

Supplementary Table 1. Baseline Characteristics and Prevalence of Risk Factors in Consecutive Cohort (N = 143,396)

Covariate	Derivation cohort (n = 95,763)			Validation cohort (n = 47,633)		
	Without recurrence (n = 34,269)	With recurrence (n = 61,494)	P value	Without recurrence (n = 16,965)	With recurrence (n = 30,668)	P value
Follow-up (yr)	3.04 ± 2.0	1.1 ± 1.4	< 0.001	3.04 ± 2.0	1.08 ± 1.4	< 0.001
Height (cm)	163.3 ± 8.8	161.2 ± 9.1	< 0.001	163.2 ± 8.8	161.2 ± 9.0	< 0.001
Weight (kg)	62.5 ± 11.1	61.9 ± 10.7	< 0.001	62.4 ± 11.2	61.9 ± 10.6	< 0.001
BMI (kg/m <sup>2</sup> )	23.4 ± 3.3	23.8 ± 3.2	< 0.001	23.3 ± 3.3	23.8 ± 3.2	< 0.001
SBP (mmHg)	122.2 ± 17.0	124.5 ± 17.3	< 0.001	121.9 ± 17.1	124.5 ± 17.3	< 0.001
DBP (mmHg)	77.1 ± 11.5	78.1 ± 11.4	< 0.001	76.9 ± 11.4	78.2 ± 11.4	< 0.001
Fasting blood glucose (mg/dL)	93.6 ± 28.5	95.5 ± 29.2	< 0.001	93.4 ± 28.6	95.7 ± 29.3	< 0.001
Total cholesterol (mg/dL)	191.4 ± 38.3	195.9 ± 38.4	< 0.001	191.4 ± 38.5	196.2 ± 38.6	< 0.001
Sex			< 0.001			< 0.001
M	16,761 (48.9)	26,339 (42.8)		8,133 (47.9)	13,154 (42.9)	
F	17,508 (51.1)	35,155 (57.2)		8,832 (52.1)	17,514 (57.1)	
Age (yr)			< 0.001			< 0.001
< 45	21,330 (62.2)	26,948 (43.8)		10,652 (62.8)	13,330 (43.4)	
45-54	6,914 (20.2)	14,571 (23.7)		3,380 (19.9)	7,448 (24.3)	
55-64	4,055 (11.8)	12,332 (20.1)		1,961 (11.6)	6,189 (20.2)	
≥ 65	1,970 (5.8)	7,643 (12.4)		972 (5.7)	3,701 (12.1)	
Income/Insurance premium (%)			< 0.001			0.0101
Low (< 30)	5,022 (14.7)	9,691 (15.8)		2,482 (14.6)	4,758 (15.5)	
Medium (30-60)	12,414 (36.2)	21,778 (35.4)		6,159 (36.3)	10,806 (35.2)	
High (> 60)	16,833 (49.1)	30,025 (48.8)		8,324 (49.1)	15,104 (49.3)	
Physical activity (times/wk)			< 0.001			< 0.001
Low (none)	20,090 (58.6)	37,167 (60.4)		9,951 (58.7)	18,511 (60.3)	
Moderate (1-3)	12,158 (35.5)	20,641 (33.6)		6,000 (35.4)	10,300 (33.6)	
High (≥ 4)	2,021 (5.9)	3,686 (6.0)		1,014 (6.0)	1,857 (6.1)	
Smoking status			< 0.001			< 0.001
Never	23,176 (67.6)	44,874 (73.0)		11,564 (68.2)	22,298 (72.7)	
Former smoker	1,526 (4.5)	2,390 (3.9)		733 (4.3)	1,163 (3.8)	
Current smoker	9,567 (27.9)	14,230 (23.1)		4,668 (27.5)	7,207 (23.5)	
Alcohol consumption (times/mo)			< 0.001			< 0.001
Rarely (< 2)	17,530 (51.2)	34,697 (56.4)		8,781 (51.8)	17,441 (56.9)	
Moderate drinker (2-3)	13,878 (40.5)	22,326 (36.3)		6,807 (40.1)	10,987 (35.8)	
Heavy drinker (≥ 4)	2,861 (8.3)	4,471 (7.3)		1,377 (8.1)	2,240 (7.3)	
BMI (kg/m <sup>2</sup> )			< 0.001			< 0.001
< 18.5	2,081 (6.1)	2,654 (4.3)		1,048 (6.2)	1,299 (4.2)	
18.5-24.9	22,175 (64.7)	38,016 (61.8)		10,947 (64.5)	19,063 (62.2)	
25.0-29.9	9,104 (26.6)	18,845 (30.7)		4,503 (26.5)	9,359 (30.5)	
≥ 30.0	909 (2.6)	1979 (3.2)		467 (2.8)	947 (3.1)	
Total cholesterol (mg/dL)			< 0.001			< 0.001
< 200	20,604 (60.1)	33,933 (55.2)		10,132 (59.7)	16,791 (54.8)	
200-239	9,998 (29.2)	19,677 (32.0)		5,037 (29.7)	9,854 (32.1)	
≥ 240	3,667 (10.7)	7,884 (12.8)		1,796 (10.6)	4,023 (13.1)	
Fasting blood glucose/Diabetes (mg/dL)			< 0.001			< 0.001
< 100	21,605 (63.1)	37,015 (60.2)		10,783 (63.6)	18,374 (59.9)	
100-125	8,645 (25.2)	16,322 (26.5)		4,205 (24.8)	8,193 (26.7)	
≥ 126 or Tx	4,019 (11.7)	8,157 (13.3)		1,977 (11.6)	4,101 (13.4)	
Blood pressure/HTN (mmHg)			< 0.001			< 0.001
SBP < 120 and DBP < 80	13,382 (39.1)	21,087 (34.3)		6,717 (39.6)	10,521 (34.3)	
SBP 120-139 or DBP 80-89	17,305 (50.5)	32,639 (53.1)		8,508 (50.1)	16,243 (53.0)	
SBP 140-159 or DBP 90-99	3,234 (9.4)	6,856 (11.1)		1,554 (9.2)	3,460 (11.3)	
SBP ≥ 160 or DBP ≥ 100 or Rx	348 (1.0)	912 (1.5)		186 (1.1)	444 (1.4)	
Diagnosed IHD			< 0.001			< 0.001
No	33,916 (99.0)	60,508 (98.4)		16,771 (98.9)	30,187 (98.4)	
Yes	353 (1.0)	986 (1.6)		194 (1.1)	481 (1.6)	
Diagnosed IVDD			< 0.001			< 0.001
No	32,149 (93.8)	54,765 (89.1)		15,888 (93.7)	27,383 (89.3)	
Yes	2,120 (6.2)	6,729 (10.9)		1,077 (6.3)	3,285 (10.7)	
History of back injuries			< 0.001			< 0.001
No	34,069 (99.4)	60,924 (99.1)		16,877 (99.5)	30,398 (99.1)	
Yes	200 (0.6)	570 (0.9)		88 (0.5)	270 (0.9)	
BMD disorders			< 0.001			< 0.001
No	33,053 (96.5)	57,294 (93.2)		16,402 (96.7)	28,632 (93.4)	
Yes	1,216 (3.5)	4,200 (6.8)		563 (3.3)	2,036 (6.6)	
Spinal stenosis			< 0.001			< 0.001
No	33,948 (99.1)	60,149 (97.8)		16,816 (99.1)	30,031 (97.9)	
Yes	321 (0.9)	1,345 (2.2)		149 (0.9)	637 (2.1)	
Spondylolisthesis			< 0.001			0.006
No	34,254 (99.96)	61,380 (99.8)		16,953 (99.9)	30,617 (99.8)	
Yes	15 (0.04)	114 (0.2)		12 (0.1)	51 (0.2)	

Values are presented as mean ± standard deviation or number (%).

BMI: body mass index, SBP: systolic blood pressure, DBP: diastolic blood pressure, Tx: medication due to diabetes, HTN: hypertension, Rx: medication due to HTN, IHD: ischemic heart disease, IVDD: intervertebral disc degeneration, BMD: bone mineral density.

**Supplementary Table 2.** HR, 95% CI, and  $\beta$ -Coefficients for Risk Predictors in the Univariate Analysis and Adjusted Analysis

Covariate	Unadjusted <sup>a</sup>			Adjusted <sup>b</sup>		
	$\beta$ (SE)	HR (95% CI)	P value	$\beta$ (SE)	HR (95% CI)	P value
Sex						
F	0.095 (0.007)	1.10 (1.09-1.12)	< 0.001	0.069 (0.009)	1.07 (1.05-1.09)	< 0.001
Age (yr)						
< 45	Reference	Reference		Reference	Reference	
45-54	0.271 (0.008)	1.31 (1.29-1.33)	< 0.001	0.266 (0.009)	1.31 (1.28-1.33)	< 0.001
55-64	0.430 (0.009)	1.54 (1.51-1.57)	< 0.001	0.426 (0.009)	1.53 (1.50-1.56)	< 0.001
$\geq 65$	0.527 (0.011)	1.69 (1.66-1.73)	< 0.001	0.523 (0.011)	1.69 (1.65-1.72)	< 0.001
Income/Insurance premium (%)						
High (> 60)	Reference	Reference		Reference	Reference	
Medium (30-60)	-0.008 (0.007)	0.99 (0.98-1.01)	0.2655	0.023 (0.007)	1.02 (1.01-1.04)	0.0023
Low (< 30)	0.056 (0.010)	1.06 (1.04-1.08)	< 0.001	0.048 (0.010)	1.05 (1.03-1.07)	< 0.001
Physical activity (times/wk)						
High ( $\geq 4$ )	Reference	Reference		Reference	Reference	
Moderate (1-3)	-0.036 (0.015)	0.97 (0.94-0.99)	0.0145	-0.019 (0.015)	0.98 (0.95-1.01)	0.2068
Low (none)	0.0007 (0.014)	1.00 (0.97-1.03)	0.9615	-0.014 (0.014)	0.99 (0.96-1.01)	0.3161
Smoking status						
Never	Reference	Reference		Reference	Reference	
Former	-0.096 (0.018)	0.91 (0.88-0.94)	< 0.001	-0.022 (0.018)	0.98 (0.94-1.01)	0.2221
Current smoker	-0.118 (0.008)	0.89 (0.88-0.90)	< 0.001	-0.012 (0.010)	0.99 (0.97-1.01)	0.2510
Alcohol consumption (times/mo)						
Rarely (< 2)	Reference	Reference		Reference	Reference	
Moderate (2-3)	-0.094 (0.007)	0.91 (0.90-0.92)	< 0.001	-0.006 (0.008)	0.99 (0.98-1.01)	0.4288
Heavy ( $\geq 4$ )	-0.100 (0.013)	0.91 (0.88-0.93)	< 0.001	0.003 (0.014)	1.00 (0.98-1.03)	0.8326
BMI (kg/m <sup>2</sup> )						
< 18.5	-0.159 (0.01677)	0.85 (0.83-0.88)	< 0.001	-0.112 (0.017)	0.89 (0.87-0.93)	< 0.001
18.5-24.9	Reference	Reference		Reference	Reference	
25.0-29.9	0.08792 (0.007)	1.09 (1.08-1.11)	< 0.001	0.048 (0.007)	1.05 (1.03-1.07)	< 0.001
$\geq 30.0$	0.097 (0.019)	1.10 (1.06-1.14)	< 0.001	0.044 (0.019)	1.05 (1.01-1.09)	0.0220
Total cholesterol (mg/dL)						
< 200	Reference	Reference		Reference	Reference	
200-239	0.083 (0.007)	1.09 (1.07-1.10)	< 0.001	0.023 (0.008)	1.02 (1.01-1.04)	0.0025
$\geq 240$	0.137 (0.010)	1.15 (1.12-1.17)	< 0.001	0.031 (0.011)	1.03 (1.01-1.05)	0.0030
Fasting blood glucose (mg/dL)						
< 100	Reference	Reference		Reference	Reference	
100-125	0.049 (0.008)	1.05 (1.04-1.07)	< 0.001	0.007 (0.008)	1.01 (0.99-1.02)	0.3489
$\geq 126$ or Tx	0.094 (0.010)	1.10 (1.08-1.12)	< 0.001	0.005 (0.010)	1.01 (0.99-1.03)	0.6059
Blood pressure/HTN (mmHg)						
SBP < 120 and DBP < 80	Reference	Reference		Reference	Reference	
SBP 120-139 or DBP 80-89	0.099 (0.007)	1.10 (1.09-1.12)	< 0.001	0.027 (0.008)	1.03 (1.01-1.04)	< 0.001
SBP 140-159 or DBP 90-99	0.167 (0.012)	1.18 (1.16-1.21)	< 0.001	0.021 (0.012)	1.02 (1.00-1.05)	0.0759
SBP $\geq 160$ or DBP $\geq 100$ or Rx	0.235 (0.028)	1.27 (1.20-1.34)	< 0.001	0.050 (0.028)	1.05 (0.99-1.11)	0.0782
BMI (kg/m <sup>2</sup> )	0.019 (0.001)	1.019 (1.017-1.021)	< 0.001	0.011 (0.001)	1.01 (1.01-1.01)	< 0.001
Fasting blood glucose (mg/dL)	0.0013 (0.0001)	1.001 (1.001-1.002)	< 0.001	0.00009 (0.00012)	1.000 (1.000-1.000)	0.4354
Total cholesterol (mg/dL)	0.002 (0.00008)	1.002 (1.001-1.002)	< 0.001	0.0004 (0.00009)	1.000 (1.000-1.001)	< 0.001
SBP (mmHg)	0.004 (0.0002)	1.004 (1.004-1.005)	< 0.001	0.0008 (0.0002)	1.001 (1.000-1.001)	< 0.001
DBP (mmHg)	0.004 (0.0003)	1.004 (1.004-1.005)	< 0.001	0.001 (0.0003)	1.001 (1.001-1.002)	< 0.001
Premorbid diseases						
History of diabetes	0.207 (0.015)	1.23 (1.20-1.27)	< 0.001	0.038 (0.015)	1.04 (1.01-1.07)	0.0110
History of HTN	0.237 (0.010)	1.27 (1.24-1.29)	< 0.001	0.037 (0.010)	1.04 (1.02-1.06)	< 0.001
Diagnosed IHD	0.158 (0.026)	1.17 (1.11-1.23)	< 0.001	-0.005 (0.027)	1.00 (0.95-1.05)	0.8566
Diagnosed IVDD	0.233 (0.011)	1.26 (1.24-1.29)	< 0.001	0.154 (0.011)	1.17 (1.14-1.19)	< 0.001
History of back injury	0.205 (0.035)	1.23 (1.15-1.31)	< 0.001	0.165 (0.035)	1.18 (1.10-1.26)	< 0.001
Spinal stenosis	0.310 (0.023)	1.36 (1.30-1.43)	< 0.001	0.108 (0.023)	1.11 (1.07-1.17)	< 0.001
BMD disorders	0.260 (0.013)	1.30 (1.26-1.33)	< 0.001	0.067 (0.014)	1.07 (1.04-1.10)	< 0.001
Spondylolisthesis	0.491 (0.078)	1.63 (1.40-1.90)	< 0.001	0.334 (0.078)	1.40 (1.20-1.63)	< 0.001
Days of consultation						
1	Reference	Reference		Reference	Reference	
2-3	-0.025 (0.009)	0.98 (0.96-0.99)	0.0073	-0.074 (0.009)	0.93 (0.91-0.95)	< 0.001
$\geq 4$	0.157 (0.014)	1.17 (1.14-1.20)	< 0.001	0.096 (0.014)	1.10 (1.07-1.13)	< 0.001
Days of prescription						
$\geq 8$	Reference	Reference		Reference	Reference	
1-7	-0.088 (0.011)	0.92 (0.90-0.94)	< 0.001	0.015 (0.011)	0.95 (0.93-0.98)	0.1558
None	-0.130 (0.011)	0.88 (0.86-0.90)	< 0.001	-0.048 (0.012)	1.02 (0.99-1.04)	< 0.001
Days of hospitalisation						
1	Reference	Reference		Reference	Reference	
2-4	-0.019 (0.009)	0.98 (0.97-0.99)	0.0333	-0.069 (0.009)	0.93 (0.92-0.95)	< 0.001
$\geq 5$	0.165 (0.014)	1.18 (1.15-1.21)	< 0.001	0.084 (0.014)	1.09 (1.06-1.11)	< 0.001
Days of consultation	0.015 (0.0015)	1.015 (1.012-1.018)	< 0.001	0.010 (0.002)	1.010 (1.007-1.013)	< 0.001
Days of prescription	0.003 (0.0004)	1.003 (1.003-1.004)	< 0.001	-0.0002 (0.0004)	1.000 (0.999-1.001)	0.6780
Days of hospitalisation	0.009 (0.001)	1.009 (1.007-1.011)	< 0.001	0.004 (0.001)	1.004 (1.002-1.006)	< 0.001

HR: hazard ratio, CI: confidence interval, SE: standard error, BMI: body mass index, Tx: medication due to diabetes, HTN: hypertension, SBP: systolic blood pressure, DBP: diastolic blood pressure, Rx: medication due to HTN, IHD: ischemic heart disease, IVDD: intervertebral disc degeneration, BMD: bone mineral density.

<sup>a</sup>Univariate analysis. <sup>b</sup>Fully adjusted accounting for age, sex, income grade, physical activity, smoking status, alcohol consumption, and each of the other risk factors (fasting blood glucose/diabetes, total cholesterol, blood pressure/HTN, prior history of [diabetes, HTN, IHD, IVDD, history of back injury, spinal stenosis, BMD disorders, spondylolisthesis]).

**Supplementary Table 3.** HR, 95% CI, and  $\beta$ -Coefficients for Risk Predictors in the Recurrence Parsimonious Prediction Models of LBP Recurrence

Covariate	$\beta$ (SE)	HR (95% CI)	P value	Risk point <sup>a</sup>
Sex				
M	Reference	Reference		0
F	0.088 (0.008)	1.09 (1.07-1.11)	< 0.001	9
Age (yr)				
< 45	Reference	Reference		0
45-54	0.236 (0.011)	1.27 (1.24-1.29)	< 0.001	24
55-64	0.400 (0.011)	1.49 (1.46-1.53)	< 0.001	40
$\geq$ 65	0.511 (0.013)	1.67 (1.62-1.71)	< 0.001	51
Income/Insurance premium (%)				
High (> 60)	Reference	Reference		0
Medium (30-60)	0.028 (0.009)	1.03 (1.01-1.05)	0.0019	3
Low (< 30)	0.051 (0.012)	1.05 (1.03-1.08)	< 0.001	5
BMI (kg/m <sup>2</sup> )				
< 18.5	-0.099 (0.021)	0.91 (0.87-0.94)	< 0.001	-10
18.5-24.9	Reference	Reference		0
25-29.9	0.049 (0.009)	1.05 (1.03-1.07)	< 0.001	5
$\geq$ 30	0.050 (0.023)	1.05 (1.01-1.10)	0.0308	5
History of IVDD				
No	Reference	Reference		0
Yes	0.159 (0.013)	1.17 (1.14-1.20)	< 0.001	16
Spondylolisthesis				
No	Reference	Reference		0
Yes	0.335 (0.094)	1.340 (1.16-1.68)	0.0004	34
Days of prescription				
$\geq$ 8	Reference	Reference		0
1-7	0.020 (0.013)	1.02 (0.99-1.05)	0.1346	2
None	-0.040 (0.014)	0.96 (0.93-0.99)	0.0046	-4

HR: hazard ratio, CI: confidence interval, LBP: low back pain, SE: standard error, BMI: body mass index, IVDD: intervertebral disc degeneration.

<sup>a</sup>The risk points were calculated by multiplying the estimated coefficients by 100 and rounding to the next integer; The most significant risk factors for 5-year recurrence based on the possible maximum risk points were age, spondylolisthesis, and IVDD which conferred maximum risk of 51, 34, and 16 points, respectively.

**Supplementary Table 4.** Discrimination and Calibration of Models in Derivation and Validation Cohorts

Model and risk score performance metrics	Derivation cohort	Validation cohort
Model based performance		
Brier score <sup>a</sup>	0.397	0.398
Nam-D'Agostino test <sup>b</sup>	$\chi^2 = 1.3849, P = 0.6815$	$\chi^2 = 1.3981, P = 0.8752$
Harrell's C statistic (95% CI) <sup>c</sup>	0.916 (0.910-0.922)	0.916 (0.907-0.924)
Sensitivity (95% CI)	0.827 (0.824-0.830)	0.823 (0.819-0.826)
Specificity (95% CI)	0.474 (0.469-0.479)	0.475 (0.468-0.482)
Positive predictive value (%)	0.726 (0.723-0.728)	0.724 (0.721-0.727)
Negative predictive value (%)	0.620 (0.615-0.624)	0.617 (0.610-0.624)
Accuracy (%)	0.695 (0.692-0.698)	0.694 (0.689-0.698)
Risk score performance evaluation		
Sensitivity (95% CI)	0.902 (0.899-0.904)	0.899 (0.895-0.902)
Specificity (95% CI)	0.176 (0.172-0.180)	0.172 (0.166-0.177)
Positive predictive value (95% CI)	0.647 (0.646-0.648)	0.646 (0.645-0.648)
Negative predictive value (95% CI)	0.517 (0.509-0.525)	0.499 (0.487-0.511)
Accuracy (95% CI) <sup>b</sup>	0.630 (0.627-0.633)	0.628 (0.624-0.632)

CI: confidence interval.

<sup>a</sup>Measures both discrimination and calibration; lower values indicate higher accuracy. <sup>b</sup>A modification of Hosmer-Lemeshow test suited for survival data; measure of calibration that is specific to censored survival data (lower  $\chi^2$  and higher  $P$  values) indicate better calibration. <sup>c</sup>A measure of discrimination for which higher values indicate better discrimination.

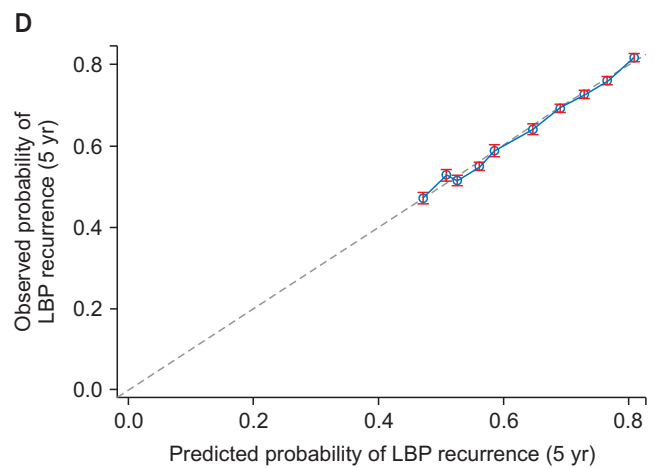
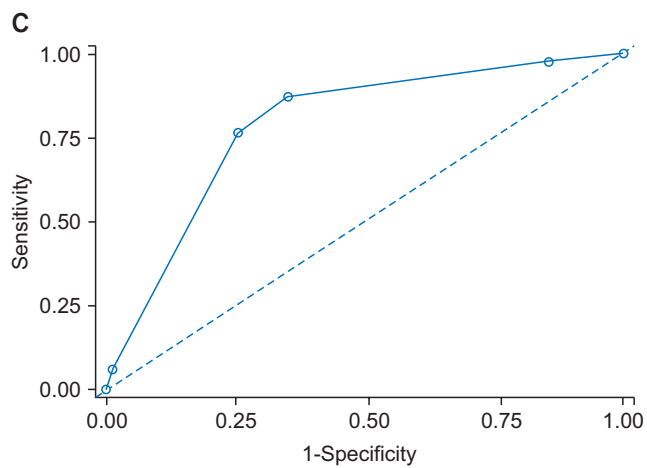
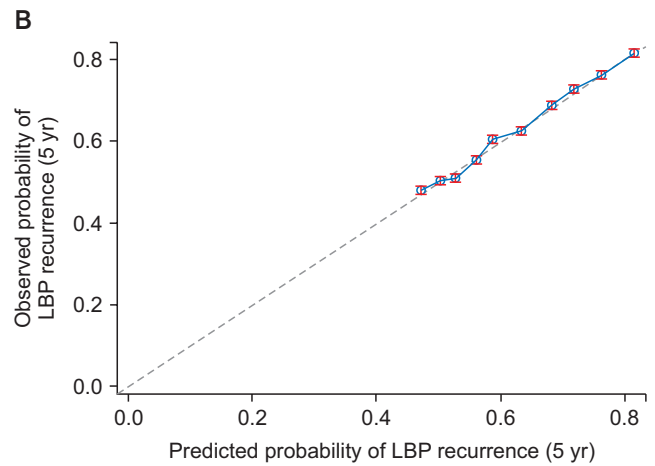
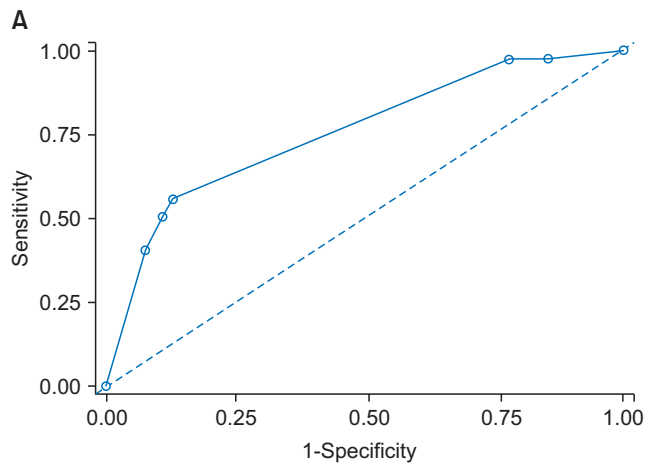
**Supplementary Table 5.** Calculated Score for a Hypothetical Example of a Recurrent LBP Risk Profile

Risk factor	Value (risk factor category)	Point
Sex	F	9
Age (yr)	< 45	0
Insurance premium/Income grade (%)	Medium (30-60)	3
BMI (kg/m <sup>2</sup> )	< 18.5	-10
Diagnosed IVDD	No	0
Spondylolisthesis	Yes	34
Days of prescription	≥ 8	0
Total Points		36
Estimate of Risk		0.847

$S_o(\hat{k}) = 0.2704$ .

The median risk score was 23, while the 25th and 75th percentiles were 7 and 45, respectively. The Youden's J statistic suggested a risk score of  $\geq 4$  as the optimal cutoff point to define high-risk individuals based on the simplified risk score.

LBP: low back pain, BMI: body mass index, IVDD: intervertebral disc degeneration.



**Supplementary Fig. 1.** Discrimination and calibration plots in the derivation and validation cohorts for 5-year low back pain (LBP) recurrence model. (A, C) Discrimination. (B, D) Calibration.