Journal of Occupational Rehabilitation (2020) 30:274–287
https://doi.org/10.1007/s10926-019-09870-1

Returning to Work Within Two Years After First-Time, Single-Level, Simple Lumbar Discectomy: A Multifactorial, Predictive Model

Dorthe Schoeler Ziegler[1,2] · **Rikke Krüger Jensen**[3,4] · **Gert Frank Thomsen**[5] · **Leah Carreon**[1,2] · **Mikkel Oesterheden Andersen**[1,2]

Published online: 23 December 2019

Abstract

Purpose Continued inability to work has societal and individual consequences. Thus, the factors associated with sustained return to work after lumbar discectomy should be identified. Prior studies of the biopsychosocial factors associated with sustained RTW were primarily based on patient-reported outcome data and have shown conflicting results because of small study samples. In patients undergoing first-time, single-level, simple lumbar discectomy, we describe the time to sustained return to work within 2 years after surgery using outcome data from a national database and identify the pre- and peri-operative factors associated with sustained return to work within 2 years by developing and validating a predictive multivariable model. *Methods* The time to a sustained return to work within the study period was described using a Kaplan–Meier plot. A temporal validated Cox proportional hazards model examined associations between biopsychosocial factors and return to work. *Results* In the derivation cohort made up by 351 operated patients who were on sick-leave for more than 3 weeks around the time of surgery, 62% returned to work (median 15 weeks). The probability of sustained return to work was associated with a high education level, positive expectations towards future labor market attachment, pre-operative stable labor market attachment, pre-operative higher physical quality of life, and less disability. *Conclusions* Through the development and validation of a predictive model, this study identifies a number of patient-related factors associated with sustained return to work after lumbar discectomy, while revealing that most disease-related clinical findings were not associated with the outcome.

Keywords Discectomy · Labor market attachment · Predictors · Return-to-work · Sick-leave

Introduction

The prevalence of symptomatic lumbar disc herniation (LDH) based on a clinical assessment in a low back pain (LBP) population is approximately 11–12% [1, 2]. An estimated 10–20% of these patients undergo discectomy because of continued or severe symptoms [3]. Like LBP, the prevalence of LDH peaks between the ages of 35 to 64 [4], coinciding with the decades that have the highest employment rates [5]. Of patients undergoing discectomy, 8–15% report continued symptoms and work incapacitation 2 years after surgery [6, 7]. As the dominating component of the total costs related to spine surgery is from productivity loss due to sick-leave [8], decreased labor market attachment (LMA) after surgery is of particular economic importance. Additionally, poor LMA is associated with impaired negative health consequences such as physical and mental complaints and, ultimately, premature all-cause and cause-specific death [9, 10]. Identifying the factors associated with

✉ Dorthe Schoeler Ziegler
dorthe.schoeler.ziegler@rsyd.dk

1 Spine Surgery and Research, Spine Center of Southern Denmark – part of Lillebaelt Hospital, Oestre Hougvej 55, 5500 Middelfart, Denmark

2 Department of Regional Health Research, University of Southern Denmark, J.B. Winsloews Vej 19, 3, 5000 Odense C, Denmark

3 Nordic Institute of Chiropractic and Clinical Biomechanics, Campusvej 55, 5230 Odense M, Denmark

4 Department of Sports Science and Clinical Biomechanics, University of Southern Denmark, Campusvej 55, 5230 Odense M, Denmark

5 Department of Occupational Medicine, Hospital of Southwest Jutland, Oestergade 81 – 83, 6700 Esbjerg, Denmark

return-to-work (RTW) after discectomy is essential, as it may influence pre-operative patient counseling [11] and, in the long run, contribute to the making of clinical decision rules and thus possibly improve stratified care management [12].

The mechanisms associated with RTW are complex. They are best described using the biopsychosocial model of Waddell [13] and are further illustrated by Loisel et al. [14], who emphasized important workplace elements, such as work relatedness, employee assistance plans and workplace accommodation. A recent review emphasizes the complexity of RTW after lumbar discectomy by listing a variety of associated factors, but these factors are based on a sparse number of studies examining each factor [15]. Furthermore, the studies included raise methodological considerations that are crucial when assessing the RTW, such as unambiguous definitions of RTW and appropriate sample sizes and follow-up times. In the above-mentioned review, the inconclusive or conflicting results were mostly explained by these limitations, which should be accommodated in future research. This in line with other reviews of the factors associated with RTW [16, 17]. This study, based on national administrative outcome data, aims to explore multifactorial candidate prognostic factors of RTW after lumbar discectomy.

Objectives

Within a cohort of patients with LDH undergoing first-time, single-level, simple lumbar discectomy, the objectives of this study are:

(1) To describe the time to sustained return-to-work within 2 years after surgery; and
(2) To identify pre-operative and peri-operative factors associated with sustained RTW within 2 years after discectomy by developing and validating a prognostic multivariable model.

Methods

Study Design

This is a longitudinal cohort study based on prospectively collected registry data from a research database "DaneSpine" [18], Statistics Denmark [19], and clinical data from the patients Electronic Medical Record (EMR) (DaneSpine and Statistics Denmark are described below). The reporting adheres to the Transparent Reporting of a multivariable prediction model for Individual Prognosis or Diagnosis (TRIPOD) guideline [20].

Data Sources

The purpose of the DaneSpine database maintained by the Danish Society of Spine Surgeons is to monitor, evaluate, and potentially change aspects of the surgical treatment with the aim of improving patient outcomes after spine surgery. The data are collected through questionnaires completed by patients at the time of admission and one and 2 years after surgery. Peri-operative data, such as surgical approach and complications, are entered into the database by the operating surgeon. Within the three-year study period, 98–99% of the patients who underwent lumbar discectomy at the hospital department studied were entered into the database (calculations based on data provided by the Danish Society of Spine Surgeons and the National Patient Register) [21].

Statistics Denmark is the central national authority that collects, compiles, and publishes statistics on the Danish society. Since 1968, all persons living in Denmark have been registered in the Danish Civil Registration System and assigned a unique personal identification number at birth or upon immigration to Denmark, which allows for an accurate linkage between all national registries and complete datasets [22, 23]. Data from the database 'DREAM' (the Danish Register Based Evaluation of Marginalization) were collected through Statistics Denmark. DREAM is owned by the Ministry of Employment and administered by the Danish Agency for Labor Market and Recruitment [24]. The database includes a weekly registration of employment information, which serves as a valid measure of sick-leave at an individual level [25].

Cohort Assembly

The study population was identified from a consecutive series of 891 patients enrolled in DaneSpine database, all of whom were 18 of age or older and undergoing lumbar open discectomy or micro-endoscopic discectomy between June 1, 2010 and December 31, 2013. All discectomies were conducted at a surgical department of a public hospital by 1 of 12 surgeons. The patients were referred from primary or secondary care due to persistent symptoms such as dermatomal leg pain or impaired muscle strength in one or both legs after nonsurgical treatment. Surgery was offered if the history-taking, clinical examination, and MRI or CT were consistent with radiculopathy due to LDH and the patient was otherwise deemed fit for surgery. Upon acceptance of surgery, the patient enrolled in the DaneSpine database.

Due to limitations in the anesthetic preparedness, only patients with an ASA-score < 3 (American Society of

Anesthesiologists classification score) [26] were offered surgery at the particular hospital. Consequently, patients with spinal pathology such as malignancy, infection, spondylolysis, spondylolisthesis, inflammatory arthritis, notable scoliosis, or metabolic bone disease at the time of surgery were not undergoing discectomy at the surgical department in which the examination took place.

If patients were unable to work during the week of surgery and thus received sickness benefits from the municipalities according to a national register, they qualified to enter the study when undergoing surgery and left the study upon returning to employment or to competing risk events no later, however, than at 2 years after the discectomy. Competing risk events included attaining supported employment or unemployment unrelated to health issues, the former being individuals who receive support such as wage subsidies, job training, or educational upgrading to enhance the likelihood of RTW, or leaving the workforce permanently. Furthermore, maternity/paternity leave was considered a competing risk. Exclusion criteria were previous spine surgery at any level and multilevel discectomies. All patients received standard advice from the medical staff that RTW should be possible at around 6–8 weeks after surgery, and 12 weeks if the patient undertook strenuous work functions.

Outcomes

The primary outcome of interest was RTW or return to education no later than 2 years after lumbar discectomy. The outcome was assessed using the 'DREAM' database as described above. No distinctions are made regarding the amount and degree of the work to which the patients return. Because public sickness benefits are preceded by an employer-paid period, only patients with sick-leaves exceeding the employer-paid period will appear in the DREAM database. The duration of sick-leave as registered in DREAM is included in the employer-paid period. The employer-paid period was 3 or 4 weeks according to the existing legislation at the time of the study period. If the individual did not receive sickness benefits or other public transfers within a given week, RTW was noted. For the purposes of this study, and to define sustainability, the RTW had to persist for 4 consecutive weeks. During the study period, the maximum length of sickness benefits allowed by the ministry reached 156 weeks [27].

Predictors

Upon admission, patients completed questionnaires on age, gender, smoking habits, height and weight, self-reported leg (VAS-LP) and back pain intensity (VAS-BP) using a visual analog score (0 to 100) [28], functional disability using the Oswestry Disability Index (ODI) [29, 30], health-related quality of life using both EuroQol (EQ-5D) [31], and the Short Form Health Survey version 1 (SF-36) [32]. The patients stated their expectations for future occupational status: 0: No sick-leave; 1: Return to full-time occupation; 2: Return to part-time occupation; 3: Change of occupation; 4: Continued sick-leave; and 5: Permanent retirement, as well as the pre-operative duration of leg pain and back pain, and the duration of work incapacitation due to back pain. Assigned personnel entered all data into the DaneSpine database using a standardized codebook.

Pre-operative neurologic and orthopedic clinical findings (muscle strength grading, deep tendon reflex grading, sensational evaluation, and straight, crossed and reverse leg raise) and admission-diagnosis, surgical technique, and perioperative complications were entered into the DaneSpine database by the examining and operating surgeon. The ASA-classification score was assessed and entered into the EMR by anesthesiologists.

Data from EMR were retrieved and entered into a data entry form (EpiData Entry Client version 4.0.2.49, Odense, Denmark) using a fully explanatory data documentation sheet and built-in checks to minimize data entry errors. For a random 10% of the EMRs, a second data entry was performed to assess the reliability and accuracy of the extracted data and the eligibility for further analysis (see Appendix "1" for the reproducibility of data extraction from EMRs).

Socio-economic data were retrieved from Statistics Denmark and included data on highest education level, ethnicity, marital status, weekly public benefits received within 2 years prior to surgery (including sick-leave benefits), annual personal income and socio-economic classification as assessed the year before surgery, and deaths or emigrations within the study period (see Appendix "1" for details on each variable retrieved from Statistics Denmark, their definitions and initial data management).

Statistical Analysis Methods

Time to Return to Work

The time to sustained RTW within 2 years after lumbar discectomy was described using a Kaplan–Meier plot. As the available data allowed informed censoring, competing risk events were illustrated as well. If none of the events occurred within the study period, the time to event was censored.

Model Building

The prognostic model was developed in the cohort operated from 2010 to 2012 and then validated in the cohort operated in 2013. The eligibility criteria for the two cohorts were similar. However, by July 1, 2014 the sickness benefit system had been reformed to support a faster return to the labor market for individuals receiving sickness benefits [27]. The reform did not change the allowable number of weeks to receive sickness benefits, but it did alter the municipal effort toward helping the citizen achieve a successful RTW. As a part of this, the length of the employer-paid period, which had been 21 days until January 1, 2012, was extended to 30 days from January 2, 2012. No other differences or modifications of conditions, definitions or measurements were found when comparing the derivation cohort to the validation cohort, which yielded narrow validation.

The hazard ratios (HRs) were estimated using univariable and multivariable Cox proportional hazards models. All estimates were reported with a 95% confidence interval, and the unadjusted estimates were further checked for proportionality using Schoenfeld residuals.

The selection of factors for the prognostic model was a three-step process. The first selection was a priori based on prior reviews and clinical reasoning. According to the bio-psycho-social models referred in the introduction, both clinical, environmental and personal factors should be included, this however to the extent that such variables were available. The factors in the derivation cohort were then checked for intercorrelations, missing values, and time-dependency. Model building was done through stepwise backward selection including all remaining factors at start and using the Harrell's *c* statistics to determine the final selection of factors [33]. Variables were tested and possibly excluded one by one according to the size of p-values, the variables with the highest p-values tested first. The multivariable analyses were adjusted by age as high age has been associated with back-related retirement after LDH surgery in other studies [34]. The model was internally validated using bootstrapping (1000 reps). An external temporal validation using more recently treated patients allowed for assessment of the performance of the prediction model through a comparison of Harrell's *c* statistics (discrimination) and the Kaplan–Meier method (calibration).

Ethics and Data Control

The Danish Health Safety Authority (#3-3013-1174/1) and the Danish Data Protection Agency (#14/26345) approved the study. According to Danish law, ethical approval from the Regional Scientific Ethics Committee for Southern Denmark was not required for this type of study [35]. When completing the DaneSpine questionnaires, the patients gave written informed consent for the use of their data in research.

All data from DaneSpine, EMRs and Statistics Denmark were merged and stored at Statistics Denmark according to the Danish Open Administration Act, the Danish Act on Processing of Personal Data, and the Health Act.

Analyses were performed using Stata 15.1 (StataCorp, College Station, TX, USA). An alpha-level of 0.05 was used in all tests.

Results

Participants

Of the patients found eligible from DaneSpine, 57% were receiving sickness benefits within the week of surgery and constituted the final study model (Fig. 1). Consequently, the remainder were either not on sick-leave or were on sick-leave 3 or 4 weeks or less in the time around discectomy according to the DREAM database and the prevailing legislation. One surgeon conducted only one surgery within the study period, which led to exclusion of the given patient. Additionally, the survey of the EMRs revealed that 14 patients had been operated despite having an ASA score = 3, which led to exclusion. In total, 512 patients were included in the study, 351 in the derivation cohort and 161 in the validation cohort. One patient was censored due to emigration. A further 56 patients (11%) were censored because they received sickness benefits throughout the entire study period. Baseline characteristics for the derivation and validation cohort are displayed in Table 1.

Time to Return to Work

Of the 351 patients who made up the derivation cohort, a total of 219 (62%) patients returned to sustained work or education within the study period (median 15 weeks, 95% CI 14–17), while 57 (16%) patients transitioned into temporarily or supported unemployment due to reasons unrelated to health issues (median 44 weeks, 95% CI 26–55) and 31 (9%) patients into being permanent out of work force or other, unclassified events (median 51 weeks, 95% CI 40–62) (Fig. 2). No significant differences in time to return to work was noted between the derivation and validation cohorts.

Model Building

The number of individuals returning to work or education was 219 (62%) in the derivation cohort and 117 (73%) in the validation cohort. Due to a few missing data within the covariates, the developed model was built on 216 events and the validation based on 114 events. The completeness of data is presented per predictor in Table 2. The following factors were excluded prior to the modelling due to either strong correlations between factors (according to Pearson's correlation coefficient) (back pain intensity, SF-36 MCS, EQ-5D, operator) or to missing data as described in Appendix "1" (neurologic and orthopedic findings). The remaining

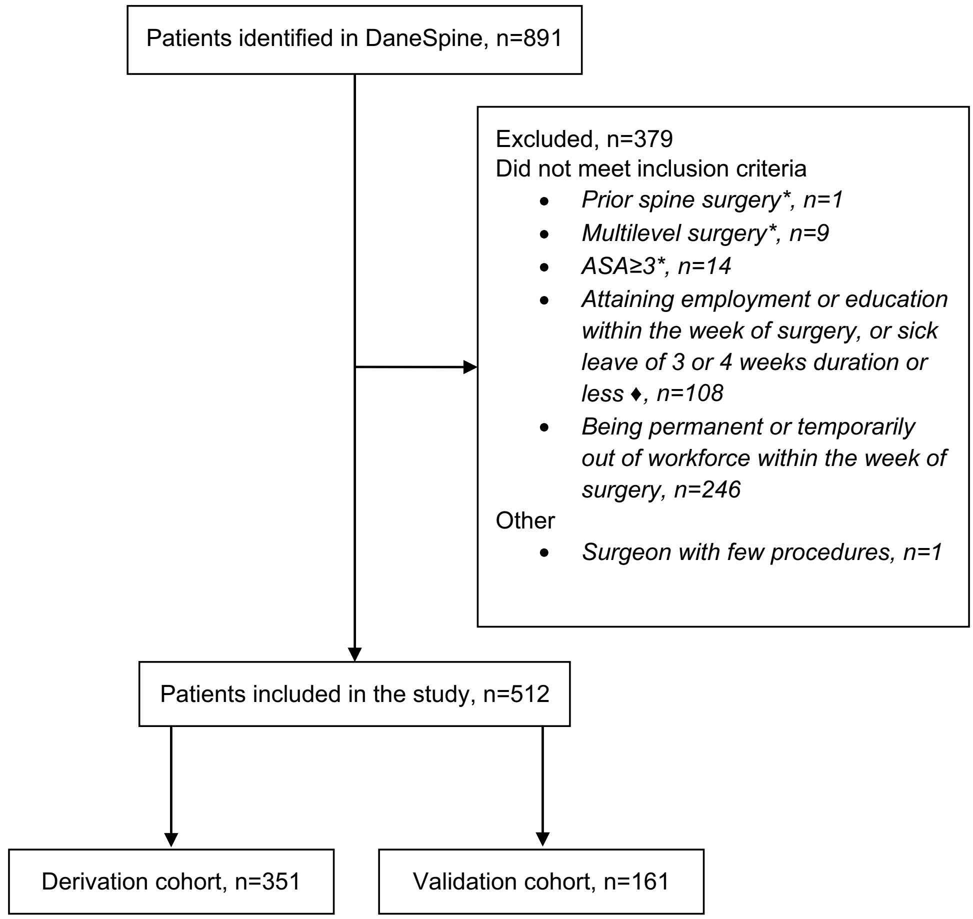

Fig. 1 Flowchart describing the selection of the study population. * Surveying electronic medical records. ♦ Depending on the current Danish sickness benefit legislation when entering the study, only patients with a duration of sick-leave exceeding 3 or 4 weeks in the time around the discectomy were registered in the DREAM database

factors were included in the model building (unadjusted and adjusted HRs are shown in Table 2). The proportional hazard assumption for the factors expectations towards future LMA and pre-operative sickness was not met; thus, a time-varying statistically significant association was found with the outcome according to the time after discectomy. The two time-varying variables were, due to methodological considerations, tested in univariate analyses to explain the time-interaction term (data not shown), while at the same time, fixed versions of the variables were kept in the multivariable analysis to test interrelations to the remaining covariates [36]. For the factor expectations towards future LMA, all categories, as presented in Table 2, were highly associated with an increased probability of RTW at the time of surgery, but due to the time-interaction, the variable had a negative impact on the outcome after 5–6 weeks after surgery. Likewise, for the factor pre-operative sickness, the association with the outcome changed from being initially negative to positive within the study period. The education level, expectations regarding future occupation, LMA in terms of weeks of sick-leave 2 years prior to surgery and socio-economic classification, and self-reported SF-36 PCS and ODI were found to have a statistically significant association with the probability of a sustained RTW within 2 years after lumbar discectomy. When evaluating the number of events per variable, no risk of overfitting was found (216/11 and 114/11).

Model Performance

The internal validation of the predictive model revealed low bias (data not shown). The discriminative ability of the model was 0.76 (0–1 scale, where 1 is scored when complete agreement between predicted and observed events) in the derivation cohort and 0.73 in the validation cohort. Figure 3 illustrates the agreement between observed and predicted outcomes, the calibration, in both cohorts. It also illustrates that the probability of sustained RTW is higher in the validation cohort compared to the derivation cohort (HR 1.28 (95% CI 1.02–1.60), $p = 0.036$).

Discussion

Time to Return to Work

Within 2 years after discectomy, 62% of the derivation cohort returned to work [median 15 weeks, (95% CI 14–17)]. This proportion is inferior to most studies that show

Table 1 Baseline socio-demographic characteristics and peri-operative characteristics for the derivation and validation cohort respectively

	Derivation cohort, n = 351	Validation cohort, n = 161	
Socio-demographics and clinical characteristics			
Mean (sd)			
Age	41.82 (10.15)	44.50 (10.16)	*
Age range	18–64	20–64	
Body mass index	27 (5)	26 (5)	
n (%)			
Male	191 (54)	83 (52)	
Age categories			
< 40	157 (45)	49 (31)	
≥ 40– < 60	185 (53)	102 (63)	
≥ 60	9 (2)	10 (6)	
Current smokers	115 (33)	47 (29)	
Married/cohabiting	212 (60)	94 (58)	
Ethnicity			*
Danish	334 (95)	146 (91)	
Immigrants/descendants	16 (5)	15 (9)	
Educational level			
Primary and lower secondary school (9–10 years)	71 (21)	36 (23)	
Higher general and preparatory examination program (12–13 years)	186 (54)	82 (53)	
Short- and medium cycle higher education (14–17 years)	80 (23)	37 (24)	
Long-cycle higher education (17–22 years)	9 (3)	1 (1)	
Socio-economic classification[b]			
Employer	9 (3)	4 (3)	
Employee	301 (86)	145 (90)	
Social benefits	41 (12)	12 (8)	
Personal income, DKK[b]			*
< 275,000	278 (80)	112 (70)	
≥ 275.000	73 (20)	49 (30)	
Expectations of future occupation			
No sick-leave	33 (10)	15 (9)	
Return to full-time occupation	233 (67)	114 (71)	
Return to part-time occupation or change of occupation	62 (18)	30 (19)	
Continued sick-leave or permanent retirement	19 (5)	1 (1)	
Physical status (ASA)			
1	229 (65)	115 (71)	
2	111 (32)	40 (25)	
Leg pain intensity higher than back pain intensity	226 (64)	104 (65)	
Duration of back pain			
No pain	33 (9)	7 (4)	
Pain < 3 months	61 (17)	35 (22)	
Pain 3 months to < 12 months	147 (42)	79 (49)	
Pain ≥ 1 year	110 (31)	40 (25)	
Duration of leg pain			
No pain or pain less than 3 months	110 (31)	53 (33)	
Pain 3 months to < 12 months	182 (52)	84 (52)	
Pain ≥ 1 year	59 (17)	24 (15)	
Muscle strength grading			
Movement against gravity or below	38 (11)	16 (10)	

Table 1 (continued)

	Derivation cohort, n = 351	Validation cohort, n = 161	
Movement against resistance	99 (28)	60 (37)	
Normal strength	192 (55)	81 (50)	
Mean (sd)			
Mental health (SF-36 MCS)	27.95 (7.17)	27.60 (7.63)	
Physical health (SF-36 PCS)	40.78 (11.96)	42.33 (11.84)	
Disability (ODI)	47.84 (18.30)	46.34 (19.14)	
Median (iqr)			
Quality of life (EQ-5D)	0.26 (0.62)	0.36 (0.57)	
Back pain intensity (VAS-BP)	48.0 (50.0)	50.0 (50.50)	
Leg pain intensity (VAS-LP)	72.0 (32.0)	72.50 (37.0)	
Pre-operative duration of sick-leave (weeks)	10.0 (21.0)	8.0 (17.0)	
Peri-operative characteristics			
n (%)			
Surgical technique			*
Open discectomy	339 (97)	140 (87)	
Micro-endoscopic	12 (3)	21 (13)	
Complications[a]	12 (3)	7 (4)	

sd standard deviation, *DKK* Danish Kroner, *ASA* American Society of Anesthesiologists Physical Status Classification System, *SF-36 MCS* Short Form 36 Mental Health Score, *SF-36 PCS* Short Form 36 Physical Health Score, *iqr* interquartile range, *EQ-5D* EuroQol-5D, *VAS-BP* Visual Analog Scale – Back pain, *VAS-LP* Visual Analog Scale – Leg pain, *ODI* Oswestry Disability Index

[a]Complications noted in the EMR were: cystitis × 2; urine retention × 1; bleeding/hematoma × 5; nerve root damage × 3; dura tear × 11. Some patients experienced more than one complication

[b]Assessed 1 year prior to surgery. DKK 275,000 is the Danish median income within the study period and equals EUR 36,800 EUR

*$p < 0.05$

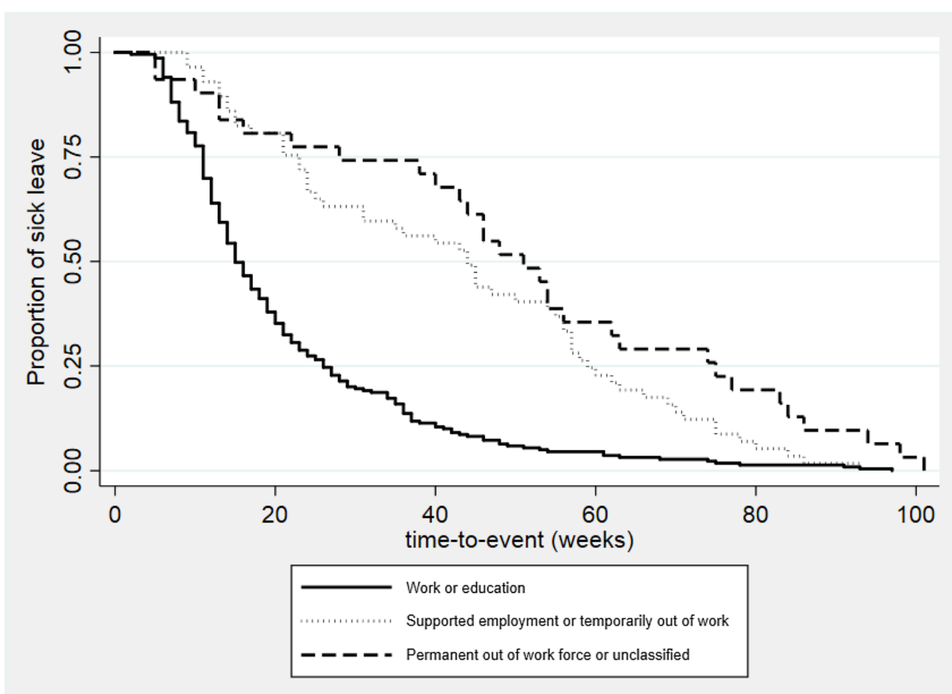

Fig. 2 Kaplan–Meier plot illustrating the time-to-event after first-time, single-level, simple lumbar discectomy within the derivation cohort: (1) returning to sustained work or education; (2) transition to supported employment or temporarily unemployment not related to own health issues; (3) transition to retirement from the labor market

Table 2 Associations between patient characteristics and the probability of sustained RTW within 2 years after discectomy in the derivation cohort presented as Hazard ratios with the 95% confidence intervals

	n	Hazard ratio (95% confidence interval)		*P*
		Unadjusted	Adjusted[a]	
Total, n = 351				
Socio-demographics and clinical characteristics				
Age (vs. < 40)	351			
≥ 40– < 60		1.15 (0.88–1.50)	1.07 (0.81–1.41)	0.620
≥ 60		0.96 (0.35–2.61)	0.84 (0.29–2.47)	0.750
Body mass index	351	0.98 (0.95–1.01)		
Male (vs. female)	351	1.06 (0.81–1.39)		
Non-smoker (vs. smoker)	351	1.47 (1.10–1.98)		
Married/cohabiting (vs. single/non-cohabiting)	351	1.26 (0.95–1.66)		
Danish ethnicity (vs. immigrant/descendant)	350	3.10 (1.15–8.35)		
Educational level [vs. primary and lower secondary school (9–10 years)]	346			
Higher general and preparatory examination program (12–13 years)		1.63 (1.09–2.43)	1.14 (0.75–1.74)	0.540
Short- and medium cycle higher education (14–17 years)		2.11 (1.36–3.28)	1.52 (0.96–2.40)	**0.072**
Long cycle higher education (17–22 years)		6.45 (2.94–14.2)	3.63 (1.56–8.43)	**0.003**
Socio-economic classification (vs. receiving social benefits)	351			
Employer		5.65 (2.10–15.21)	2.50 (0.90–6.89)	0.077
Employee		4.70 (2.41–9.61)	2.84 (1.44–5.62)	**0.003**
Personal income DKK (vs. < 275,000)[b]	351			
≥ 275,000		1.59 (1.21–2.09)		
Expectations of future occupation (vs. expectation of continued sick leave or retirement)	347			
Expect no sick leave		2.04 (1.40–2.97)	4.91 (1.45–16.60)	**0.010**
Expect return to full-time occupation		1.79 (1.26–2.56)	3.49 (1.09–11.15)	**0.035**
Expect return to part-time occupation or change of occupation		1.32 (0.90–1.92)	2.52 (0.75–8.52)	0.136
ASA-score 1 (vs. ASA-score 2)	340	1.63 (1.20–2.21)		
Leg pain intensity higher than back pain intensity (vs. back pain dominating)	351	1.71 (1.28–2.29)		
Duration of back pain (vs. pain ≥ one year)	351			
No pain		1.96 (1.21–3.18)		
Pain < 3 months		1.81 (1.23–2.67)		
Pain 3 months to < 12 months		1.35 (0.97–1.89)		
Duration of leg pain (vs. pain ≥ 1 year)	351			
No pain or pain < 3 months		1.93 (1.27–2.92)		
Pain 3 months to < 12 months		1.20 (0.80–1.81)		
Muscle strength grading (vs. normal strength)	329			
Movement against gravity		1.57 (1.04–2.38)		
Movement against resistance		1.32 (0.97–1.79)		
SF-36 PCS	351	1.03 (1.02–1.04)	1.02 (1.01–1.03)	**0.003**
ODI	350	0.99 (0.98–1.00)	0.99 (0.15–1.00)	**0.040**
Leg pain intensity	351	1.00 (0.99–1.00)		
Pre-operative sick leave	351	0.99 (0.98–0.99)	0.96 (0.95–0.97)	**< 0.001**
Peri-operative characteristics				
Surgical technique (vs. open discectomy)	351			
Microendoscopic		1.27 (0.65–2.47)		
Complications (none vs. present)	351	1.14 (0.56–2.32)		

Values in bold indicate factors found significantly associated with the probability of a sustained return to work within 2 years after lumbar discectomy. Alpha level of 0.05 used in all tests

CI confidence interval, *SE* standard errors, *DKK* Danish Kroner, *ASA* ASA Physical Status Classification System, *SF-36 PCS* Short Form 36 Physical Health Score, *ODI* Oswestry Disability Index

[a]The HR are adjusted for age as a covariate

[b]DKK 275,000 is the Danish median income within the study period and equals EUR 36,800 EUR

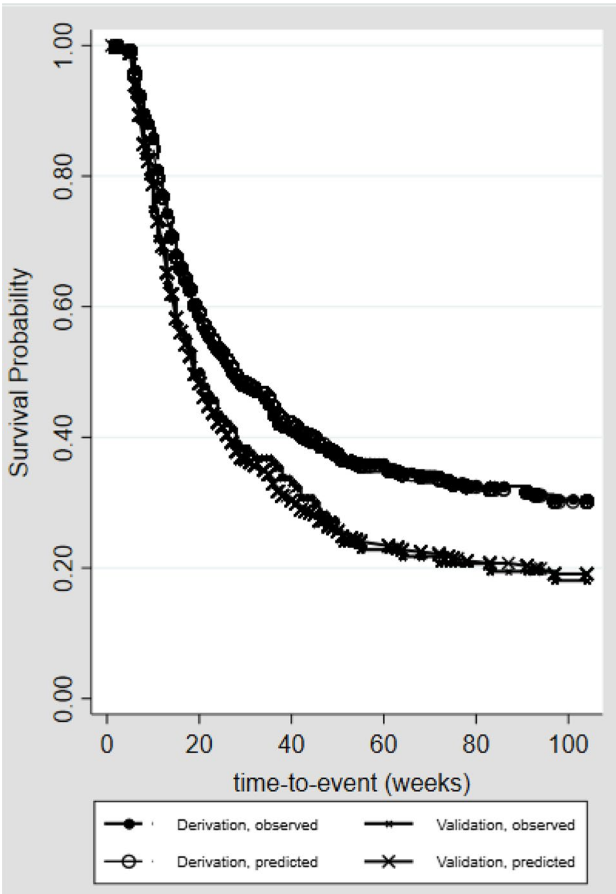

Fig. 3 The predicted Cox Proportional Hazards model vs. the observed, unadjusted Kaplan–Meier survival curves illustrating the calibration for both cohorts [37]

proportions of up to 94% within alternating follow-ups from 3 months to 2 years and some in mixed cohorts [37–39]. The exclusion of patients with short sick-leave in the present study is an obvious explanation for the discrepancy. The degree of pre-operative LMA is among the most important predictors for work resumption after LDH surgery [39], and patients with a short sick-leave are expected to have a good prognosis regarding RTW. Consequently, the mean time-to-event presented in this study is likely overestimated and the proportion of patients returning to work underestimated. It is, however, fair to argue that patients with only short sick-leaves are of no interest to the overall aim of prognostic studies like the present one: to identify the vulnerable patients who need special attention in order to avoid poor outcomes.

When comparing rates of RTW, differences in compensation policies are important as the presence of workers' compensation negatively affects RTW within the area of lumbar spine surgery [38]. Anema et al. [40] quantified the impact as they found that the Danish RTW at two-year follow-up after first sick-leave for LBP was 10% and 30% lower than American and Dutch equivalents. Finally, the definition of RTW needs to be clarified. The requirements for the amount of work presence constituting RTW affects both the time to RTW and the proportion of RTW within a study period. Using a 4-week period of work presence to define RTW in this study, we accommodated the post-surgical, possibly unstable, courses [41]. All the above-mentioned uncertainties necessitate a careful comparison with other studies. In this study, return to work covered return to part-time, full-time or changed work-functions irrespectively of the LMA prior to the surgery as the DREAM database did not allow further distinction. However, follow-up questionnaires in the DaneSpine database revealed that 24–28% of the operated patients reported, that they had returned to a lower level of work after surgery (data not shown). Also, according to the DaneSpine database, patients being on full-time or part-time sick-leave prior to surgery reported full-time and part-time workplace attachment at one-year follow-up in 60% and 66% of cases respectively, and in 60% and 64% of cases at two-years follow-up (data not shown).

The median time to sustained RTW was 15 weeks (95% CI 14–17), which is in line with other findings within the area [15, 42]. The medical staff advised patients that RTW would be possible at 6–12 weeks after surgery, and consequently, adjusting patient-information given to the patients receiving sickness benefits would likely make expectations more realistic and thus benefit the patients, employers and municipalities [11]. Adding the 108 patients with short sick-leave to the individuals who, according to the DREAM database, had returned to work at 6 and 12 weeks (25 and 129, respectively), we found that 30% [(25 + 108)/(336 + 108)] had returned after 6 weeks and 53% [(129 + 108)/(336 + 108)] had returned after 12 weeks. This, however, would be a best-case scenario under the assumption that all 108 patients returned to work.

Factors Associated with Sustained Return to Work

High pre-operative expectations regaining LMA after discectomy were associated with a high probability of sustained RTW. The statistically significant fixed categories were expectations of return to full-time occupation (HR 3.49 (95% CI 1.09–11.15) or expecting no sick-leave (HR 4.91 (95% CI 1.45–16.60). This association is similar to that of studies within the areas of LDH [43] and MSKD [16], and in general [44]. The time-varying effect as found in this study may explain why unmet expectations showed a strong association with dissatisfaction and negative patient-related outcomes after surgery [11, 45], and these findings suggest that expectations should be discussed during the pre-operative counseling or shared decision-making. Other identified psychological influencers of RTW after discectomy found in the literature are pre-operative depression and/or anxiety, the presence of which is associated with lower probability of sustained RTW [6, 43, 46]. In this study, mental health was examined using the SF-36 MCS, which was excluded from analyses due to strong inter-correlation with the ODI, and the predictive importance therefore remains unknown. Using a more specific questionnaire that captures the mental health issues mentioned in daily clinical practice would probably contribute to further prognostic research.

A higher education level was associated with a higher probability of sustained RTW. This finding is comparable to other findings within the target population examined [38], other medical areas [16, 47] and the general population [9]. The small proportion of patients in the category of long cycle higher education (17–22 years of school/education) was reflected in the wide CI [HR 3.63 (95% CI 1.56–8.43)]. Consistent with the literature, more weeks of sick-leave prior to surgery (the fixed variable), a lower SF-36 and a higher ODI, showed a statistically significant association with a lower probability of sustained RTW within 2 years after surgery [HR 0.96 (95% CI 0.95–0.97)], (HR 1.02 (95% CI 1.01–1.03) and HR 0.99 (95% CI 0.98–1.00), respectively [34, 39, 48]. The time-varying effect found related to the pre-operative sick-leave, however, reduced the negative effect on the outcome with the passage of time.

The remaining factors examined in this study showed no statistically significant association with the probability of sustained RTW in the multivariable analysis. The knowledge about demographic factors associated with RTW after lumbar discectomy is generally inadequate in the literature [15], and as such, our findings contribute to their clarification.

Predictive Model

At any time point within 2 years after lumbar discectomy, the probability of returning to work was 27% higher in the validation cohort compared to the derivation cohort. Furthermore, the ability to separate individuals returning to work from those experiencing a competing event was slightly inferior in the validation cohort (0.73 vs. 0.76 in the derivation cohort). The c statistics being > 0.7 in both the derivation and validation cohort did, however, indicate an overall good discrimination, and the calibration was likewise satisfying as illustrated in Fig. 3. Comparing the baseline characteristics of the derivation and validation cohort, we found few statistically significant differences (Table 1). The mean age, proportion of immigrants/descendants and the use of micro-endoscopic technique was higher in the validation cohort. In addition, fewer patients with an income below the median Danish income [275,000 DKK (36,800 EUR)] and more patients with an equal to or above the median income were found in the validation cohort compared to the derivation cohort. Studies have found inconsistent associations between surgical techniques and the probability of RTW [49] and that being older or being an immigrant/descendant is associated with a lower probability of LMA [48, 50]. Therefore, the difference in calibration and time to sustained RTW is likely explained either by the sickness benefit reform mentioned earlier or the difference in income. Regarding the latter, higher annual income is associated with higher socio-economic classification and a higher degree of pre-operational employment and thus options for RTW [44, 51].

Strengths and Limitations

The apparent strengths of the study are the completeness of the data sources used. The study population was identified from the DaneSpine database containing all patients undergoing lumbar discectomy at the public spine center, which prevented biased sampling of the study population and added size to the study population and thus allowed model building without the risk of overfitting.

The data provided by Statistics Denmark were considered to have high data completeness. In particular, the outcome of interest retrieved from the DREAM database and based on national, administrative data is a major strength. Nevertheless, the lack of data on sick-leaves less than 3 or 4 weeks within the time of surgery is an important flaw, as it affects the generalizability. The study population is, however, at higher risk of poor LMA after discectomy compared to the patients not included because of short sick-leave. As such, it is reasonable to conclude that the study answers its objectives, which were to identify important factors of those at risk of a poor outcome in terms of failing to re-enter the labor market. Comparison to study populations with no limitations to the length of sick-leave should, however, be done with caution.

Aside from affecting the generalizability of the results, the clinic not accepting individuals with ASA scores ≥ 3 is a possible source of prevalence-incidence bias as the presence of co-morbidity is negatively associated with RTW, time to RTW or improvement after surgery in general [38, 40]. However, multi-morbid individuals are markedly less represented in the labor market compared to healthy individuals, which dilutes the effect of the bias [52], but a comparison of our findings with similar studies including patients with higher ASA-scores should be done with caution.

A final limitation of the study is that it included no variables related to the post-operative course. Examples of such variables would be workplace interventions and rehabilitation. Workplace interventions, in particular, have proven to be strongly associated with RTW after LDH surgery and within the area of MSKD [16, 46], whereas the knowledge regarding rehabilitation is sparse. Both areas are difficult to assess, but they should ideally be prioritized in future studies to ultimately facilitate sustained RTW after lumbar discectomy. Furthermore, it could strengthen the discriminative ability of the predictive model.

Conclusion

Among patients with more than 3 or 4 weeks of sick-leave around the time of surgery, higher education level, stronger pre-operative LMA, more positive expectations towards future LMA, higher SF-36 PCS, lower ODI and less disability were significantly associated with a higher probability of sustained RTW within 2 years after lumbar discectomy. That is, more person-related and less disease-related factors were associated with the outcome. The prediction model performed well but the narrow external validation implies that the findings should be used only in similar cohorts or validated in other cohorts before used more extensively.

Some of the identified associated person-related factors could be modifiable, and future studies should examine whether interventions targeting these factors improve the time to sustained RTW. At this point, the results can contribute to pre-operative counseling and enhance the accuracy of informed prognosis.

Acknowledgements The authors are grateful to Karen Hoejmark Hansen, Spine Surgery and Research, Spine Center of Southern Denmark, for help with data extraction from DaneSpine.

Funding DSZ was funded by the IMK foundation, the Danish Foundation for Chiropractic Research and Postgraduate Education and the Region of Southern Denmark.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval No drug, materials, or devices described in the paper.

Appendix 1: Selection and Handling of Possible Predictors Prior to the Modeling

Possible predictors in alphabetic order:

ASA Physical Status Classification System (ASA-score):

Formed by the smoking status, Body Mass Index (BMI), alcohol use and co-morbidity. Within this cohort, finding less than 5% of the ASA-score variation explained by the three former using a nonparametric regression (data not shown), it is safe to conclude, that the ASA-score primarily is a proxy for comorbidity and that both the ASA-score and the independent variables could be included in the analyses.

Complications:

The following peri-operative complications would be noted in the electronic medical record if present: death, thrombosis, pulmonary embolism, cystitis, urine retention, bleeding/hematoma, wound infection, nerve root damage, cauda equine or dura tear. The complications were categorized into none, minor or major per Glassman et al. [53] but combined as the prevalence of major complications was too small to perform isolated analyses.

Domination leg pain:

Binary variable generated from the leg pain and back pain intensity measured as VAS-LP and VAS-BP respectively. The comparison of leg pain intensity to back pain intensity adds value to the decision-making prior to surgery as the patients with leg pain tends to be more severely affected in activity limitation, work participation, psychological factors and quality of life and thus in risk of poorer prognosis [54, 55]

Duration of pain:

Measured as individual variables *duration of back pain* and *duration of leg pain*. The categories *no leg pain* and *leg pain less than three months* were combined due to low prevalence of the former. Within both variables, in order to reduce the degrees of freedom, the categories *pain one year or less than two years* and *pain two years or more* were combined to one category.

Duration of pre-operative sick leave:

Duration of pre-operative sick leave was assessed using the DREAM database. Within a period of 2 years prior to the LDH surgery weeks coded 890-899 were summed.

The hazard function was found to vary significantly over time, thus not fulfilling the proportional hazards assumption and a time-varying variable was constructed and included in the study.

Educational level:

Retrieved from Statistics Denmark predictor HFAUDD being the highest completed education per October 1st. In this study, using a key provided by Statistics Denmark, the 2969 categories were converted into a nine-level educational classification, DISCED-15, which ensures consistency between the classification in the Danish education system and the international educational classification. Due to statistical insufficient cell sizes, the variable was further reduced as described in Table 1.

Ethnicity:

Retrieved from the Statistics Denmark variable named IE_type; Danish, Immigrant, Descendant. Due to low prevalence of descendants, the categories *immigrants* and *descendants* were combined. Descendants are defined as being born in Denmark, but none of the parents are both Danish citizens and born in Denmark. If no information is available about any of the parents and the person is a foreign national, the person is also considered a descendant.

EuroQol-5D (EQ-5D):

A strong negative correlation was found between EQ-5D and the variable *ODI*, and a moderate positive correlation found with the variable *SF-36 PCS*. Therefore excluded from further analyzes.

Expectations of future occupational status:

In order to reduce the degrees of freedom in the model, the categories was reduced from six categories to four categories as described in Table 1. The hazard function was found to vary significantly over time, thus not fulfilling the proportional hazards assumption and a time-varying variable was constructed and included in the study.

Married/cohabiting:

Binary possible predictor retrieved from the Statistics Denmark DREAM register.

Neurological examination:

Surveying the electronic patient journals for neurological and orthopedic pre-operative findings, up to 30% missing values were found which excluded the variables *deep tendon reflex grading*, *sensational evaluation*, and *straight leg raise tests* from further analyses. Only *muscle strength grading* (0–5) showed acceptable 6% missing values. Due to statistical inadequate cell sizes, the variable was reduced as described in Table 1.

Pain intensity:

Measured as Visual Analog Scale (0–100): VAS-leg pain (LP) and VAS-back pain (BP).

Both had a strong correlation to the possible predictor *Dominating leg pain*, but VAS-LP was kept in the analyses being identified as an important predictor in earlier studies.

Personal income:

The annual taxable personal income in Danish Kroner equal to the Statistics Denmark variable named QSPLINDK. The income included was as assessed 1 year prior to surgery, as changes within the year of surgery was assumed. Using paired t test the income 1 year and 2 years prior to surgery were compared, stratified by the year of surgery (data not shown). Finding no statistic significant differences validated the use of the variable as described. To enhance the clinical usefulness and the comparability to other countries the continuous variable was dichotomized according to the median income within the study period and as established by Statistics Denmark

Short Form (36) Health Survey, mental component summary (SF-36 MCS):

Strong positive correlation with *ODI* and consequently excluded from further analyzes.

Socio-economic classification:

Derived from the Statistics Denmark variable named PRE_SOCIO, which is based on the main source of income or employment within the tax year and assessed per 31.12. In this study, the 16 categories expressing the labor market attachment were reduced into the three groups: Employer (PRE_SOCIO codes 110-120), employee (PRE_SOCIO codes 130 + 310) and receiving social benefits (PRE_SOCIO codes 210 + 220 + 321–323 + 330 + 410). The classification examined as potential predictor is as assessed 1 year prior to surgery, as work-related events during the year of surgery could affect the classification. The degree of transition (10%, data not shown) between the groups from 2 years to 1 year prior to surgery validated the use as described.

Surgeon:

Twelve surgeons conducted between 1 and 17% of the surgeries within the derivation cohort. Using the Mann–Whitney ranksum test the possible predictor *technique* was found to be a statistic significant proxy for the surgeon, $p < 0.001$, and the possible predictor surgeon was excluded from further analyses.

References

1. Deyo RA, Tsui-Wu YJ. Descriptive epidemiology of low-back pain and its related medical care in the United States. Spine. 1987;12(3):264–268.
2. Hartvigsen L, Hestbaek L, Lebouef-Yde C, Vach W, Kongsted A. Leg pain location and neurological signs relate to outcomes in primary care patients with low back pain. BMC Musculoskelet Disord. 2017;18(1):133.
3. Bush K, Cowan N, Katz DE, Gishen P. The natural history of sciatica associated with disc pathology. A prospective study with clinical and independent radiologic follow-up. Spine. 1992;17(10):1205–1212.
4. Albert HB, Briggs AM, Kent P, Byrhagen A, Hansen C, Kjaergaard K. The prevalence of MRI-defined spinal pathoanatomies and their association with modic changes in individuals seeking care for low back pain. Eur Spine J. 2011;20(8):1355–1362.
5. Hansen JZ. Projection of the population's labor market attachment. Socio-economic projection 2016. DREAM; 2016.
6. Schade V, Semmer N, Main CJ, Hora J, Boos N. The impact of clinical, morphological, psychosocial and work-related factors on the outcome of lumbar discectomy. Pain. 1999;80(1–2):239–249.
7. Hakkinen A, Ylinen J, Kautiainen H, Airaksinen O, Herno A, Kiviranta I. Does the outcome 2 months after lumbar disc surgery predict the outcome 12 months later? Disabil Rehabil. 2003;25(17):968–972.
8. Mummaneni PV, Whitmore RG, Curran JN, Ziewacz JE, Wadhwa R, Shaffrey CI, et al. Cost-effectiveness of lumbar discectomy and single-level fusion for spondylolisthesis: experience with the NeuroPoint-SD registry. Neurosurg Focus. 2014;36(6):E3.
9. Gustafsson K, Marklund S. Consequences of sickness presence and sickness absence on health and work ability: a Swedish prospective cohort study. Int J Occup Med Environ Health. 2011;24(2):153–165.
10. Jansson C, Mittendorfer-Rutz E, Alexanderson K. Sickness absence because of musculoskeletal diagnoses and risk of all-cause and cause-specific mortality: a nationwide Swedish cohort study. Pain. 2012;153(5):998–1005.
11. Witiw CD, Mansouri A, Mathieu F, Nassiri F, Badhiwala JH, Fessler RG. Exploring the expectation-actuality discrepancy: a systematic review of the impact of preoperative expectations on satisfaction and patient reported outcomes in spinal surgery. Neurosurg Rev. 2018;41(1):19–30.
12. Croft P, Altman DG, Deeks JJ, Dunn KM, Hay AD, Hemingway H, et al. The science of clinical practice: disease diagnosis or patient prognosis? Evidence about "what is likely to happen" should shape clinical practice. BMC Med. 2015;13:20.
13. Burton A, Waddell G, Main C. Screening to identify people at risk of long-term incapacity for work: a conceptual and scientific review. Disability Medicine: American Board of Independent Medical Examiners; 2003. p. 72–83.
14. Loisel P, Buchbinder R, Hazard R, Keller R, Scheel I, van Tulder M, et al. Prevention of work disability due to musculoskeletal disorders: the challenge of implementing evidence. J Occup Rehabil. 2005;15(4):507–524.

15. Huysmans E, Goudman L, Van Belleghem G, De Jaeger M, Moens M, Nijs J, et al. Return to work following surgery for lumbar radiculopathy: a systematic review. Spine J. 2018;18(9):1694–1714.
16. Cancelliere C, Donovan J, Stochkendahl MJ, Biscardi M, Ammendolia C, Myburgh C, et al. Factors affecting return to work after injury or illness: best evidence synthesis of systematic reviews. Chiropr Man Ther. 2016;24(1):32.
17. Steenstra IA, Munhall C, Irvin E, Oranye N, Passmore S, Van Eerd D, et al. Systematic review of prognostic factors for return to work in workers with sub acute and chronic low back pain. J Occup Rehabil. 2017;27(3):369–381.
18. Simony A, Hansen KH, Ernst C, Andersen MO. Implementation of the Danish national database Danespine for spinal surgery. Ugeskr Laeger. 2014;176(2a):V01130019.
19. Statistics Denmark. About us: Statistics Denmark; 2018. https://www.dst.dk/en/OmDS. Updated 2018.
20. Collins GS, Reitsma JB, Altman DG, Moons KG. Transparent reporting of a multivariable prediction model for individual prognosis or diagnosis (TRIPOD): the TRIPOD Statement. BMC Med. 2015;13:1.
21. Lynge E, Sandegaard JL, Rebolj M. The Danish National Patient Register. Scand J Public health. 2011;39(7 Suppl):30–33.
22. Pedersen CB. The Danish Civil Registration System. Scand J Public health. 2011;39(7 Suppl):22–25.
23. Thygesen LC, Daasnes C, Thaulow I, Bronnum-Hansen H. Introduction to Danish (nationwide) registers on health and social issues: structure, access, legislation, and archiving. Scand J Public health. 2011;39(7 Suppl):12–16.
24. Hjollund NH, Larsen FB, Andersen JH. Register-based follow-up of social benefits and other transfer payments: accuracy and degree of completeness in a Danish interdepartmental administrative database compared with a population-based survey. Scand J Public health. 2007;35(5):497–502.
25. Stapelfeldt CM, Jensen C, Andersen NT, Fleten N, Nielsen CV. Validation of sick leave measures: self-reported sick leave and sickness benefit data from a Danish national register compared to multiple workplace-registered sick leave spells in a Danish municipality. BMC public health. 2012;12:661.
26. The American Society of Anesthesiologists. ASA Physical Status Classification System American Society of Anesthesiologists web site Updated 15 Oct 2014. https://www.asahq.org/standards-and-guidelines/asa-physical-status-classification-system.
27. Employment Mo. The importance of the sickness benefit reform for the case handling in the municipalities. Styrelsen for Arbejdsmarked og Rekruttering; 2014. p. 1–13.
28. Huskisson EC. Measurement of pain. Lancet (London, England). 1974;2(7889):1127–1131.
29. Fairbank JC, Couper J, Davies JB, O'Brien JP. The Oswestry low back pain disability questionnaire. Physiotherapy. 1980;66(8):271–273.
30. Lauridsen HH, Hartvigsen J, Manniche C, Korsholm L, Grunnet-Nilsson N. Danish version of the Oswestry Disability Index for patients with low back pain. Part 1: cross-cultural adaptation, reliability and validity in two different populations. Eur Spine J. 2006;15(11):1705–1716.
31. Group E. EuroQol—a new facility for the measurement of health-related quality of life. Health Policy. 1990;16(3):199–208.
32. McHorney CA, Ware JE Jr, Raczek AE. The MOS 36-Item Short-Form Health Survey (SF-36). II. Psychometric and clinical tests of validity in measuring physical and mental health constructs. Med Care. 1993;31(3):247–263.
33. Harrell FE Jr, Lee KL, Califf RM, Pryor DB, Rosati RA. Regression modelling strategies for improved prognostic prediction. Stat Med. 1984;3(2):143–152.
34. Puolakka K, Ylinen J, Neva MH, Kautiainen H, Hakkinen A. Risk factors for back pain-related loss of working time after surgery for lumbar disc herniation: a 5-year follow-up study. Eur Spine J. 2008;17(3):386–392.
35. Denmark TRCoHREfS. The Scientific Ethics Committees: The Region of Southern Denmark; 2016. https://komite.regionsyddanmark.dk/wm428123. Updated December 13, 2016.
36. Fisher LD, Lin DY. Time-dependent covariates in the Cox proportional-hazards regression model. Annu Rev Public Health. 1999;20:145–157.
37. den Boer JJ, Oostendorp RA, Beems T, Munneke M, Evers AW. Reduced work capacity after lumbar disc surgery: the role of cognitive-behavioral and work-related risk factors. Pain. 2006;126(1–3):72–78.
38. Asher AL, Devin CJ, Archer KR, Chotai S, Parker SL, Bydon M, et al. An analysis from the Quality Outcomes Database, Part 2. Predictive model for return to work after elective surgery for lumbar degenerative disease. J Neurosurg Spine. 2017;27(4):370–381.
39. Than KD, Curran JN, Resnick DK, Shaffrey CI, Ghogawala Z, Mummaneni PV. How to predict return to work after lumbar discectomy: answers from the NeuroPoint-SD registry. J Neurosurg Spine. 2016;25(2):181–186.
40. Anema JR, Schellart AJ, Cassidy JD, Loisel P, Veerman TJ, van der Beek AJ. Can cross country differences in return-to-work after chronic occupational back pain be explained? An exploratory analysis on disability policies in a six country cohort study. J Occup Rehabil. 2009;19(4):419–426.
41. Schultz IZ, Stowell AW, Feuerstein M, Gatchel RJ. Models of return to work for musculoskeletal disorders. J Occup Rehabil. 2007;17(2):327–352.
42. Dorner TE, Helgesson M, Nilsson K, Pazarlis KA, Ropponen A, Svedberg P, et al. Course and characteristics of work disability 3 years before and after lumbar spine decompression surgery- a national population-based study. Sci Rep. 2018;8(1):11811.
43. Zieger M, Luppa M, Meisel HJ, Gunther L, Winkler D, Toussaint R, et al. The impact of psychiatric comorbidity on the return to work in patients undergoing herniated disc surgery. J Occup Rehabil. 2011;21(1):54–65.
44. de Wit M, Wind H, Hulshof CTJ, Frings-Dresen MHW. Person-related factors associated with work participation in employees with health problems: a systematic review. Int Arch Occup Environ Health. 2018;91(5):497–512.
45. Johansson AC, Linton SJ, Rosenblad A, Bergkvist L, Nilsson O. A prospective study of cognitive behavioural factors as predictors of pain, disability and quality of life one year after lumbar disc surgery. Disabil Rehabil. 2010;32(7):521–529.
46. den Boer JJ, Oostendorp RA, Beems T, Munneke M, Oerlemans M, Evers AW. A systematic review of bio-psychosocial risk factors for an unfavourable outcome after lumbar disc surgery. Eur Spine J. 2006;15(5):527–536.
47. Clay FJ, Newstead SV, McClure RJ. A systematic review of early prognostic factors for return to work following acute orthopaedic trauma. Injury. 2010;41(8):787–803.
48. Jensen LD, Frost P, Schiottz-Christensen B, Maribo T, Christensen MV, Svendsen SW. Predictors of vocational prognosis after herniated lumbar disc: a two-year follow-up study of 2039 patients diagnosed at hospital. Spine. 2011;36(12):E791–E797.
49. Akinduro OO, Kerezoudis P, Alvi MA, Yoon JW, Eluchie J, Murad MH, et al. Open versus minimally invasive surgery for extraforaminal lumbar disk herniation: a systematic review and meta-analysis. World Neurosurg. 2017;108(924–938):e3.
50. Scheermesser M, Bachmann S, Schamann A, Oesch P, Kool J. A qualitative study on the role of cultural background in patients' perspectives on rehabilitation. BMC Musculoskelet Disord. 2012;13:5.
51. Jacobsen KF. Educational level of the population. Copenhagen: Statistics Denmark; 2004. http://www.dst.dk/pukora/epub/upload/8310/befudd.pdf. Accessed 12 Dec 2019.

52. Statens Serum Institut. Few people with multi-disease on the labor market. Statens Serum Insitut. 2015. https://sundhedsdatastyrelsen.dk/da/404/?item=%2fda%2ftal-oganalyser%2fanalyser-og-rapporter%2fsygdomme%2fkronisk-sygdom&user=extranet%5cAnonymous&site=sds. Accessed 12 Dec 2019.
53. Glassman SD, Hamill CL, Bridwell KH, Schwab FJ, Dimar JR, Lowe TG. The impact of perioperative complications on clinical outcome in adult deformity surgery. Spine. 2007;32:2764–2770.
54. Cook CE, Arnold PM, Passias PG, Frempong-Boadu AK, Radcliff K, Isaacs R. Predictors of pain and disability outcomes in one thousand, one hundred and eight patients who underwent lumbar discectomy surgery. Int Orthop. 2015;39:2143–2151. https://doi.org/10.1007/s00264-015-2748-0.
55. Kongsted A, Kent P, Albert H, Jensen TS, Manniche C. Patients with low back pain differ from those who also have leg pain or signs of nerve root involvement—a cross-sectional study. BMC musculoskeletal disorders. 2012;13:236. https://doi.org/10.1186/1471-2474-13-236.