)	5	Protrusion Extrusion	40% (28%-54%) 18% (10%-30%)
Carragee et al, 2006[42]	Cervical disc disease patients with no history of LBP causing functional loss or requiring treatment	200 (119)	39 (NA *)	5	Protrusion Extrusion	31% (24%-37%) 7% (4%-12%)
Tong et al, 2006[56]	Asymptomatic volunteers	33 (13)	65 (55-79)	5	Herniation	18% (7%-36%)

* NA = not available

Europe PMC Funders Author Manuscripts

Spine (Phila Pa 1976). Author manuscript; available in PMC 2011 July 15.

Table 2

Association of disc herniation with low back pain

Reference	Population studied	Grade of disc herniation	Low back pain		No low back pain		Odds ratio (95% CI)
			Disc herniation n (%)	No disc herniation n (%)	Disc herniation n (%)	No disc herniation n (%)	
Boos et al, 1995[20]	46 LBP patients with concordant symptoms on discography: 46 volunteers who had never consulted or been absent from work because of LBP	≥ protrusion ≥ extrusion	44 (96) 19 (41)	2 (4) 27 (59)	35 (76) 6 (13)	11 (24) 40 (87)	6.9 (1.4-33.3) 4.7 (1.7-13.3)
Jensen et al, 1994[51]	27 patients with back pain; 98 volunteers with no history of back pain lasting >48 hours or of lumbosacral radiculopathy	≥ protrusion ≥ extrusion	21 (78) 7 (26)	6 (22) 20 (74)	28 (28) 1 (1)	70 (71) 97 (99)	8.8 (3.2-24.0) 34 (4.0-291)
Kjaer et al, 2005[6]	Volunteers from general population, including 284 with LBP in past year and 128 without such pain	≥ protrusion	74 (26)	210 (74)	28 (22)	100 (78)	1.3 (0.8-2.1)
Parkkola et al, 1993[52]	48 patients with chronic LBP; 60 volunteers from general population with no history of back pain	Protrusion or prolapse	20 (42)	28 (58)	9 (15)	51 (85)	4.1 (1.6-10.1)
Savage et al, 1997[7]	149 volunteers from 5 occupations, including 79 with LBP in past year and 70 without such pain	≥ protrusion	12 (15)	67 (85)	3 (4)	67 (96)	4.0 (1.1-14.8)
Visuri et al, 2005[24]	108 male conscripts with chronic LBP: 90 male conscripts who had never had LBP	Protrusion Extrusion with nerve root or dural contact and spinal or root canal compromise	33 (31) 31 (29)	75 (69) 77 (71)	11 (12) 13 (14)	79 (88) 77 (86)	3.2 (1.5-6.7) 2.4 (1.2-4.9)

Europe PMC Funders Author Manuscripts

Spine (Phila Pa 1976). Author manuscript; available in PMC 2011 July 15.

Table 3

Prevalence of nerve root impingement in people who do not have low back pain

Reference	Population studied	Numbers of subjects (number male)	Mean age (range)	Number of levels examined per person	Grade of nerve root impingement	Prevalence % (95% CI)
Boos et al, 1995[20]	Volunteers from trauma clinic who had never consulted or been absent from work because of LBP	46 (34)	36 (20-50)	5	Contact or displacement	17% (8%-31%)
Jarvik et al, 2001[16]	Patients with no LBP in the past 4 months that was more than mildly bothersome	148 (131)	54 (36 -71)	5	Compression Displacement or compression	4% (1%-15%) 3% (1%-8%)
Kjaer et al, 2005[6]	Volunteers from general population with no LBP in past year	128 (NA *)	40 (40-40)	5	Displacement or compression	4% (1%-9%)
Savage et al, 1997[7]	Volunteers from 5 occupations with no LBP in past year	70 (70)	NA * (≥20-≤58)	5	Compression	3% (0%-10%)
Weishaupt et al, 1998[18]	Volunteers referred for non-spinal imaging who had never consulted or been absent from work because of LBP	60 (30)	35 (20-50)	5	Contact Displacement Compression	23% (13%-36%) 5% (1%-14%) 2% (0%-9%)
Carragee et al, 2006[42]	Cervical disc disease patients with no history of LBP causing functional loss or requiring treatment	200 (119)	39 (NA *)	5	Contact Displacement or compression	11% (7%-15%) 3% (1%-6%)

* NA = not available

Europe PMC Funders Author Manuscripts

Spine (Phila Pa 1976). Author manuscript; available in PMC 2011 July 15.

Table 4

Association of nerve root impingement with low back pain

Reference	Population studied	Grade of nerve root impingement	Low back pain		No low back pain		Odds ratio (95% CI)
			Nerve root impingement n (%)	No nerve root impingement n (%)	Nerve root impingement n (%)	No nerve root impingement n (%)	
Boos et al, 1995[20]	46 LBP patients with concordant symptoms on discography: 46 volunteers who had never consulted or been absent from work because of LBP	Contact, displacement or compression Compression	38 (83) 25 (54)	8 (17) 21 (46)	10 (22) 2 (4)	36 (78) 44 (96)	17 (6.1-48) 26 (5.7-121)
Kjaer et al,2005[6]	Volunteers from general population, including 284 with LBP in past year and 128 without such pain	Displacement or compression	23 (8)	251 (92)	5 (4)	123 (96)	2.2 (0.8-5.6)
Savage et al, 1997[7]	149 volunteers from 5 occupations, including 79 with LBP in past year and 70 without such pain	Compression	5 (6)	74 (94)	2 (3)	69 (97)	2.3 (0.4-12.4)

Europe PMC Funders Author Manuscripts

Spine (Phila Pa 1976). Author manuscript; available in PMC 2011 July 15.

Table 5

Prevalence of high intensity zone in people who do not have low back pain

Reference	Population studied	Numbers of subjects (number male)	Mean age (range)	Number of discs examined per person	Prevalence % (95% CI)
Jarvik et al, 2001[16]	Patients with no LBP in the past 4 months that was more than mildly bothersome	148 (131)	54 (36 -71)	5	38% (30%-46%)
Kjaer et al, 2005[6]	Volunteers from general population with no LBP in past year	128 (NA*)	40 (40-40)	5	27% (19%-34%)
Schellhas et al, 1995[54]	Volunteers with no history of LBP or radicular pain	17 (NA*)	30 (22-54)	5	6% (0%-29%)
Stadnik et al, 1998[40]	Volunteers referred for head and neck imaging with no LBP or sciatica in past 6 months	36 (20)	42 (17-71)	3	56% (38%-72%)
Weishaupt et al, 1998[18]	Volunteers referred for non-spinal imaging who had never consulted or been absent from work because of LBP	60 (30)	35 (20-50)	5	32% (20%-45%)
Carragee et al, 2006[42]	Cervical disc disease patients with no history of LBP causing functional loss or requiring treatment	200 (119)	39 (NA*)	5	20% (14%-25%)
Carragee et al, 2000[45]	Patients from various sources with no recent LBP	54 (44)	40 (22-57)	3	24% (13-38%)

*NA = not available

Europe PMC Funders Author Manuscripts

Table 6

Estimates of prevalence rate ratio and attributable fraction in cases for associations of MRI abnormalities with low back pain

MRI abnormality	Prevalence of MRI abnormality in people without LBP	Odds ratio for association of MRI abnormality with LBP	Prevalence of LBP = 30%		Prevalence of LBP = 50%		Prevalence of LBP = 67%	
			PRR	AF_{cases}	PRR	AF_{cases}	PRR	AF_{cases}
Disc protrusion	27%	3.6	2.4	0.58	1.8	0.45	1.5	0.33
Nerve root displacement / compression	4%	2.3	1.7	0.40	1.4	0.29	1.2	0.19
Disc degeneration	54%	2.5	1.9	0.49	1.6	0.39	1.4	0.28
HIZ/annular tear	28%	2.5	1.9	0.46	1.5	0.35	1.3	0.25

Spine (Phila Pa 1976). Author manuscript; available in PMC 2011 July 15.