Can We Identify People at Risk of Non-recovery after Acute Occupational Low Back Pain? Results of a Review and Higher-Order Analysis

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ABSTRACT

Purpose: To identify prognostic factors in the literature that may predict a poor recovery from acute occupational low back pain (LBP).

Methods: Four international databases (Medline, CINAHL, EMBASE, and PsycINFO) were reviewed, searching all articles indexed up to November 2007 with the term *low back pain* combined with the terms *prognostic*, *prospective*, or *cohort*. Following application of inclusion criteria, 10 articles were found to be appropriate for data extraction. Each article was critically appraised by two independent reviewers. Statistical pooling was performed on any factor evaluated in at least three independent cohorts.

Results: Seven cohorts were identified, with a total sample size of 2,484 subjects. Only three factors were followed in at least three cohorts and were therefore suitable for statistical pooling: female gender (OR = 1.28, 95% CI: 1.03–1.58); pain radiation (OR = 1.37, 95% CI: 0.79–2.39); and previous history of back pain (OR = 0.91, 95% CI: 0.52–1.60). There was significant heterogeneity within the female gender factor; compensation of subjects for study participation appeared to moderate its effect.

Conclusion: After statistical pooling, only female gender achieved statistical significance as a prognostic factor for prolonged recovery. Further research is necessary to determine prognostic factors for non-recovery in acute LBP.

Key Words: chronic disability, chronic pain, higher-order analysis, occupational low back pain, prognosis

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RÉSUMÉ

Objectif : Identifier, dans la littérature, les facteurs pronostiques susceptibles d'indiquer un piètre rétablissement d'une lombalgie professionnelle aiguë.

Méthode : Examen de quatre bases de données internationales : Medline, CINAHL, EMBASE et PsycINFO, dans le but de rechercher tous les articles répertoriés depuis novembre 2007 avec le mot « lombalgie » combiné à « pronostic », « prospective » ou « cohorte ». À la suite de l'application du critère d'inclusion, dix articles ont été jugés appropriés pour faire l'objet d'une extraction de données. Chaque article a ensuite été critiqué par deux réviseurs indépendants. Une mise en commun statistique a été réalisée pour tous les facteurs ayant été évalués au sein d'au moins trois cohortes indépendantes.

Résultats : Sept cohortes ont été identifiées, pour un échantillon comptant au total 2 484 sujets. Seuls trois facteurs ont fait l'objet d'un suivi dans au moins trois cohortes et pouvaient, par conséquent, faire l'objet d'une mise en commun statistique. Les facteurs ayant fait l'objet d'un suivi sont : les sujets de sexe féminin (RO = 1,28, CI 95 %, 1,03 à 1,58), le degré de radiation de la douleur (RO = 1,37, 0,79 à 2,39) et les antécédents de lombalgie (RO = 0,91, 0,52 à 1,60). On a constaté une hétérogénéité considérable chez les sujets de sexe féminin. L'indemnité offerte aux sujets pour leur participation a semblé en modérer l'effet.

Conclusion : À la suite de la mise en commun statistique, seuls les sujets de sexe féminin avaient une signification statistique en tant que facteur pronostique pour un rétablissement à long terme. D'autres recherches seront nécessaires pour préciser les facteurs pronostiques de non-rétablissement des cas de lombalgie aiguë.

Mots clés : analyse d'ordre supérieur, douleur chronique, incapacité chronique, lombalgie professionnelle, pronostic

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INTRODUCTION

The burden of disability as a result of low back pain (LBP) has increased steadily over recent decades in Western countries.¹ The lifetime prevalence of LBP ranges from 60% to 90%, and it has been estimated that more than 1% of the population between the ages of 18 and 65 is totally and permanently disabled by this problem, representing a significant burden on health care.^{1,2} Canadian statistics show that although only 7.4% of acute back injuries progress to disability, this group accounts for 68% of sick days and 76% of sick-leave payment costs.³ While back pain is associated with considerable disability and economic loss,⁴ we believe that these costs can be minimized by early identification of those at risk of non-recovery from acute LBP. Presumably, if these “at risk” patients could be identified early, intervention resources could be mobilized more effectively and efficiently, thereby minimizing the risk of persistent pain or disability.

A number of studies have explored prognostic factors for LBP. The factors identified as increasing an individual's likelihood of developing persistent pain or disability include being female, having lower educational attainment, and being of non-Caucasian descent.^{2,4} Furthermore, greater age, pain, and physical disability have also been identified as prognostic indicators, often reported in individual studies.³ However, such results are not consistent; for example, Bakker et al. found greater age to be a protective factor against persistent LBP.⁵ Part of the heterogeneity in findings may be attributable to wide variations in inclusion criteria and time from injury (injury acuity). Conflicting results interfere with effective knowledge translation and mobilization.

Pain or disability that persist for more than 6 weeks is likely to become a chronic problem⁶ and tends to be resistant to conventional therapies. For these reasons, prognosis should be determined prior to 6 weeks post-onset if interventions to prevent chronicity in the high-risk sub-population are to be effective. Previous findings of individual prognostic studies may be strengthened by pooling data and determining an overall effect, which will help guide clinical decision making in forming a prognosis and treatment plan for the person with acute occupation-related LBP.

The purpose of this systematic review and higher-order analysis is to identify prognostic factors in the literature that may predict non-recovery from acute occupational LBP, using a higher-order analysis with statistical pooling.

METHODS

Search Strategy

An electronic literature search was conducted using four international databases: Medline, CINAHL, EMBASE,

Table 1 Number of Articles Excluded by Exclusion Criteria

Exclusion Criteria	From Titles	From Abstracts	From Articles
Chronic LBP	117	50	1
Not occupational	50	22	0
Not LBP	430	42	1
Interventions used	224	21	2
Fractures / bony issues	24	8	3
Age <18 or >65	47	6	2
Not English/French	0	0	0
Books	2	0	0
Follow-up <6 months post onset	0	16	1
Inception >6 weeks post onset	1	69	24
Not prognostic / predictive / cohort	260	88	4
Duplicate	737	2	0
Article unavailable	0	0	16
Unuseable data	0	0	15

and PsycINFO. The search included all papers published up to November 2007. The search terms used were *low back pain* combined with *prognostic*, *prospective*, or *cohort*. A secondary search of the reference lists of relevant articles was also performed. Articles were then excluded by applying the inclusion criteria (see Table 1) to the title, the abstract, and the body of the text, in that order. Figure 1 offers a graphic representation of the search strategy and results.

Inclusion Criteria

Articles were included for review if they met all of the following criteria: (1) all subjects were between 18 and 65 years of age; (2) the study included only subjects with occupational (acute/traumatic) injuries of the low back; (3) subjects entered the study, and all baseline data were collected, within 6 weeks of the initial injury; (4) follow-up was conducted at least 6 months after the injury, and outcome was reported as the presence or absence of ongoing back problems; (5) subjects experienced LBP with or without symptoms radiating into the lower extremity; (6) subjects with fractures or dislocations were excluded; (7) all predictive items would be feasible to collect in a non-medical rehabilitation setting (i.e., no EMG or nerve-conduction studies); and (8) the study was published in either English or French.

Quality Scoring

Each of the included articles was independently evaluated by two researchers, using the scoring tool adapted from Walton et al.⁷ to determine the article's quality. The overall interrater reliability of the tool for this study was $\kappa = 0.76$ (95% CI: 0.68–0.82), indicating good overall agreement. Discrepancies in scoring were settled easily during a group discussion session conducted at the end of the independent scoring phase of the study. The scoring tool includes 17 different criteria, each scored on a 3-point ordinal scale (0 = criteria not met, 1 =

Figure 1 Search strategy and results

criteria partly met, 2 = criteria met) for an overall maximum score of 34. Items were categorized under the subheadings *sampling*, *methodology*, *data analysis*, and *interpretation of results*. The scoring tool and manual are available from author DW upon request.

Based on their scores, each article was assigned to one of three categories: good quality (>25), moderate quality (20–25), and poor quality (<20). In order to avoid giving artificially greater weight to those studies that produced multiple publications from the same cohort, quality evaluation and data extraction were done by cohort rather than by publication.

Data Extraction

Data from the articles were extracted by each of the reviewers. The data were entered into a spreadsheet that identified each cohort based on publication year, author, study quality, sampling frame, time to follow-up, and out-

come measure. The data were then entered into Comprehensive Meta-Analysis version 2.0 (Biostat, Englewood, NJ), a statistical analysis software package, for analysis and statistical pooling. For the purposes of this student-led study, we did not contact the authors of those articles that provided data insufficient for pooling. Thus, the results reported below represent pooled results using only the data available in the published literature.

Moderator Analysis

The statistic, or effect, of interest in this analysis was the pooled odds ratio (OR). It is possible that the results of statistical pooling are influenced by systematic sources of bias that can be explored separately. A moderator variable can be thought of as a stratification variable: data are grouped and analysed within and between levels of the variable to determine what effect, if any, that variable has on the outcome. Specifically, we evaluated the mod-

erating effect of four variables determined *a priori*: (1) study quality, based on our quality scoring tool, categorized as strong ($>25/34$, $n = 2$), moderate ($20-25/34$, $n = 4$), or weak ($<20/34$, $n = 1$); (2) outcome, categorized as the presence of ongoing symptoms ($n = 1$) or ongoing disability ($n = 6$); (3) sampling frame, categorized as primary care ($n = 6$) or insurance claims ($n = 1$); and (4) length of follow-up, categorized as 6 months ($n = 3$), or >6 months ($n = 4$). Other moderators were identified through the review process.

The Q statistic is a statistical test of the null hypothesis, which states that the effect sizes (ORs) from each cohort in the sample are the same for each predictor. The test provides a p -value indicating the probability that the heterogeneity within the sample of effect sizes is truly greater than zero. To avoid Type II errors, we chose a liberal p value of 0.1 as significant for heterogeneity. For each individual predictor identified, a significant overall Q_{within} indicates substantial heterogeneity within the sample of effect sizes and suggests the presence of a moderator variable. In this case, the sample is categorized based on one of the moderator variables listed above, and the Q_{within} for each category is determined, along with the Q_{between} as an omnibus test of significance between the levels of the moderator variable. A moderator variable was identified as appropriate when the Q_{within} for each level of the variable was non-significant, indicating homogeneity within levels, and the Q_{between} was significant, indicating heterogeneity between levels of the moderator. This procedure can be considered analogous to the F test in an analysis of variance.

Publication Bias

It is possible that the results of a meta-analysis or higher-order synthesis such as this one are biased as a result of the fact that studies with non-significant findings are less likely to be published, leading to an overestimation of the effect size after statistical pooling. The risk of publication bias can be investigated using a statistic called the failsafe N , which is the number of studies with non-significant results that would have to be included in the pooling procedure in order to nullify any findings of significance from the studies included in the evaluation.⁸ (The failsafe N therefore has meaning only for significant findings.)

Data Analysis

For this review, prognostic factors were included for statistical pooling only if they had been explored in three or more independent cohorts. Effect sizes of prognostic factors explored in less than three cohorts were not pooled because of the potential for spurious findings, especially where heterogeneity exists. Where necessary, data were converted to a common metric before the sta-

tistical pooling procedure was performed. Details of the conversions performed are beyond the scope of this paper, but interested readers can look to the supplementary material from Walton et al.⁷ for more information.

RESULTS

The primary search of the four databases identified 2,341 articles. Abstracts were reviewed and included in the sample if they met the inclusion criteria. Full articles were retrieved where further review was necessary to determine suitability for inclusion. Reference lists of relevant publications were also reviewed. A total of 10 publications following seven independent cohorts satisfied the inclusion criteria and were retained for data extraction. The total sample size of the seven cohorts combined was 2,484. Table 2 outlines the findings in each of the seven cohorts. The outcomes used to determine non-recovery varied and included return to work, continued compensation, and self-reported disability.

In total, 92 different effect sizes were extracted from the seven independent cohorts. We identified three prognostic factors that had been followed in at least three independent cohorts: female gender ($n = 2,364$), pain radiating to the leg ($n = 491$), and past history of back pain ($n = 371$). The mean quality score of these papers was 22.4, with a range of 13.5–34.

Female gender as a risk factor for non-recovery was followed in six of the seven included cohorts.^{2,4,5,9-12} The pooled OR (using a fixed-effects model because of the non-random variation in response options) showed that females were at slightly higher odds of reporting ongoing pain or disability compared to males (OR = 1.28, 95% CI: 1.03–1.58). The Q statistic (14.6, $p = 0.01$) suggested significant heterogeneity among the effect sizes (see Figure 2). The following variables were explored to determine their appropriateness as moderator variables: study quality (low, high); geographic region (United States or other); intervention provided (none, PT, education); compensation to participants for their involvement in the study (yes, no); funding source of the study (private, public); gender ratio ($>50\%$ female or not); length of follow-up (6 months or >6 months); type of outcome (pain, disability); whether the majority of subjects were receiving worker's compensation (yes, no); and method of follow-up (telephone, clinical assessment). Worker's compensation status could not be evaluated as a moderator, because most cohorts were mixed in this regard. Only one factor was identified that could function statistically as a potential moderator variable, this being whether or not participants were compensated for their involvement in the study (see Figure 3). Where participants were compensated, female gender showed significance in its ability to predict outcome (OR = 1.78, 95% CI: 1.30–2.43); where participants were not compensated, however, female gender was not a significant

Table 2 Characteristics of the Studies Included in the Analysis

	Bakker ⁵	Dixon ⁴	Gatchel ^{2,9}	Grotle ¹⁰	Turner ^{3,11}	Van der Weide ¹³	Werneke ¹²
Sample size	88	435	421	123	1,068	120	171
Significant findings	Smoking is risk factor, advanced age is protective	Female gender and higher disability are risk factors	Lower education, Caucasian, high pain, personality disorders are all risk factors	Psychological distress is risk factor	Lower education, Caucasian, expectation, mental health, catastrophizing, fear-avoidance are all risk factors	Low emotional effort, lack of energy, lack of variation in work are all risk factors	Non-centralizing LBP is risk factor
Study quality (/34)	26	14	20	25	26	24	20
Sampling frame	Primary care	Primary care	Primary care	Primary care	Compensation claimants	Primary care	Primary care
% female	59	37	38	56	31	67	46
Geographic region	Netherlands	United States	United States	Norway	United States	Netherlands	United States
Length of follow-up	6 months	1 year	1 year	1 year	6 months	1 year	1 year
Intervention provided	Education, some PT	None	None	Education	None	Not reported	PT
Method of follow-up	Telephone	Telephone	Telephone	Postal mail	Telephone	Not reported	Telephone
Primary outcome	Pain	Work status	Work status	RMQ	Compensation status	Multidimensional	Work status
Subjects compensated for participation?	No	\$20	\$20	No	No	Not reported	No
Pregnancy excluded?	Yes	No	No	Yes	No	Yes	Yes

LBP = low back pain; PT = physical therapy; RMQ = Roland Morris Low Back Pain Disability Questionnaire

predictor of outcome (OR = 0.96, 95% CI: 0.72–1.29). The Q_{within} was 6.70 ($p = 0.15$), and Q_{between} was 7.91 ($p = 0.005$), indicating an appropriate moderator. No other variable functioned as an appropriate moderator. The failsafe N for female gender as a significant risk factor for persistent problems was 4.

Four cohorts explored the prognostic value of pain radiating to the leg in predicting non-recovery.^{5,10,12,13} The results of statistical pooling using a random-effects model were homogenous ($Q = 5.99$, $p = 0.11$) and showed no significant ability of radiating leg pain to predict recovery (OR = 1.37, 95% CI: 0.79–2.39; see Figure 4). A past history of back pain was evaluated in three cohorts.^{5,10,12} Again, statistical pooling using random-effects modelling revealed homogeneity ($Q = 1.64$, $p = 0.44$) and no significant ability of past history of back pain to identify who would or would not recover from a current episode of acute LBP (OR = 0.91, 95% CI: 0.52–1.60; see Figure 5). Calculation of the failsafe N statistic was not indicated for either of these factors because the findings were not significant.

DISCUSSION

Using a systematic search strategy that incorporated four international and transdisciplinary databases and strict but meaningful inclusion criteria, we were able to identify seven independent cohorts that served as the data sources for a statistical pooling procedure on the risk of non-recovery after acute occupational LBP. We identified three potential prognostic factors that had been followed in at least three of the seven independent cohorts. After statistical pooling, and despite a common belief among clinicians and researchers, neither reports of radiating leg pain nor past history of back pain demonstrated significance in their ability to predict non-recovery. Female gender, however, was found to be a significant predictor of non-recovery. Moderator analysis due to heterogeneity revealed that female gender was a significant risk factor for poor outcome only in those studies that compensated participants for their involvement. This finding is difficult to rationalize and may be coincidental, given the relatively small number of studies included. However, it is also possible that compensating subjects for their participation introduces some form of social desirability bias into self-report data collection, and perhaps the effects of social desirability are different between the sexes. This idea is pure speculation at this point but should be considered in designing future research.

The failsafe N for female gender as a risk factor was 4, suggesting that adding only four more studies that showed no significant effect into this analysis would suffice to nullify the current finding of significance. This result suggests that the latter finding is not overly robust to publication bias.

Figure 2 Forest plot showing the results of statistical pooling of female gender as a prognostic factor. Squares represent individual cohort results; diamond represents overall pooled result. The plot is formatted such that point estimates (squares or diamond) that fall to the left of the parity (1) line are protective in nature, while those that fall to the right of the line are risk factors. Total $N = 2,306$.

Figure 3 Results of the pooled OR of female gender as a prognostic factor after stratification by subject compensation for participation: subjects not compensated for their participation in the study (A) and subjects compensated for participation (B). Note the difference in overall effect between the two groups.

Figure 4 Pooled OR of radiating leg pain as a prognostic factor (total $N = 502$)

Figure 5 Pooled OR of a past history of back pain as a prognostic factor (total $N = 382$)

A previous systematic review by Crook et al. found considerable variability in the literature with respect to the prognostic value of predictive factors.¹⁴ Based on their review, the authors concluded that the most important predictive factors for continued disability following low back injury include age, gender, number of children, and depression or other indicators of psychological distress. Of the above-listed predictive factors, we were able to statistically pool only the data on gender, providing a numeric estimate of the magnitude of risk of poor outcome (1.28 times greater odds).

A number of factors were investigated in two or fewer cohorts, or did not have data presented in such a way as to allow for meaningful statistical pooling, including pain intensity, age, functional outcome scores, fear-avoidance, compensation status, catastrophizing, and other psychosocial factors, all thought to be predictive of chronicity in acute LBP.⁹ Pooling results using data from only two studies may produce misleading findings, especially where there is heterogeneity in the study results. Additional data points for such predictors would be re-

quired from independent cohorts for confidence in the results of pooling to determine predictive ability.

Vlaeyen and Linton¹⁵ proposed a cognitive-behavioural model for the development of chronic pain after acute injury that incorporates the constructs of catastrophizing, fear-avoidance, and psychological morbidity (depression), suggesting that the extent of the physical injury is less important than the personal reaction to the injury in predicting outcome. While evidence in support of this model is growing,¹⁶ we have yet to see higher-order analyses on the size of these effects in mediating outcome. The results of the current study do not provide direct support for such a model, but they are certainly not at odds with it. The more biological factors of radiating leg pain and past history of back pain do not appear to be good predictors of outcome, in keeping with a cognitive-behavioural model of chronic-pain development.

While meta-analysis of homogenous studies is considered Level 1a evidence by the Centre for Evidence-Based Medicine,¹⁷ readers should be aware that there are limitations in interpreting the results of meta-analyses

or of higher-order analyses such as this one, the former term being reserved for those analyses in which an exhaustive search for all data, published and unpublished, has been completed. In the present higher-order analysis, literature that was not indexed by any of the four international databases would not have been included in this review unless found in the reference lists of other relevant articles; similarly, unpublished data were not included. It is possible that the data from such sources would have changed the results of this study had they been included. Similarly, the results of higher-order analyses are only as strong as the quality of the data that make up the sample. In the present case, there was often limited information on the validity and methods of data collection used in the included studies. The exact questions posed to subjects were rarely reported in the published articles; for example, data on past history of back pain may be subject to recall bias depending on how the data were collected (i.e., direct questioning vs. chart review). Finally, it should be noted that many potential prognostic factors were not evaluated in this study. We found a surprising paucity of well-designed prospective cohort studies of acutely injured LBP patients. Lack of evidence is not synonymous with evidence against. Limitations in interpretation must be understood.

This systematic review and higher-order analysis indicates that female gender is predictive of a small but statistically significant increase in the risk of non-recovery after acute occupational LBP. Two other factors previously believed to be predictive of persistent problems after low back injury, namely pain radiating to the leg and history of back pain, do not have statistical evidence to support their application in isolation in clinical practice. Readers should be aware, however, that a factor which is unable to predict outcome in isolation may be able to predict outcome when combined with other factors. For example, it is possible that people with radiating LBP and a past history of back pain have a worse prognosis than those with radiating pain but no past history. The combined prognostic ability of factors, including meta-regression, could not be evaluated using the data presented in the published literature.

CONCLUSION

Based on data available in the existing literature, the results of this higher-order analysis do not support a patho-anatomical model of the development of chronic pain or disability after acute LBP. The ability of female gender to predict outcome is not yet clear, as the only factor that satisfied the criteria for an appropriate moderator was more an issue of research methods than of clinical practice. Clinicians should be aware of these

results when trying to determine long-term (6 months to 1 year) prognosis of their patients following acute (within 6 weeks) occupational low back injury. Whether these factors are more effective predictors of outcome when evaluated in the subacute phase of recovery has yet to be determined.

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