What is the best time point to identify patients at risk of developing persistent low back pain?

Markus Melloh, Achim Elfering, Anja Käser, Cornelia Rolli Salathé, Rebecca J. Crawford, Thomas Barz, Thomas Zweig, Emin Aghayev, Christoph Röder and Jean-Claude Theis

Abstract.
BACKGROUND: Early identification of patients at risk of developing persistent low back pain (LBP) is crucial.
OBJECTIVE: Aim of this study was to identify in patients with a new episode of LBP the time point at which those at risk of developing persistent LBP can be best identified.
METHODS: Prospective cohort study of 315 patients presenting to a health practitioner with a first episode of acute LBP. Primary outcome measure was functional limitation. Patients were assessed at baseline, three, six, twelve weeks and six months looking at factors of maladaptive cognition as potential predictors. Multivariate logistic regression analysis was performed for all time points.
RESULTS: The best time point to predict the development of persistent LBP at six months was the twelve-week follow-up (sensitivity 78%; overall predictive value 90%). Cognitions assessed at first visit to a health practitioner were not predictive.
CONCLUSIONS: Maladaptive cognitions at twelve weeks appear to be suitable predictors for a transition from acute to persistent LBP. Already three weeks after patients present to a health practitioner with acute LBP cognitions might influence the development of persistent LBP. Therefore, cognitive-behavioral interventions should be considered as early adjuvant LBP treatment in patients at risk of developing persistent LBP.

1. Introduction

Costs associated with persistent low back pain (LBP) in industrialised countries exceed costs associated with acute LBP several times over [1]. While the definitions for acute ($\leqslant$ six weeks) and subacute LBP ($\leqslant$ twelve weeks) are widely accepted [2], there is no consensus on the definitions for recurrent or persistent LBP [3].

It is beyond dispute that early identification of patients at risk of developing persistent LBP is crucial [4–6]. Currently, a wide range of screening instruments to identify these patients is available such as the Örebro Musculoskeletal Pain Questionnaire [5] or its modified version, the Örebro Musculoskeletal Screening Questionnaire [7] which has been adapted for acute/subacute LBP working populations. Recent evidence suggests, that psychological factors [4], especially maladaptive cognitions including fear-avoidance beliefs, pain magnification and thoughts to be helpless [8] would be the best predictors for the development of persistent LBP [9,10].

Recommended follow-up times for LBP interventions differ based on both the type of intervention and the type of LBP. Further, these recommended follow-ups times may be arbitrary and based on habit rather than being informed by clinical research. For example, in LBP surgery, a minimum follow-up period of two years was recommended for a very long time. However, as was shown recently, most patients demonstrate no change in pain and disability outcomes between the first and the second year after surgery [11]. Indeed, even a three-month follow-up was highly predictive of surgical outcome after two years [11]. Thus, by implementing the registry approach to LBP surgery, a minimum follow-up period of three to six months after surgery has been recently recommended [12]. It is unclear if similar recommendations for follow-up periods in non-specific LBP are also based on clinical evidence.

In guidelines of acute non-specific LBP in primary care, the checklist for methodological quality of prognostic (observational) studies recommends a follow-up period greater than twelve months [2]. However, a new documentation system for the conservative treatment of spinal disorders in an international spine registry was proved useful and feasible in a three-month follow-up [13]. And indeed, recurrence of LBP episodes might bias results in long-term follow-up outcome measures when new episodes during follow-up period that started after having recovered from the first acute LBP period are interpreted as 'lack of initial treatment success'. Thus, multiple follow-ups seem reasonable and short-term as well as long-term follow-ups should be included as was recently proposed by Rodriguez-Blanco et al. Specifically, these authors proposed using a three-month follow-up as short-term measures and six-month follow-up as long-term follow-up measures [14]. Thereby, the six-month follow-up seems to cover the time when LBP may become persistent. The three-month follow-up covers the time when most individuals have recovered from an episode of acute LBP [15–17].

Whilst various recommendations have been given for the length of follow-ups in non-specific LBP, there is a gap in the knowledge regarding the ideal time point to screen patients at risk of developing persistent LBP. Therefore, our research question was, "what is the best time point to identify patients with acute/subacute LBP at risk of developing persistent LBP at six months"? We hypothesised, that the predictive value of maladaptive cognitions for the transition from acute to persistent LBP increases over time with the highest predictive value in the crossectional prediction at six months. However, in order to prevent persistent LBP successful prediction with early assessments after three weeks or even assessed at first visit to the family physician would be of great value. Thus, a second question was: "what is the earliest useful time point for prediction?"

2. Material and methods

We conducted a prospective cohort study of 315 participants from primary care settings across New Zealand, presenting to a health practitioner with a first episode of acute/subacute LBP or for recurrent LBP [18]. Participants were recruited consecutively from 14 health practitioners (twelve general practitioners and two physiotherapists). Acute LBP was defined as LBP lasting for no longer than six weeks, subacute LBP as LBP with a duration of up to twelve weeks [2]. Recurrent LBP was defined according to Stanton et al. as LBP with a minimum of 30 LBP-free days between two episodes and a score higher than 20 out of 100 points on the Visual Analogue Scale (VAS) [3]. The protocol for our study has been published previously [18].

Patients aged between 18 and 65 years who were able to read and write in English, and who provided written consent were included. Exclusion criteria were chronic LBP ($>$ twelve weeks at time of first visit to health practitioner) [19,20], specific LBP such as LBP due to infection, tumour, etc. [2], a comorbidity compromising the overall well-being, pregnancy, being unable to complete questionnaires, and absence of LBP at the time of the screening interview.

Potential participants were first screened employing a structured, standardised phone interview, and if eligible, sent a baseline questionnaire to return within one week. Patients were followed up three, six, twelve

weeks and six months after initial presentation to a health practitioner by sending out questionnaires. If not returned, patients were sent a reminder after one and two weeks. $NZ10 grocery, fuel or book vouchers were provided as compensation for their time for each returned questionnaire.

In order to reduce multi-collinearity between predictor variables and to preserve the power of the regression procedure the number of potential predictors was reduced by combining fear-avoidance beliefs about work and physical activity from the fear-avoidance beliefs questionnaire [21] and magnification and helplessness from the pain catastrophizing scale [22] to the risk index 'maladaptive cognitions'.

The fear-avoidance beliefs questionnaire comprises a seven-item work scale (range 0–42) and a four-item physical activity scale (0–24) addressing patients' beliefs about how work and physical activity affect their LBP; higher scores are associated with higher amounts of fear-avoidance beliefs [21]. The pain catastrophizing scale contains a four-item rumination component (range 0–16), a three-item magnification component (range 0–12) and a six-item helplessness component (range 0–24); higher scores are related to more severe pain catastrophizing [22]. We chose to include fear-avoidance beliefs and pain catastrophizing in the index 'maladaptive cognitions' following the recommendations of a recent study by George et al. [23]. This study demonstrated that fear-avoidance beliefs contributed significantly to the explained variance of persistent LBP whereas pain catastrophizing contributed additional variance [23]. We did not include rumination due to the low variation of participants' answers for this subscale at baseline.

The data analysis procedure comprised four steps:

1) We calculated a principle component factor analysis to look whether fear-avoidance beliefs, magnification and helplessness loaded on a common factor, thus indicating a problem of multicollinearity when all subscales should be used in multiple logistic regression. Items from fear-avoidance beliefs, magnification and helplessness are all about cognitions that are pessimistic about the presence or future and the passive instead of active role of the person with respect to activity, daily living and coping with pain. In principal components factor analysis items of fear-avoidance beliefs, magnification and helplessness show high loadings on that common factor.
2) We searched for valid cut-off scores for fear-avoidance beliefs, magnification and helplessness that indicate problematic thoughts. As cut-off for fear-avoidance beliefs we chose > 29 for the work subscale and > 14 for the physical activity subscale according to George et al. [24]; $>$ 5 for magnification and > 13 for helplessness according to Sullivan [25].
3) We coded 0 as below the cut-off and 1 as problematic when the cut-off score and higher levels were reached.
4) We added the scores into a 'maladaptive cognitions' index ranging from 0 (no problematic thoughts) to 4 (problematic thoughts with respect to physical activity, work activity, pain evaluation and coping with pain).

In addition to fear-avoidance beliefs and pain catastrophizing, baseline and follow-up instruments included functional limitation measured by the Oswestry Disability Index (ODI), pain on the VAS, Short Form 12 Health Survey Questionnaire (SF-12) Mental and Physical Component Scales, and depression defined by the Zung self-rating depression scale. The ODI assesses limitations to various activities of daily living in ten categories: Pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life and travelling [26]. The total possible score of the ODI is 100%, where 0% is no or 'minimal disability'. The VAS assesses perceived pain intensity on a scale from 0 to 100 where 0 is 'no pain at all' and 100 'pain as bad as it could be' [27]. At baseline we also documented age, gender, body mass index and ethnicity.

2.1. Statistical analysis

Participants with persistent LBP at six-month follow -up were compared with participants with non-persistent LBP. Non-persistent LBP was defined by an ODI score at six months lower than 22 points that were considered to be clinically relevant [28]. The normal value for the ODI in the general population is ten points with a standard deviation of approximately six points [29]. Therefore, participants with an ODI score less than 22 at six-month follow-up were considered to be non-persistent.

To determine whether change in ODI score over time was linear a trend analysis including all time points was completed for persistent and non-persistent LBP, and the difference between groups tested using an independent sample t-test. We conducted an analysis of variance including the repeated measurement factor (baseline and all follow-ups) and a between factor (persistent vs. non-persistent). We tested the interaction of

fixed effect polynomial linear trend factor and between factor to be significant indicating that linear decrease of ODI across time was restricted to the non-persistent group while there was no change in ODI in the persistent group. Following this, Pearson correlation, then multivariate logistic regression analysis was performed for the outcomes fear-avoidance beliefs, magnification and helplessness, controlling for age, gender, body mass index and ODI at baseline. Sensitivity, specificity and overall predictive value for the development of persistent LBP were calculated for all time points. They were constructed using the entire logistic regression model. All predictors entered the model simultaneously. The overall predictive value was calculated as a percentage containing true positives (correctly identified persistent LBP) and true negatives (correctly detected non-persistent LBP). To decide whether logistic regression models performed at various time points differed from each other we performed likelihood ratio tests with one degree of freedom. All statistical analyses were conducted using IBM SPSS Statistics 19 (IBM Corp., Armonk, NY, USA) and statistical significance was accepted at the $p < 0.05$ level.

Our study was performed according to the recommendations of the Declaration of Helsinki (2008) and has been approved by the local Lower South Regional Ethics Committee (LRS/08/03/008).

3. Results

From April 2008 to October 2010, 562 patients experiencing an acute, subacute or recurrent LBP were screened consecutively. We found 124 patients to be ineligible due to being LBP-free (ten); having chronic LBP $>$ twelve weeks (93) or specific LBP (eight); having kee or hip osteoarthritis (two); being pregnant (three); not being available for follow-ups (two) or being older than 65 (six). Twenty-six patients chose not to participate; ninety-seven did not send back any of the questionnaires. In total, 315 patients were enrolled in the study with 146 being lost to follow-up. One-hundred-sixty-nine patients participated over the whole study period of six months. Table 1 shows the baseline characteristics of these participants as well of the persons lost to follow-up. Patients lost to follow-up demonstrated a significantly lower mental health measured by the SF-12 Mental Component Scale, a higher depression score according to the Zung self-rating depression scale and a higher affective pain score measured by the McGill Pain Questionnaire. All other

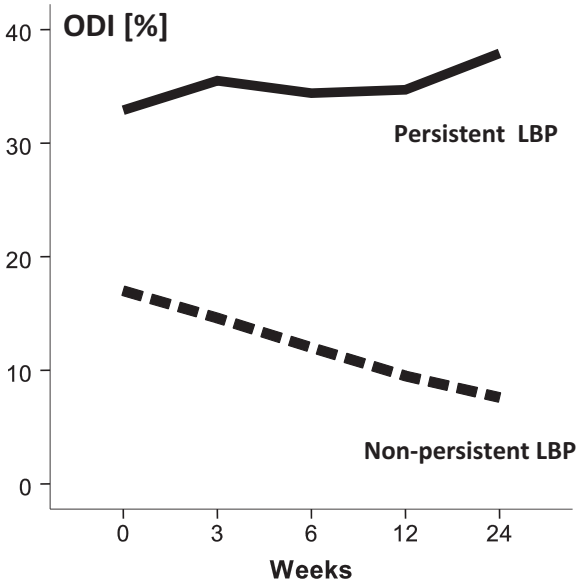

Fig. 1. Trend analysis of ODI between baseline and six-month follow-up in persistent and non-persistent group.

baseline characteristics were similar between included participants and those lost to follow-up.

At six-month follow-up 6.9% of participants with persistent LBP at baseline were not working because of LBP, 0.9% of participants with non-persistent LBP. The mean number of sick leave days in the last week due to LBP in the persistent LBP group was 0.41 days and 0.06 days in the non-persistent LBP group. The typical approach for acute LBP management in the clinical setting was pain medication in the first instance; the extent of physical therapy was 30%; other physical rehabilitation strategies included exercise therapy (20%), osteopathy (11%), acupuncture (6%) and chiropractic (5%).

At the six-month follow-up, 44 patients were categorised as having persistent LBP and 125 as having non-persistent LBP (Table 2). In the persistent LBP group ODI scores remained at a consistent level over the six-month period whereas the ODI scores in the non-persistent group declined over time. Indeed, the trend analysis between baseline and six-month follow-up revealed a linear decrease of the ODI score over time in the non-persistent group which was a first-order trend at all time points, i.e. a decrease of the ODI score between all five time points (Fig. 1). In contrast, there was no evidence of first-order trend in the persistent LBP group. At baseline, ODI scores in the persistent group ranged between 7 and 60 points (mean: 33), scores in the non-persistent group between 0 and 62 points (mean: 18). Patients in the persistent group

Table 1
Baseline characteristics of participants who completed 6-month follow-up vs. participants lost to follow-up

	Variables	Participants ($n = 315$)	Completed ($n = 169$)	Lost to follow-up ($n = 146$)	p
Pain history	Duration LBP				
	Duration LBP (days); mean[+/-SD]	1959 (3529)	1814 (2843)	2128 (4194)	0.749[a]
	Duration present episode (days); mean[+/-SD]	21 (15)	21 (15)	21 (15)	0.898[a]
	Recurrent LBP (n[%])	92 (29%)	48 (28%)	44 (30%)	0.559[b]
Radiating pain	Radiating pain below knee (n[%])	48 (15%)	31 (18%)	17 (12%)	0.096[b]
Health behaviour	IPAQ score (physical activity) (n[%])				0.053[a]
	Low	39 (13%)	18 (11%)	21 (15%)	
	Moderate	180 (58%)	91 (55%)	89 (62%)	
	High	90 (29%)	57 (34%)	33 (23%)	
	Smoking status (n[%])	131 (42%)	63 (37%)	68 (47%)	0.074[b]
Education status (n[%])					0.328[a]
	No formal schooling	2 (1%)	0 (0%)	2 (1%)	
	< primary school	4 (2%)	2 (1%)	2 (1%)	
	Primary school	17 (5%)	7 (4%)	10 (7%)	
	Secondary school	46 (15%)	28 (17%)	18 (12%)	
	High school	96 (30%)	46 (27%)	50 (35%)	
	College/university	118 (37%)	70 (42%)	48 (33%)	
	Postgraduate degree	32 (10%)	16 (9%)	16 (11%)	
Occupation	N/A	62 (20%)	27 (16%)	35 (24%)	0.102[b]
	Legislator/senior official/manager	22 (7%)	12 (7%)	10 (7%)	
	Professional	81 (27%)	48 (28%)	33 (23%)	
	Technician	19 (6%)	11 (7%)	8 (5%)	
	Clerk	52 (17%)	27 (16%)	25 (17%)	
	Service/sales	7 (2%)	3 (2%)	4 (3%)	
	Agricultural/fishery	11 (3%)	8 (5%)	3 (2%)	
	Craft/trades	27 (9%)	13 (8%)	14 (10%)	
	Plant/machine operator	19 (6%)	11 (7%)	8 (5%)	
	Elementary worker	11 (3%)	8 (5%)	3 (2%)	
	Armed forces	4 (1%)	1 (1%)	3 (2%)	
Functional limitation	ODI (mean[+/-SD])	22 (13)	22 (13)	22 (12)	0.526[a]
	Minimal disability (0–20) (n[%])	167 (53%)	91 (54%)	76 (52%)	
	Moderate disability (21–40) (n[%])	120 (38%)	65 (38%)	55 (38%)	
	Severe disability (41–60) (n[%])	27 (9%)	12 (7%)	15 (10%)	
	Crippled (> 61) (n[%])	1 (0.3%)	1 (1%)	0 (0%)	
General health	SF-12-PCS (mean[+/-SD])	45 (9)	45 (9)	45 (9)	0.612[a]
	SF-12-MCS (mean[+/-SD])	45 (11)	47 (10)	43 (11)	0.002[a]
Pain	Sensory pain (mean[+/-SD])	28 (18)	27 (18)	29 (18)	0.286[a]
	Affective pain (mean[+/-SD])	9 (13)	7 (9)	11 (16)	0.025[a]
	Pain intensity last week (VAS) (mean[+/-SD])	37 (24)	36 (24)	38 (23)	0.438[a]
Psychological factors	DRAM classification (depression/somatization) (n[%])				0.006[a]
	No depression: ZUNG < 17	105 (33%)	68 (40%)	37 (24%)	
	At risk: ZUNG 17–33; MSPQ < 12	98 (31%)	49 (29%)	49 (34%)	
	Distressed depressive: ZUNG > 33	58 (19%)	28 (17%)	30 (21%)	
	Distressed somatic: ZUNG 17-33; MSPQ > 12	54 (17%)	24 (14%)	30 (21%)	
	Fear avoidance beliefs (FAB)				
	Work activity (n[%])	26 (8%)	12 (7%)	14 (10%)	0.424[b]
	Physical activity (n[%])	148 (47%)	87 (52%)	61 (42%)	0.085[b]
	Catastrophizing (PCS)				0.057[a]
	Non-catastrophizers	188 (60%)	111 (66%)	77 (53%)	
	Intermediate catastrophizers	64 (20%)	29 (17%)	35 (24%)	
	Catastrophizers	63 (20%)	29 (17%)	34 (23%)	
	Pain magnification (n[%])	60 (19%)	25 (15%)	35 (24%)	0.039[b]
	Helplessness thoughts (n[%])	42 (13%)	18 (11%)	24 (16%)	0.132[b]
Occupational factors	Job satisfaction (mean[+/-SD])	3.7 (1.0)	3.7 (1.2)	3.7 (1.0)	0.689[a]
	Resigned attitude job (mean[+/-SD])	3.2 (1.5)	3.2 (1.3)	3.2 (1.6)	0.673[a]
	Job content				
	Method control (mean[+/-SD])	3.6 (1.2)	3.6 (1.1)	3.6 (1.2)	0.988[a]
	Time control (mean[+/-SD])	3.3 (1.3)	3.2 (1.3)	2.9 (0.8)	0.514[a]

Table 1, continued

	Variables	Participants ($n = 315$)	Completed ($n = 169$)	Lost to follow-up ($n = 146$)	p
	Uncertainty (mean[+/-SD])	2.4 (0.9)	2.4 (0.8)	2.4 (0.9)	0.838[a]
	Organisation (mean[+/-SD])	2.6 (0.7)	2.7 (0.7)	2.6 (0.7)	0.334[a]
	Work interruptions (mean[+/-SD])	3.1 (1.0)	3.1 (1.0)	3.1 (1.0)	0.253[a]
	Concentration (mean[+/-SD])	3.2 (0.9)	3.2 (0.9)	3.3 (1.0)	0.644[a]
	Time pressure (mean[+/-SD])	3.1 (1.0)	3.1 (0.9)	3.2 (1.1)	0.315[a]
	Ergonomics (mean[+/-SD])	3.0 (0.7)	3.1 (0.6)	3.0 (0.9)	0.673[a]
	Emotion (mean[+/-SD])	3.0 (1.3)	2.9 (1.2)	3.0 (1.4)	0.228[a]
	Social support at work (mean[+/-SD])	3.7 (1.1)	3.6 (1.1)	3.8 (1.3)	0.192[a]
Demographics	Age (mean[+/-SD])	34.9 (12.6)	36.0 (13.1)	35.0 (21.1)	0.062[a]
	BMI (mean[+/-SD])	28 (6)	28 (6)	28 (6)	0.890[a]
	Female (n[%])	210 (67%)	106 (62%)	104 (71%)	0.089[b]

[a] = T-Test; [b] = Chi^2-Test. Figures are given as numbers (percentages) or mean (+/-SD) where appropriate; 'recurrent' according to the definition by Stanton et al. Eur Spine J 2011: VAS > 20; at least 30 days pain-free btw episodes; 'low', 'moderate' and 'high' according to IPAQ (International Physical Activity Questionnaire) score; 'smoking status'

Table 2
Maladaptive cognitions at baseline in patients with persistent vs. non-persistent LBP

Variables	Persistent LBP ($n = 44$)	Non-persistent LBP ($n = 125$)	p
Fear avoidance beliefs: Work activity (n[%])	5 (11%)	7 (6%)	0.200[b]
Fear avoidance beliefs: Physical activity (n[%])	28 (64%)	59 (47%)	0.061[b]
Pain magnification (n[%])	14 (32%)	11 (9%)	0.001[b]
Helplessness thoughts (n[%])	10 (23%)	8 (6%)	0.003[b]
Index 'maladaptive cognitions' (mean[+/-SD])	1.6 (1.4)	0.8 (0.9)	0.001[a]

[a] = T-Test; [b] = Chi^2-Test.

presented a higher ODI at baseline ($p < 0.001$). Table 3 shows patient characteristics at baseline and at all follow-up time points for all study participants.

The time point that best predicted the development of persistent LBP at six months was the twelve-week follow-up. Prediction at this time point had a sensitivity of 78% and a specificity of 95% (Table 4). The overall predictive value was 90%. The odds ratio of predicting persistent LBP was 3.82 for the index 'maladaptive cognition' (95%CI 1.98–7.33) and 1.15 (95%CI 1.08–1.22) for baseline ODI.

The six-week follow-up assessment was the next best time point to predict the development of persistent LBP at six months. Sensitivity of predicting persistent LBP at this time point was 55%, specificity 94% and overall predictive value 84% (Table 4). The odds of predicting persistent LBP were 2.92 for the index 'maladaptive cognition' (95%CI 1.69–5.03) and 1.11 (95%CI 1.05–1.18) for baseline ODI.

The index 'maladaptive cognitions' at three-week follow-up showed comparable sensitivity and predictive value at six-week follow-up (Table 4). The overall predictive value at the three-week follow-up was 83%. Sensitivity of predicting persistent LBP was 56%, specificity 92%. The odds of predicting persistent LBP were 2.58 for the index 'maladaptive cognition' (95%CI 1.47–4.54) and 1.12 (95%CI 1.06–1.18) for ODI.

The predictive value of the model at six-month follow-up (crossectional prediction) was 89%, with a sensitivity of predicting persistent LBP of 68% and a specificity of 97%. At baseline, the model was not significant.

4. Discussion

The present study provides moderate evidence that in the primary care setting, the time point at which maladaptive cognitions best predicted progression of a new episode of LBP to persistent LBP at six months was the twelve-week follow-up. This was in contrast to our Hypothesis that the best time point for predicting persistent LBP would be the prediction at six-month follow-up.

Consequently, according to our results patients at risk of developing persistent LBP should preferably not only be screened at baseline but also at a later time point such as the twelve or three-week follow-up for a better overall predictive value. However, a recent inception cohort study by Costa et al. on the prognosis of chronic LBP demonstrated that people still recov-

Table 3
Patient characteristics at baseline and follow-ups

Variables	Participants ($n = 315$)	3 wk FU ($n = 256$)	6 wk FU ($n = 224$)	12 wk FU ($n = 195$)	6 mth FU ($n = 1$ 69)
Age (mean[+/-SD])	34.9 (12.6)				
BMI (mean[+/-SD])	28 (6)				
Female (n[%])	210 (67%)				
Ethnicity (n[%])					
NZ European	233 (74%)				
Maori	11 (4%)				
Samoan	3 (1%)				
Chinese	5 (2%)				
Indian	5 (2%)				
Other	38 (12%)				
ODI (mean[SD])	22 (13)	20 (14)	19 (15)	17 (15)	15 (15)
Minimal disability (0–20) (n[%])	167 (53%)	156 (61%)	137 (61%)	132 (68%)	125 (74%)
Moderate disability (21–40) (n[%])	120 (38%)	72 (28%)	67 (30%)	43 (22%)	28 (16%)
Severe disability (41–60) (n[%])	27 (9%)	26 (10%)	19 (8%)	17 (9%)	15 (9%)
Crippled (> 61) (n[%])	1 (0.3%)	2 (1%)	1 (0.4%)	3 (1%)	1 (1%)
Maladaptive cognitions					
Fear avoidance beliefs: Work activity (n[%])	26 (8%)	15 (6%)	10 (5%)	4 (2%)	6 (4%)
Fear avoidance beliefs: Physical activity (n[%])	148 (47%)	109 (43%)	86 (38%)	65 (34%)	55 (33%)
Pain magnification (n[%])	60 (19%)	39 (15%)	40 (18%)	33 (17%)	24 (14%)
Helplessness thoughts (n[%])	42 (13%)	12 (5%)	13 (6%)	11 (6%)	8 (5%)
Index 'maladaptive cognitions' (mean[+/-SD])	0.9 (1.0)	0.7 (0.9)	0.7 (0.9)	0.6 (0.9)	0.6 (0.8)

Table 4
Prediction of persistent LBP at six-month follow-up ($n = 169$)

	B	OR	CI(OR)	p	Sensitivity	Specificity	-2Log likelihood	Difference in -2Log likelihood	p
Index 'maladaptive cognitions'									
... at baseline	0.35	1.41	0.89–2.23	0.139	52.7	96.6	123.19		
... at 3-week FU	0.95	2.58	1.47–4.54	0.001	56.1	92.3	112.43	10.76	< 0.001
... at 6-week FU	1.07	2.92	1.69–5.03	< 0.001	55.0	94.1	99.59	12.84	< 0.001
... at 12-week FU	1.34	3.82	1.98–7.33	< 0.001	77.5	94.8	91.99	7.60	0.006
... at 6-month FU	1.30	3.67	2.00–6.71	< 0.001	68.3	96.6	98.83	6.84	1.00

Note. $n = 169$. Results are controlled for age, sex, BMI, and ODI at baseline. B = unstandardized logistic regression coefficient; OR: Odds ratio; CI(OR): 95% confidence interval of the odds ratio.

ered from chronic LBP at one year suggesting that we should use even longer time points (e.g., six months) to define someone as having persistent LBP [31].

The inception cohort study by Costa et al. looked at factors at three months that predicted delayed recovery at nine and twelve-month follow-up. These are not the same follow-up points as in our study, but the same assessment point. The study by Costa et al. investigated recovery from LBP and found that high disability at three months was significantly associated with delayed recovery which is similar to our findings.

The accuracy to detect at twelve-week follow-up the patient group at risk of developing persistent LBP was 90%, with 78% of persistent LBP patients being correctly identified. This can be considered as a good predictive value for this time point. From the clinical standpoint it appears to be acceptable that about 75% of persistent LBP patients are correctly identified, bearing in mind that the specificity for the index is higher than 90%. It is important to note that this is not identical to 75% chance, but that 90% were correctly identified with either persistent of non-persistent LBP and 10% were not.

Our study looked at factors of maladaptive cognition predicting this progression to persistent LBP. At all time points from three-week follow-up onwards maladaptive cognitions proved to have a an increased sensitivity for the transition from acute to persistant LBP. Therefore, we partially accepted our Hypothesis, that the predictive value of maladaptive cognitions for the transition from acute to persistent LBP increases over time.

The recommendation to screen for maladaptive cognitions is supported by a recent systematic review of twenty studies that investigated more than 10,000 patients with LBP of less than eight weeks duration [32]. In this review 'maladaptive pain coping behaviours' were identified as strong predictors of persistent LBP

and recovery from acute LBP at three to six months. These findings are in line with the conclusion from a recent prospective cohort study on early predictors of a disadvantageous outcome in LBP consulters in primary care, which stated pathoanatomical signs were for most patients "irrelevant for treatment and indicators of the perception of the illness . . . may be more adequate indicators of outcome" [33]. In the end it might not be important if the "usual suspects" are found to be guilty as predictors of persistent LBP or not [34,35]. Ultimately, it could be the cumulative effect of the very number of individual risk factors of an acute LBP patient that determines if the patients will recover or go on to the persistent state [36].

A recently published secondary analysis merged data from three randomised controlled trials on patients with acute/subacute LBP factors. It was shown that psychosocial characteristics in the first three months proved to be predictors of persistent LBP defined by functional limitation at six months [37]. The authors concluded that a new research priority should be to investigate "at which time point of reassessment by the physician, for example, after one or two weeks, prognostic information is already of value for the clinical setting".

This is exactly what was done in the present study when looking at the best time point to predict the development of persistent LBP at six months. By using factors of maladaptive cognition as suggested by Boersma and Linton to employ when screening to identify patients at risk [38] and as found to be the strongest predictors in a previous feasibility study by our author group [8], the twelve-week follow-up demonstrated to be the best time point. Second best time point was at three weeks. Maladaptive cognitions assessed at baseline, i.e. at the first visit to a health practitioner were not predictive for persistent LBP at six months. This means that early screening should already start as early as three weeks after initial presentation to allow health practitioners reliable predictions of their patients' prognosis as suggested by Heymans et al. [37].

These findings are supported by recommendations from a systematic review that patients with LBP should be reassessed six weeks after the onset of a new episode of LBP [39]. In the present study, however, the duration of LBP at the time of the first visit to a health practitioner was three weeks; and the three-week follow-up was found to be of value for reassessment, comparably good as the six-week time point for reassessment identified in the review. Thus, three weeks might be appropriate, too.

Further support for an early reassessment of patients at risk comes from an inception cohort study in primary care investigating recovery from acute LBP [40]. The authors showed that both functional limitation and pain intensity were significantly different for those who recovered from an acute LBP episode compared to those who did not at all time points from four weeks to twelve weeks after LBP onset [40]. This time frame corresponds to the one to nine-week follow-up time points in the present study (when subtracting the three-week LBP duration before initial presentation to a health practitioner). The results from the present and other supporting studies are confirmed by the current European guidelines for the management of acute non-specific LBP in primary care recommending reassessment in the subacute state, i.e. between six and twelve weeks from onset of LBP [19].

A limitation of this study is that patients lost to follow-up present characteristics (higher depression score and lower mental health) that are related to helplessness in particular. This could have had an impact on the results. The predictive value of maladaptive cognitions in the present study might be only a conservative estimate due to the better mental health of those that stayed in the study. Also, the predominant use of patient-reported outcome measures for generating information is subjective by nature. Furthermore, attrition bias can be seen as a threat to the representativeness of the study sample. Though, a recent study found that attrition has only marginal influence on the point estimates of LBP-related outcomes [41]. In the present study the loss-to-follow-up was consistently about 15% at each follow-up time point. This means that the loss was a systematic one and not due to any specific event. The total loss-to-follow-up was 46% over the whole study period. This apparently high rate should be considered in the context of a postal survey, where direct contact with the participants was limited to the initial screening interview. A recent study on 342 LBP patients presenting in primary care were followed up six times over a six-month period and showed a comparable loss-to-follow-up of 45% [42].

5. Conclusion

Our study revealed that maladaptive cognitions at twelve weeks appear to be the most suitable predictors for a transition from acute to persistent LBP in primary care. Already three weeks after patients present to a health practitioner with an episode of acute or subacute

LBP, cognitions might influence the development of persistent LBP. Therefore, cognitive-behavioral interventions should be considered as early adjuvant LBP treatment options in this patient group at risk of developing persistent LBP.

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