Risk factors for the first episode of low back pain in children are infrequently validated across samples and conditions: a systematic review

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**Question:** What risk factors have been identified for the first episode of low back pain in children and adolescents? Have these risk factors been validated? **Design:** Systematic review of prospective studies designed to identify possible modifiable and non-modifiable risk factors for the onset of low back pain in children and adolescents. **Participants:** School children aged up to 18 years without low back pain at enrolment. **Results:** Five studies were included in the review. The included studies varied considerably in methods used to gather data, definitions of low back pain, and recall periods for an episode of low back pain. Forty-seven possible risk factors had been assessed for association with a first episode of low back pain in children. Of these, 13 were significantly associated with a first episode of low back pain. No risk factor was found to be associated with future low back pain in children in more than one study. **Conclusion:** Inconsistency in definitions of low back pain, pre-defined recall periods, and methods used to collect and analyse data limit conclusions that can be drawn about factors that identify children at risk of developing low back pain. As no risk factor has been validated in independent investigation, we have no certainty that any factor places children at risk of developing low back pain. [Hill JJ, Keating JL (2010) Risk factors for the first episode of low back pain in children are infrequently validated across samples and conditions: a systematic review. *Journal of Physiotherapy* 56: 237–244]

**Key words:** Low Back Pain, Back Pain, Risk, Adolescent, Children

**Introduction**

In a systematic review of 35 studies of the incidence and prevalence of low back pain (Hill and Keating 2009), 18 studies provided data on lifetime prevalence. Lifetime prevalence of low back pain gradually increases from 1% at age 7 years, to 12–40% at 12 years (Balague et al 1988, Balague et al 1994). Lifetime prevalence continues to increase steadily with age, almost doubling between 12 and 15 years to reach 39–71%, and continuing to increase into the late teens. Given these high prevalence rates, and that a previous episode of low back pain is a known risk factor for a new episode (Battie and Bigos 1991, Burton et al 2005, Hestbaek et al 2006, Hestbaek et al 2003, Jones and Macfarlane 2005), primary prevention of the first episode of low back pain would appear to be a sensible target.

It may be possible to develop strategies to prevent first instance of low back pain if risk factors were understood. Low back pain may be an inherent consequence of a person’s individual genetic factors (Leboeuf-Yde 2004). It may be a consequence of, or influenced by, psychological factors (Balague et al 1999, Cardon and Balague 2004, Leboeuf-Yde 2004). It may be due to loads placed on the body by lifestyle demands and physical activity or school-related activity (Balague et al 1999, Duggleby and Kumar 1997, Jones et al 2003). Identification of modifiable risk factors for future low back pain could help in the development of preventive strategies.

Previous literature reviews have investigated risk factors related to recalled episodes of low back pain, or monitored episodes prospectively over defined study periods (Balague et al 1999, Cardon and Balague 2004, Duggleby and Kumar 1997, Jones and Macfarlane 2005, Leboeuf-Yde 2004, Steele et al 2001, Trevelyan et al 2006). However, no review has specifically sought factors associated with the first episode of low back pain. This may be why no studies have evaluated how modification of risk factors affects the incidence of low back pain in children (Burton et al 2005). Therefore, this review specifically focuses on risk factors for the first episode of low back pain. Of particular interest is the identification of potentially modifiable risk factors, as these may indicate possible strategies to protect young people from developing low back pain.

Earlier studies and reviews into risk factors for low back pain in children and adolescents have implicated genetic factors, environmental factors (El-Metwally et al 2008), psychosocial factors such as negative psychosocial experiences in childhood (Cardon and Balague 2004, Jones and Macfarlane 2005), and levels of physical activity (Duggleby and Kumar 1997, Leboeuf-Yde 2004). The only risk factor established by these reviews for an episode of low back pain is a previous episode (Battie and Bigos 1991, Burton et al 2005, Hestbaek et al 2006, Hestbaek et al 2003, Jones and Macfarlane 2005). Only one of these reviews was a systematic review (Cardon and Balague 2004), and it searched only one database, searched publications in only a 9-year period, and was published in 2004. Furthermore, none of the reviews investigated risk factors for the first episode of low back pain specifically. Therefore an up-to-date systematic review is required. Such a review should consider children and adolescents up to 18 years of age, because children appear more prone to low back pain during times of increased growth (Fairbank et al 1984, Feldman et al 2001, Harreby et al 1996, Olsen et al 1992). Rapid growth in males begins at around 12.5 years, with completion typically between 13.5 and 17.5 years. Females
commence and finish growth spurts on average two years prior to this (Duggleby and Kumar 1997).

Therefore, the specific study questions for this systematic review were:
1. What modifiable and non-modifiable risk factors have been identified for the first episode of low back pain in children and adolescents?
2. Have these risk factors been validated?

**Method**

**Identification and selection of studies**

The method of this review was based on the Cochrane Handbook for Systematic Reviews of Interventions (Higgins and Green 2006), adapted for the systematic review of longitudinal and cross-sectional studies, and the MOOSE Statement (Stroup et al 2000). A grid of search terms and definitions of interest was developed and converted to a sensitive search strategy for each database searched. The following databases were searched for all available records up to and including August 2009: MEDLINE (see Appendix 1 on the eAddenda for the full MEDLINE search strategy), CINAHL, AMED, Embase, PsycINFO, Australian Medical Index, the Cochrane Database of Systematic Reviews, and the Cochrane Central Register of Controlled Trials. Authors cited in relevant reports were followed with citation tracking. The reference lists of relevant articles were hand searched for additional relevant papers. Search results were imported into bibliographic management software and duplicates discarded. The titles and abstracts were screened against the inclusion criteria (Box 1) by one author (JH). The full text of potentially relevant papers was obtained and assessed against the same criteria. Non-English language publications were excluded.

**Box 1. Inclusion criteria.**

**Design**
- Prospective cohort studies
- Randomised trials
- Any other study where quantitative data on possible risk factors were collected at enrolment and subsequent occurrence of low back pain was recorded prospectively

**Participants**
- Aged 18 years or younger
- Unselected participants (eg, not specific athletic groups)

**Outcomes**
- Risk of subsequent onset of low back pain associated with a previously measured factor, where an episode of low back pain and any recall period are clearly defined, and where the low back pain does not develop as a result of serious pathology, as defined by red flags (Rosen 1994).

**Assessment of the characteristics of the studies**

**Quality:** There is no ‘gold standard’ for assessing the quality of the methods used in studies of risk factors. Bias, confounding, and chance can distort the validity of epidemiological studies (Zaccai 2004) and studies of predictive utility. Quality assessment criteria were therefore developed to identify sources of bias that might affect the credibility of conclusions about the relationships between possible risk factors and the first episode of low back pain.

Nine quality assessment criteria were chosen, based on arguments made in the MOOSE Statement (Stroup et al 2000) and by Hoogendorn and colleagues (2000). The criteria were grouped under three questions related to the representativeness of the study population, the definition of an episode of low back pain, and the data collection and analysis. Included studies were awarded a ‘yes’ for each of the quality criteria that were clearly met and a ‘no’ for criteria that were not met or that could not be determined from the methods reported. The maximum quality score that could be achieved was 9.

**Box 2. Questions and criteria used to assess the methodological quality of included studies.**

- Is the target population accurately represented?
  - Sampling: the whole target population, a random sample, or authors state ‘representative of target population’
  - Response rate: 70% or greater
  - Non-responders: any characteristics that could influence the results are similar to those of responders
- Is an episode of low back pain accurately and clearly defined?
  - Area: participants are told which areas of the body can be considered sources of low back pain
  - Episode: definition includes a duration and a time period of separation from a previous episode
  - Severity: definition includes ‘troublesomeness’ via self-reported pain, activity limitation or participation restriction
- Are the data appropriate?
  - Data: collected directly from the participant
  - Prevalence: proportion of cases in each group is stated
  - 95% CI: confidence interval around prevalence estimate is stated or calculable

**Description of studies:** The following data were systematically extracted from included papers: participants (number, age, gender, source), representativeness of the cohort (response rate, information about non-responders), measures (definition of first episode of low back pain, list of possible risk factors assessed, measurement tools), and analysis (statistical method, results of analyses of association between possible risk factors and the first episode of low back pain). These data were extracted by one author (JH) using a standardised form, with duplicate extraction by the second author in cases that required interpretation.

**Data analysis**

The characteristics of the included studies were tabulated for comparison. Possible risk factors that were assessed in any of the studies were categorised as: anthropometry, growth, mobility and endurance, pain provocation tests, activity, or other. Risk factors, number of times investigated, number of times found to be a significant predictor and the strength of the association between the risk factor and subsequent back pain were extracted or calculated.
Results

Flow of studies through the review
The search identified 73 papers, of which five met the inclusion criteria (Jones et al 2003, Nissinen et al 1994, Poussa et al 2005, Sjolie and Ljunggren 2001, Szpalski et al 2002). Figure 1 shows the process of study selection and the number of studies excluded at each stage.

Table 1. Quality of included studies (n = 5).

<table>
<thead>
<tr>
<th>Study</th>
<th>Sampling</th>
<th>Non-responders</th>
<th>Response rate</th>
<th>Total (0 to 9)</th>
<th>Prevalence</th>
<th>95% CI</th>
<th>Data</th>
<th>Severity</th>
<th>Episode</th>
<th>Area</th>
<th>Non-specific area of pain</th>
<th>Adult participants</th>
<th>No data about first episode of low back pain</th>
<th>Not prospective data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jones et al (2003)</td>
<td>Y</td>
<td></td>
<td>Y</td>
<td>8</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Nissinen et al (1994)</td>
<td>Y</td>
<td></td>
<td>Y</td>
<td>7</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Poussa et al (2005)</td>
<td>Y</td>
<td></td>
<td>Y</td>
<td>7</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Sjolie &amp; Ljunggren (2001)</td>
<td>Y</td>
<td></td>
<td>Y</td>
<td>8</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Szpalski et al (2002)</td>
<td>Y</td>
<td></td>
<td>Y</td>
<td>7</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

Table 2 summarises the characteristics of the participants in the included studies. Sample sizes varied from 88 to 1046. There was variation in the socioeconomic status of schools,
Table 2. Summary of included studies (n = 5).

<table>
<thead>
<tr>
<th>Study</th>
<th>Participants</th>
<th>Source</th>
<th>Design</th>
<th>Physical examination</th>
<th>Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jones et al (2003)</td>
<td>n = 1046</td>
<td>39 secondary schools in northwest England</td>
<td>Cross-sectional and prospective over 1 yr</td>
<td>Medical examination (details not specified)</td>
<td>Questionnaire survey</td>
</tr>
<tr>
<td></td>
<td>Age range (yr) = 11-14</td>
<td>Gender = ?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Niissinen et al (1994)</td>
<td>n = 855</td>
<td>All Grade 4 of the Western school district of Helsinki (&gt; 2 schools), Finland</td>
<td>Cross-sectional and prospective over 2 yr</td>
<td>Medical examination (details not specified)</td>
<td>Questionnaire (validated)</td>
</tr>
<tr>
<td>Poussa et al (2005)</td>
<td>n = 430</td>
<td>All Grade 4 of the Western school district of Helsinki (&gt;2 schools), Finland</td>
<td>Prospective over 11 yr</td>
<td>Medical examination (details not specified)</td>
<td>Questionnaire at 13.8 and 21.9 yr (validated)</td>
</tr>
<tr>
<td>Sjolie &amp; Ljunggren (2001)</td>
<td>n = 88</td>
<td>All Grade 8 and 9 (1 urban and 1 rural school) in Eastern Norway</td>
<td>Cross-sectional and prospective over 3 yr</td>
<td>Lumbar mobility, using Schober's modified technique, Lumbar static strength, using endurance extension strength</td>
<td>Nordic questionnaire and additional specific child questions</td>
</tr>
<tr>
<td>Szpalski et al (2001)</td>
<td>n = 287</td>
<td>City of Antwerp, Belgium</td>
<td>Cross-sectional and prospective over 2 yr</td>
<td>Medical examination (details not specified)</td>
<td>Questionnaire at start of yr 1 and 3 (validated)</td>
</tr>
</tbody>
</table>

SDQ = Strengths and Difficulties Questionnaire, ? = unknown

Table 3. Methods of defining low back pain for participants in the included studies (n = 5).

<table>
<thead>
<tr>
<th>Study</th>
<th>Description of low back pain/ Determination of a previous episode</th>
<th>Affected area</th>
<th>New episode</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jones et al (2003)</td>
<td>'Low back pain'</td>
<td>Diagram of the lumbar spine</td>
<td>'New onset'</td>
<td>Time in the previous month you have had low back pain for 1 day or more?</td>
</tr>
<tr>
<td></td>
<td>No low back pain at baseline or in the previous month</td>
<td></td>
<td></td>
<td>Not assessed</td>
</tr>
<tr>
<td>Niissinen et al (1994)</td>
<td>'Low back pain'</td>
<td>Diagram of the lumbar spine, with the area demonstrated by the examiner to each participant</td>
<td>Time in the previous year with low back pain?</td>
<td>Visited doctor, Affected stand, sit, walk, run, leisure, physical education</td>
</tr>
<tr>
<td>Poussa et al (2005)</td>
<td>'Low back pain'</td>
<td>Diagram of the lumbar spine, with the area demonstrated by the examiner to each participant</td>
<td>'Incident low back pain'</td>
<td>Time in the previous 12 months you have had low back pain for 8 days or more?</td>
</tr>
<tr>
<td></td>
<td>No low back pain before 14 yr of age</td>
<td></td>
<td></td>
<td>Not assessed</td>
</tr>
<tr>
<td>Sjolie &amp; Ljunggren (2001)</td>
<td>Low back pain identified by the Modified Nordic questionnaire</td>
<td>Diagram of the lumbar spine</td>
<td>Time in the previous 12 months you have had low back pain for 1-30 days, or for 31 days or more?</td>
<td>Visited a health professional, Affected daily activities, gym, leisure, Analgesia required</td>
</tr>
<tr>
<td>Szpalski et al (2001)</td>
<td>'Back pain'</td>
<td>Diagram of the lumbar spine</td>
<td>New back pain in the previous 2 years?</td>
<td>Visited a health professional, Affected gym, sport, Stayed at home, 'Was the pain bearable?' Pain visual analogue scale</td>
</tr>
</tbody>
</table>
Table 3 shows the methods used by the authors to define low back pain. All five studies used a diagram of the lumbar area to clarify the location of the pain of interest but the period of time defined as an episode varied from one day (Jones et al. 2003) to 31 days (Sjolie & Ljunggren 2001). The severity of an episode was not defined in two studies (Jones et al. 2003, Poussa et al. 2005), with the remaining studies using variable definitions of severity including pain that required a visit to a doctor or pain that affected daily activities. Variable methods were used to report associations between factors and a back pain event. Only one study (Nissinen et al. 1994) reported data that enabled the construction of contingency tables.

Table 4 shows the factors that have been studied for their association with the risk of a first episode of low back pain in children, the number of times each one was studied, and the number of times significant associations were found. In the five included studies 47 potential risk factors were investigated. Of the 47 factors, only 13 were investigated in more than one study. Of these 13, nine factors were not significant in any study. The other four were found to be significant risk factors in only one study. Therefore, none of the 13 was found to be a significant risk factor in more than one study. The remaining 34 potential risk factors were assessed once, and nine were significantly associated with first episode low back pain in children.

Table 5 shows the nine factors from Table 4 that were significantly associated with a future episode of low back pain but have not yet been validated in a second study. Nissinen and colleagues (1994) found females with asymmetry of the spine at initial assessment were more likely to have low back pain the following year. Sjolie and Ljunggren (2001) found significant associations between the onset of low back pain within three years and lumbar extension endurance, the ratio of lumbar flexion mobility to lumbar extension endurance, the ratio of lumbar extension mobility to lumbar extension endurance, and the ratio of lumbar flexion and extension mobility to lumbar extension endurance. Jones and colleagues (2003) found a significant association between low back pain and the number of sporting activities each week (> 18 sessions of at least 20 min/wk). These authors also reported a positive relationship between having a part-time job and future low back pain, but not between manual labour and future low back pain. They also found that future low back pain was significantly associated with abdominal pain, and with a higher level of psychosocial difficulties, measured as the sum of four difficulties on the Strengths and Difficulties Questionnaire (Goodman 1997).

Discussion

Five prospective studies of the first episode of low back pain in children have been reported. These studies have investigated the association of 47 specified risk factors with future low back pain in children. Some additional factors were also investigated, but their association with low back pain was not reported (see, eg, Jones et al. 2003). Of those that were adequately reported, only 13 factors
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Table 5. Odds ratio or relative risk (95% CI) of future low back pain with risk factors identified once in children.

<table>
<thead>
<tr>
<th>Study and factor</th>
<th>Odds Ratio or Relative Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nissinen et al (1994)</td>
<td></td>
</tr>
<tr>
<td>Spine asymmetry in females aged 12 yr (hump size, mm)</td>
<td>OR 1.29 (1.01 to 1.57) per one SD hump size difference&lt;br&gt;OR 1.22 (1.03 to 1.42) adjusted for gender&lt;br&gt;OR 1.19 (1.00 to 1.39) adjusted for 14 other variables</td>
</tr>
<tr>
<td>Sjolie &amp; Ljunggren (2001)</td>
<td></td>
</tr>
<tr>
<td>Lumbar ext endurance in children aged 14–16 yr (min)</td>
<td>OR 0.5 (0.3 to 0.8)&lt;br&gt;OR 0.5 (0.3 to 0.8) adjusted for gender&lt;br&gt;OR 0.5 (0.3 to 0.9) adjusted for gender and baseline low back pain&lt;br&gt;OR 0.5 (0.3 to 0.9) adjusted for gender, baseline low back pain and follow-up well being and physical activity</td>
</tr>
<tr>
<td>Lumbar flex mobility: ext endurance in children aged 14–16 yr (cm/min)</td>
<td>OR 2.2 (1.4 to 3.6)&lt;br&gt;OR 2.2 (1.3 to 3.6) adjusted for gender&lt;br&gt;OR 1.9 (1.2 to 2.8) adjusted for gender and baseline low back pain&lt;br&gt;OR 1.9 (1.1 to 3.2) adjusted for gender, baseline low back pain and follow-up well being and physical activity</td>
</tr>
<tr>
<td>Lumbar ext mobility: ext endurance in children aged 14–16 yr (cm/min)</td>
<td>OR 3.2 (1.3 to 8.1)&lt;br&gt;OR 3.2 (1.3 to 8.3) adjusted for gender&lt;br&gt;OR 2.4 (0.9 to 6.2) adjusted for gender and baseline low back pain&lt;br&gt;OR 2.5 (0.9 to 6.8) adjusted for gender, baseline low back pain and follow-up well being and physical activity</td>
</tr>
<tr>
<td>Lumbar flex+ext mobility: ext endurance in children aged 14–16 yr (cm/min)</td>
<td>OR 1.7 (1.2 to 2.4)&lt;br&gt;OR 1.7 (1.2 to 2.4) adjusted for gender&lt;br&gt;OR 1.5 (1.1 to 2.2) adjusted for gender, baseline low back pain&lt;br&gt;OR 1.5 (1.1 to 2.2) adjusted for gender, baseline low back pain and follow-up well being and physical activity</td>
</tr>
<tr>
<td>&gt; 18 vs &lt; 5 sporting activities/wk in children 11–14 yr</td>
<td>RR 1.6 (1.1 to 2.7) adjusted for age and gender</td>
</tr>
<tr>
<td>Part–time job in children 11–14 yr</td>
<td>RR 1.5 (1.1 to 2.1) adjusted for age and gender</td>
</tr>
<tr>
<td>Abdominal pain &gt; 7d/mo in children 11–14 yr</td>
<td>RR 1.8 (1.1 to 3.0) adjusted for age and gender</td>
</tr>
<tr>
<td>Psychosocial difficulties in children 11–14 yr (SDQ score)</td>
<td>RR 1.6 (1.1 to 2.3) adjusted for age and gender</td>
</tr>
</tbody>
</table>

OR = odds ratio, RR = relative risk, 95% CI = 95% confidence interval, flex = flexion, ext = extension, SDQ = Strengths and Difficulties Questionnaire (Goodman 1997)

had undergone repeat assessment. None of these 13 was identified as a significant predictor of low back pain by two independent studies (Table 4). There is considerable potential for chance findings arising from the large number of factors tested. Studies to validate associations that have only been identified once are critical prior to using these factors to identify children at risk of future low back pain.

Many confounders could affect whether a variable is identified as indicating significant risk for future low back pain. Ideally, validation studies should exactly replicate the conditions of the study in which the association was first found. Examples of confounders include sample sizes (these varied from 88 to 1046 in this review), variation in the socioeconomic status of the schools, the type of school (eg, urban or rural, state or private), and the age of children (this varied across studies from 4 to 14 at the start of the study to 12 to 22 at completion). The definition of low back pain was also a confounder, with the five included studies defining different durations and severities (Table 3). Inconsistent definition of low back pain is commonly identified as a key methodological obstacle in reviews of low back pain in both adults and children (Balague et al 1999, Duggleby and Kumar 1997, Goodman and McGrath 1991, Leboeuf-Yde and Lauritsen 1995, Walker 2000). Standardisation of the definition of an episode of low back pain would facilitate comparison and pooling of data between studies.

Periods for recalling the occurrence of low back pain also varied between the studies from one year (Jones et al 2003) to 11 years (Poussa et al 2005). Szpalski and colleagues (2002) noted that 18% of participants who reported a lifetime history of low back pain at baseline did not do so when questioned again two years later. Burton and colleagues (1996) performed a 5-year prospective study and reported high levels of error in recall of previous low back pain in children. Harreby and colleagues (1995) asked their study participants to recall low back pain that had occurred during school age after 25 years. Only 29% of participants’ reports were consistent with school records. Clearly, episodes of low back pain can be forgotten. Even with a recall period of four months, Carey and colleagues (1995) reported poor recall
of an episode of low back pain. A method of reporting that involves immediate documentation of an episode would be a credible approach to collecting data.

There was little additional support for any specific risk factor when relationships between factors were investigated. Nissinen and colleagues (1994) found that spinal asymmetry increased the risk of back pain a year later in females. However, when progression of spinal asymmetry was measured in the same cohort over eight years, it was not predictive (Poussa et al 2005). In the study by Sjolie and Ljunggren (2001), endurance of the lumbar extensors was identified as a significant risk factor. Three other measures in this study also included the endurance of lumbar extensors in their calculation, and all three were found to be significant risk factors as well, and this factor may warrant further investigation. In the same study, none of the three measures related to lumbar mobility were significantly associated with back pain risk, reinforcing the unlikely role of this factor. Results were also consistent among palpation tests, with none being associated with future low back pain. In the activity category, a very high number of sporting sessions per week was a significant risk factor, but in the same study, high levels of physical education at school were not predictive of future back pain (Jones et al 2003). These authors also reported an association between having a part-time job and future low back pain. This might appear intuitively sensible as work that loads the spine has increased the risk of back pain a year later in females.

In summary, as many variables were examined in the five studies, many of the significant associations with future low back pain may have been chance findings. Although 13 risk factors were identified, none was confirmed as significant in an independent study. Four failed to be validated as predictive in a subsequent study, which amplifies the need for validation studies. The remaining nine that await validation are spinal symmetry, lumbar spine extension endurance, the ratio of lumbar flexion mobility to extension endurance, the ratio of lumbar extension mobility to extension endurance, the ratio of lumbar flexion and extension mobility to extension endurance, high levels of physical activity, part-time work, abdominal pain, and psychosocial difficulties. Future research should use a standard definition of low back pain, use short recall periods, and report raw data to enable results to be meaningfully pooled across studies. Given the constraints of predictive studies and the many covariates, measurement of predictors may be futile and a focus on intervention studies may yield greater benefit.

References


eAddenda: Appendix 1 available at www.JoP.physiotherapy.org

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