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Complete List of Authors:	Grøn, Søren; Nordic Institute for Kiropraktik og Klinisk Biomekanik, Chiropractic Knowledge Hub Jensen, Rikke; Nordic Institute for Kiropraktik og Klinisk Biomekanik, Chiropractic Knowledge Hub; University of Southern Denmark, Department of Sports Science and Clinical Biomechanics Kongsted, Alice; Nordic Institute for Kiropraktik og Klinisk Biomekanik, Chiropractic Knowledge Hub; University of Southern Denmark Department of Sports Science and Clinical Biomechanics
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Beliefs about back pain and associations with clinical outcomes: a primary care cohort study

Søren Grøn[1], Rikke Krüger Jensen[1 2], Alice Kongsted [1 2]

1: Chiropractic Knowledge Hub, Campusvej 55, 5230 Odense M, Denmark
2: Department of Sports Science and Clinical Biomechanics, University of Southern Denmark, Campusvej 55, 5230 Odense M, Denmark.

Correspondence to Søren Grøn sgron@health.sdu.dk

Abstract

Objective: To investigate associations between beliefs about low back pain (LBP) at baseline and pain intensity and disability at the 2-, 13- and 52-week follow-ups in patients with LBP.

Design: An observational cohort study.

Setting: Primary care private chiropractic clinics in Denmark.

Participants: A total of 2734 adults consulting a chiropractor for a new episode of LBP, with follow-up data available from 71%, 61% and 52% of the participants at 2, 13 and 52 weeks, respectively.

Outcome measures: Beliefs about LBP were measured by the Back Belief Questionnaire (BBQ) before consulting the chiropractor. Pain was measured on a Numerical Rating Scale and disability was measured by the Roland Morris Disability Questionnaire at baseline and at the 2-, 13- and 52-week follow-ups. Associations were explored using longitudinal linear mixed models estimating interactions between BBQ and time.

Results: More positive beliefs about LBP were weakly associated with a reduction in pain at 2 weeks (β interaction BBQ#Time = -0.01 (95% CI -0.03; -0.004)) at 13 weeks -0.03 (95% CI -0.04; -0.01) and at 52 weeks follow-up, -0.03 (95% CI -0.05; -0.01) (p=0.005). For disability, the association was uncertain (p=0.81). The item "*Back trouble means periods of pain for the rest of one's life*" had the strongest association with both reduction in pain (-0.29, 95% CI -0.4; -0.19, p=<0.001) and disability (-2.42, 95% CI -3.52; -1.33, p=<0.001) at 13 weeks follow-up.

Conclusion: Positive beliefs regarding LBP, measured by the BBQ, were associated with a reduction in pain intensity at both short- and long-term follow-up. However, the association was weak, and the clinical relevance is therefore questionable. No clear association was demonstrated between beliefs and disability. This study did not show promise that back beliefs as measured by the BBQ were helpful for predicting or explaining the course of LBP in this setting.

Keywords:

Low back pain, beliefs, attitudes, health knowledge, primary care

Article Summary

Strengths and limitations of this study

- This longitudinal observational study was the largest cohort to date investigating beliefs about LBP (n=2,734)
- The cohort provided an opportunity to investigate associations in acute episodes of LBP as well as in long-lasting LBP.
- The BBQ is a widely used questionnaire that has previously shown good reliability but has not been tested in the Danish version, so we assessed its construct validity and scale reliability before conducting the primary analysis.
- The BBQ mainly measures beliefs regarding negative consequences of LBP, thus neglecting other potentially relevant aspects of beliefs.
- The cohort only consisted of chiropractic patients with generally positive beliefs and is thus not generalizable to all LBP patients.

Introduction

Low back pain (LBP) is a common condition that is mostly nonspecific, which means no single structure can be identified as the cause of the pain (1). Both biophysical, psychological, and social factors are recognized to contribute to pain perception and disability (2). Among these biopsychosocial factors, one aspect that is considered important in relation to both disability and recovery is what people think and believe about their back and LBP (3). This could involve beliefs that LBP is a sign of structural damage and, consequently, the back is fragile and needs protection. Such beliefs can affect the behavior of a person with LBP, and thereby influence recovery if a person adopts unhelpful behavior such as fear-avoidance behavior or over-protective behavior (3-7).

Multiple questionnaires have been developed to measure beliefs about pain and investigate the association between beliefs and LBP. A systematic review of back beliefs in the general population from 2018 found that negative beliefs, measured using the Back Belief Questionnaire (BBQ), were cross-sectionally associated with higher levels of pain and disability (8). Similarly, a systematic review from 2018 found a moderate level of evidence for a cross-sectional association between maladaptive illness perceptions, measured by the illness perception questionnaire (IPQ), and pain intensity and disability in patients with musculoskeletal pain(9). The evidence regarding the prognostic value of illness beliefs was inconclusive due to lack of longitudinal studies (9). However, a recent longitudinal study from 2021 found that the IPQ only added a small and non-substantial predictive value for poor recovery at 3 months in people with musculoskeletal pain (10). For recovery expectations as a prognostic factor for LBP, a Cochrane review from 2019 concluded that having positive expectations towards recovery might be associated with a reduction in pain and disability, although the evidence was of low quality (11). In general, there is evidence supporting a cross-sectional association between negative beliefs regarding LBP and higher levels of pain and disability. However, as longitudinal studies are few and of low quality and mostly investigate recovery expectations, the relationship between other aspects of beliefs and clinical outcomes over time is uncertain (8, 9, 11-15). Longitudinal studies can help to determine if specific beliefs are associated with clinical outcomes, which is relevant as beliefs are potentially modifiable and could therefore be targets for clinical interventions. It has been proposed that the association between psychological factors, such as beliefs, and long-term disability might be more relevant for those with persistent pain compared to those with subacute pain (16). A verification of this theory would be clinically relevant as it could help clinicians prioritize when to address beliefs.

The objectives of this study were therefore to investigate if back beliefs at baseline, measured by the BBQ, were associated with pain intensity and disability at the 2-, 13-, and 52 -week follow-ups in patients with

LBP who consulted a chiropractor, and whether the association differed according to pain duration. Also, we assessed if any items of the BBQ had a stronger association with pain intensity and disability at the 13-week follow-up compared to the other items.

Methods

Study design

This study was an observational cohort study based on data from The Danish Chiropractic Low Back Pain Cohort (ChiCo) (17). The study was reported according to the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) cohort reporting guidelines and a STROBE checklist has been completed (18).

Patient and public involvement

Patients were not involved in designing the study or interpreting the results.

Setting and procedures

Participants were recruited from 10 chiropractic clinics in Denmark between November 2016 and December 2018. At the initial visit to the chiropractor, the patient filled out a baseline questionnaire, divided into two parts. The first part included items that might be influenced by consulting the chiropractor and was therefore filled out before the initial consultation (Baseline 1). The second part was filled out after the initial consultation and included demographic and background data less likely to be influenced by the consultation (Baseline 2). Follow-up questionnaires were obtained at 2, 13 and 52 weeks after inclusion. Participants who did not respond to the follow-up questionnaires at 13 and 52 weeks received a phone call for a structured interview on a limited number of questions from the survey. Data were collected electronically and stored using the online system REDCap (Research Electronic Data Capture) hosted and supported by the Odense Patient data Explorative Network (OPEN). Further details on the data collection procedure have been described elsewhere (17), as have cross-sectional data from the BBQ in some of the study sample (19).

Participants

To be enrolled in the study, the patient needed to be 18 years of age or older, be seeking a consultation with the chiropractor with a new onset of LBP with or without leg pain, and be able to complete electronic questionnaires in Danish. A new onset of LBP was defined as a new or recurring LBP problem for which the

patient was not currently receiving treatment or long-term management. Patients referred for acute surgical assessment or patients with suspicion of pathology leading to referral for further diagnostic assessment were not enrolled in the study (17).

Variables

Primary measures

Beliefs about LBP were measured at Baseline 1, before consulting the chiropractor, using a Danish version of the BBQ. The BBQ consists of 14 statements regarding inevitable negative consequences of LBP that are scored on a 5-point Likert scale. Five statements are not included in the final score, and thus the score ranges from 9 to 45. The scores are reversed so that higher scores indicate positive beliefs (20). The translation process has been described in a previous paper (19). The questionnaire has been widely used in research and has previously been validated and translated into multiple languages, showing good test-retest reliability and demonstrating good construct validity (measuring only one construct) (21-25).

Disability was measured by the 23-item Danish version of the Roland-Morris Disability Questionnaire (RMDQ) (0-100, higher scores indicating higher levels of disability) (26), and LBP intensity on a Numerical Rating Scale (NRS) examining typical LBP intensity during the previous week (0 = no pain to 10 = worst imaginable pain) (24-25). Both disability and LBP intensity were measured at Baseline 1 (before the consultation), and at the 2-, 13-, and 52-week follow-ups. Only LBP intensity was part of the telephone interview with non-respondents.

Additional baseline variables

Baseline 1: Age and sex (derived from the patient's personal identification (social security) number); duration of current pain episode (1–2 days, 3–7 days, 1–2 weeks, 2–4 weeks, 1–3 months, 3–12 months, more than a year).

Baseline 2: Previous treatment for LBP (yes/no); previous episodes of LBP (none, 1, 2–3, more than 3); number of days with LBP last year (≤30 days, > 30 days).

Statistical methods

Missing responses on the BBQ and previous treatment for LBP were imputed using chained multiple imputations. For BBQ, we excluded participants who answered 6 or fewer items at baseline, and then used imputation for the remaining incomplete questionnaires. For both BBQ and previous treatment for LBP, the imputations were informed by age, sex, RMDQ scores, LBP intensity at baseline, duration of current pain

episode, previous treatment, and number of days with pain last year. Multiple imputations of missing RMDQ sum scores were performed as part of the standard preparation of ChiCo cohort data (17).

Construct validity and scale reliability

Before conducting the analyses, we tested the construct validity and scale reliability of the Danish version of the BBQ. The scale showed acceptable reliability (Cronbach's alpha= 0.77), but our findings did not support a unidimensional structure of the scale. However, as we were unable to detect a better factor structure of the scale, we decided to use the scale as originally intended and as it had been applied in previous studies. The process is described in Supplemental File 1.

Data analysis

Baseline characteristics were presented as means with standard deviations (SD) or proportions.

To estimate associations between BBQ and outcomes, we used a linear mixed model with random effect parameters to conduct longitudinal regression analysis with baseline BBQ score, time, and the interaction between the BBQ score and time as independent variables, and LBP intensity or RMDQ score as the dependent variable. We performed unadjusted analyses and adjusted analyses controlling for age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment. Variables controlled for were chosen as they have been shown in a previous study on the same population to be associated with baseline BBQ scores (19). P-values for the interaction term were based on ANOVA tests using the 'contrast' command in STATA. A linear relationship was assumed between baseline BBQ and both LBP intensity and RMDQ score at follow-up, based on inspection of a Locally Weighted Scatterplot Smoothing (LOWESS) plot. For visualization of the findings, the adjusted analyses were repeated with BBQ scores divided into quartiles, which were used to create a marginsplot for the association. The quartiles of BBQ scores had the following division: scores from 9-29 (n=846), 28-32 (n=525), 33-37 (n=823) and 38-45 (n=540). Results were presented as regression coefficients with 95% confidence intervals and p-values.

To investigate if the association differed according to pain duration, the analyses with the outcomes on the original scales were repeated, stratified on the following four groups categorized by duration of the current episode and number of previous LBP episodes: Group 1 (Acute new): Onset within 2 weeks and no previous LBP episodes; Group 2 (Acute episodic): Onset within 2 weeks but with one or more previous LBP episodes; Group 3 (Subacute): Pain for more than 2 weeks but less than 3 months; and Group 4 (Long-lasting): Pain for more than 3 months.

To explore the association between single items of the BBQ and LBP intensity and RMDQ, we performed a linear regression analysis with LBP intensity or RMDQ at the 13-week follow-up as the dependent variable and each BBQ item at baseline as independent variables, controlling for age, sex, baseline LBP intensity, baseline RMDQ-score and previous treatment. The 13-week follow-up was chosen based on inspection of the overall change in LBP intensity and disability at follow-up, as most of the change had occurred by 13 weeks. All items were included in one model for each outcome and results were presented as regression coefficients with 95% confidence intervals and p-values. Variance inflation factors (VIF) were calculated to check the influence on estimates from multicollinearity. With LBP intensity as the dependent variable, the mean VIF was 1.28 (range 1.06 to 1.57) and with RMDQ score as the dependent variable, the mean VIF was 1.27 (range 1.06 to 1.56). Thus, both models indicated no sign of multicollinearity.

The impact of single items on the amount of variance explained was explored by noting the reduction in the R^2-value obtained from the linear regression model with a single item removed from the model at a time compared to a model with all items.

All analyses were performed using Stata/MP 16 (StataCorp LLC, TX 77845, USA).

Results

A total of 3165 participants were included in the ChiCo cohort and, of those, 2734 were included in the current study (Figure 1). Mean age was 44 years and 41% were female. The mean baseline score of LBP intensity was 6.7 and the mean RMDQ score was 55 (Table 1). Follow-up data on LBP intensity were available for 72%, 69% and 65% (at 2, 13, 52 weeks respectively) of the participants, and data on disability were available for 71%, 61% and 52% (at 2, 13, 52 weeks respectively) (Figure 1). Baseline characteristics were similar regarding pain intensity, RMDQ scores and BBQ scores between participants who completed the 52-week follow up and those who were lost to follow-up, but those not completing the follow-up were younger than those who did (Table 1).

TABLE 1
Characteristics of study population

	Baseline (n=2734)	52 weeks drop out [a] (n=952)	52 weeks completed (n=1782)
Age in years, mean (SD)	44 (14)	41 (14)	46 (13)
Age range in years	18 – 87	18 – 81	18 – 87
Females	41%	40%	42%
Time since start of current episode of LBP			
1 – 2 days	18%	20%	17%
3 – 7 days	29%	27%	30%

1 – 2 weeks	13%	13%	13%
2 – 4 weeks	11%	10%	11%
1 – 3 months	12%	10%	13%
3 – 12 months	7%	8%	7%
More than a year	10%	12%	9%
Missing (n)	0.5% (14)	0.4% (4)	0.6% (10)
LBP intensity (NRS 0 – 10), mean (SD)			
Baseline	6.7 (2.0)	6.7 (2.0)	6.7 (2.0)
Missing (n)	2% (46)	2% (16)	2% (30)
2 weeks	3.7 (2.3)	3.8 (2.3)	3.7 (2.3)
Missing (n)	28% (766)	58% (550)	12% (216)
13 weeks	2.3 (2.3)	2.6 (2.4)	2.3 (2.3)
Missing (n)	31% (854)	66% (632)	12% (222)
52 weeks	2.3 (2.4)	-	2.3 (2.4)
Missing(n)	35% (956)	-	0.2% (4)
Disability (RMDQ 0 – 100), mean (SD)			
Baseline	55 (24)	55 (25)	55 (23)
Missing (n)	1% (23)	2% (17)	0.3% (6)
2 weeks	30 (26)	32 (27)	29 (26)
Missing (n)	29% (786)	57% (545)	12% (211)
13 weeks	19 (23)	24 (27)	19 (23)
Missing (n)	39% (1064)	66% (628)	12% (219)
52 weeks	20 (23)	-	21 (23)
Missing (n)	48% (1305)	-	-
Back beliefs (BBQ 9 – 45), mean (SD)	32 (6)	32 (6)	33 (6)

[a] Missing data on both RMDQ and LBP intensity at the 52-week follow-up

SD: standard deviation, LBP: Low back pain, NRS: numerical rating scale, RMDQ: Roland Morris Disability Questionnaire, BBQ: Back Belief Questionnaire

-----Insert Figure 1 here-----

The association between BBQ scores at baseline and LBP intensity and disability after 2, 13 and 52 weeks

Higher BBQ scores at baseline, indicating positive back beliefs, were weakly associated with lower LBP intensity at follow-up in both unadjusted and adjusted analyses (Table 2).

The coefficient of the interaction between BBQ and LBP intensity over time denotes the additional reduction in LBP intensity for each additional point on the BBQ scale. This means that if two participants are alike on all parameters except that one scores 10 points higher on the BBQ at baseline, then that patient would be expected to have an additional reduction in LBP intensity at 13 weeks of -0.3 points (10 x-0.03 (13-week coefficient)) compared to the other participant.

The association between quartiles of BBQ at baseline and LBP intensity at follow-up indicated higher reduction of LBP intensity for patients with the most positive beliefs compared to those with more negative beliefs (Figure 2).

Associations between BBQ at baseline and disability at follow-up were weak and had large p-values (Table 2). The association is visualized in a marginsplot in Figure 3.

TABLE 2
Association between back beliefs at baseline and LBP intensity and disability at follow-up

	Unadjusted				Adjusted			
LBP Intensity (NRS)	Coefficient	*p*	95% CI		Coefficient	*p*	95% CI	
Time								
2 weeks	-2.50	<0.001	-3.15;	-1.86	-2.34	<0.001	-3.01;	-1.76
13 weeks	-3.52	<0.001	-4.18;	-2.87	-3.43	<0.001	-4.07;	-2.79
52 weeks	-3.39	<0.001	-4.06;	-2.71	-3.27	<0.001	-3.93;	-2.61
BBQ	-0.04	<0.001	-0.06;	-0.03	-0.03	<0.001	-0.04;	-0.01
Interaction between BBQ and time								
2 weeks	-0.01	0.148	-0.03;	-0.01	-0.02	0.061	-0.04;	-0.001
13 weeks	-0.03	0.011	-0.05;	-0.01	-0.03	0.004	-0.05;	-0.01
52 weeks	-0.03	0.004	-0.05;	-0.01	-0.03	0.001	-0.05;	-0.01
Interaction term		0.014				0.0028		
DISABILITY (RMDQ)								
	Unadjusted				Adjusted			
	Coefficient	*p*	95% CI		Coefficient	*p*	95% CI	
Time								
2 weeks	-23.92	<0.001	-30.19;	-17.65	-24.13	<0.001	-30.14;	-18.12
13 weeks	-34.45	<0.001	-41.08;	-27.81	-34.87	<0.001	-40.20;	-27.53
52 weeks	-37.38	<0.001	-44.53;	-30.22	-37.54	<0.001	-44.36;	-30.72
BBQ	-1.05	<0.001	-1.2;	-0.9	-0.48	<0.001	-0.61;	-0.35
Interaction between BBQ and time								
2 weeks	-0.02	0.802	-0.21;	0.17	-0.03	0.760	-0.21;	0.15
13 weeks	-0.02	0.839	-0.22;	0.18	-0.05	0.604	-0.24;	0.14
52 weeks	0.09	0.393	-0.12;	0.31	0.08	0.440	-0.13;	0.28
Interaction term		0.7353				0.6940		

Adjusted analyses were controlled for: age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment
Coefficients for the interaction between BBQ and time explain additional changes in LBP intensity or RMDQ scores accounting for the increase of one point on the BBQ score compared to a BBQ score of 9
BBQ: Back Belief Questionnaire, CI: Confidence Interval, LBP: Low Back Pain, RMDQ: Roland Morris Disability Questionnaire,

-----Insert Figure 2 here-----

-----Insert Figure 3 here-----

The association between BBQ -scores and LBP intensity and disability stratified by LBP history

Dividing the populations into groups based on episode duration and number of previous episodes ('Acute new' n=209, 'Acute episodic' n=932, 'Subacute' n=615 and 'Long-lasting' n=473) did not show any substantial difference between the groups in the associations between BBQ at baseline and LBP intensity or disability at follow-up. The results are shown in Supplementary File 2.

TABLE 3
Single item association with LBP intensity or disability at 13 weeks

	LBP INTENSITY				DISABILITY			
Item	Coefficient	*p*	95% CI		Coefficient	*p*	95% CI	
1) There is no real treatment for back trouble.	-0.08	0.184	-0.21;	0.04	-0.80	0.230	-2.12;	0.51
2) Back trouble will eventually stop you from working.	0.07	0.155	-0.03;	0.17	0.12	0.816	-0.9;	1.14
3) Back trouble means periods of pain for the rest of one's life.	-0.31	<0.001	-0.41;	-0.2	-2.55	<0.001	-3.66;	-1.44
4) Doctors cannot do anything for back trouble.	-0.01	0.913	-0.10;	0.09	-0.24	0.649	-1.27;	0.79
5) A bad back should be exercised.	-0.12	0.051	-0.24;	0.001	-0.87	0.180	-2.14;	0.40
6) Back trouble makes everything in life worse.	-0.04	0.423	-0.13;	0.05	-1.05	0.031	-2.01;	-0.09
7) Surgery is the most effective	0.05	0.426	-0.07;	0.18	0.07	0.918	-1.25;	1.39

The association between single items on the BBQ and LBP intensity and disability at 13 weeks

Higher scores on an item (more positive beliefs on a scale from 1 to 5) were generally associated with slightly lower LBP intensity and disability scores at 13 weeks (Table 3).

Item 3 "*Back trouble means periods of pain for the rest of one's life*" had the strongest association with a reduction in both LBP intensity and disability at 13 weeks. For LBP intensity, the coefficient was -0.29 (95% CI -0.4; -0.19, *p*=<0.001) and for disability, -2.42 (95% CI -3.52; -1.33, *p*=<0.001).

For LBP intensity, the second strongest association was with item 11 "*Medication is the only way of relieving back trouble*" (coef. -0.16, 95% CI -0.28; -0.04, *p*=<0.007). For disability, the second strongest association was with item 9 "*Alternative treatments are the answer to back trouble*" (-1.31, 95% CI -2.36; -0.26, *p*=0.015) (Table 3).

way to treat back trouble.								
8) Back trouble may mean you end up in a wheelchair.	-0.03	0.489	-0.12;	0.06	-0.48	0.310	-1.41;	0.45
9) Alternative treatments are the answer for back trouble.	-0.05	0.288	-0.15;	0.05	-1.62	0.003	-2.68;	-0.56
10) Back trouble means long periods of time off work.	-0.04	0.448	-0.16;	0.07	-0.19	0.764	-1.41;	1.04
11) Medication is the only way of relieving back trouble.	-0.15	0.013	-0.27;	-0.03	-0.65	0.312	-1,91;	0.61
12) Once you have had back trouble there is always a weakness.	-0.04	0.495	-0.14;	0.07	-0.73	0.187	-1.81;	0.35
13) Back trouble must be rested.	0.04	0.506	-0.07;	0.14	-0.74	0.196	-1.87;	0.38
14) Later in life back trouble gets progressively worse.	-0.13	0.029	-0.24;	-0.01	-0.62	0.314	-1.83;	0.59

Score ranges from 1 to 5. With higher scores indicating positive beliefs (disagreeing with the statement), except item 5 where higher scores indicate agreeing with the statement.
Linear multivariate regression analysis adjusted for: age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment
BBQ: Back Belief Questionnaire, CI: Confidence Interval

When removing one item at a time from the model, the reduction in R^2 was low for all items. Item 3 showed the greatest reduction in R^2 accounting for 1.5% of the explained variance in the association with LBP intensity and 1% in the association with disability. Among the other items, the variance explained ranged from 0% to 0.35%.

Discussion

Main findings

To our knowledge, this is the first study using longitudinal data to investigate if back beliefs, measured by the BBQ, are associated with LBP intensity and disability at follow-up in patients with LBP who consult a chiropractor. Overall, we found that more positive beliefs at baseline were associated with decreasing LBP intensity at follow-up. However, the coefficients were small, and thus might not be of clinical relevance. There was no certain association between back beliefs and disability outcomes. The associations were not substantially different between groups with different LBP history. Assessment of the individual BBQ items showed that the item *"Back trouble means periods of pain for the rest of one's life"* had the strongest association with a reduction in both disability and LBP intensity at 13 weeks.

Interpretation

The way that beliefs about back pain potentially affect disability is depicted by the Common-Sense Model (CSM). The Model explains how individuals respond to and manage health threats based on the way pain or other stimuli related to illness is understood. The CSM describes the representation of health threats in five different domains: identity (what is this pain?), cause (what caused this pain?), consequence (what consequences will this pain have?), control (how can I control this pain?), and timeline (how long will this pain last?) (3, 4, 6, 27). The BBQ is designed to measure beliefs regarding negative consequences of LBP and thus, most of the questions reflect the consequence domain (20). Our findings indicate that perceptions related to consequences are not strongly related to outcomes in this population, whereas one item related to timeline (*"Back trouble means periods of pain for the rest of one's life"*) had a noticeably stronger association with LBP intensity and disability at the 13-week follow-up compared to the other items. This might imply that recovery expectations is an important subdomain in the BBQ, which is in line with the finding from other studies reporting that recovery expectations are a predictor of prognosis for LBP (11).

The consequence domain was reported in a systematic review to be a prognostic factor for pain outcomes in people with musculoskeletal pain (9). The review investigated relationships of illness perceptions, pain intensity and disability in people with musculoskeletal pain. However of the included studies, only two studies focused on LBP in a longitudinal design and both these studies only investigated outcomes of disability (9). Nevertheless, both studies found maladaptive illness perceptions to be associated with worse outcomes regarding pain-related disability at follow-up, whereas our findings did not provide such evidence (28, 29). Similar to our findings, a prospective cohort study (2020) of people with acute LBP found that maladaptive illness perceptions measured by IPQ was predictive of pain but not disability at 12-weeks although the predictive value was low (30). The same trend was seen for musculoskeletal pain, where IPQ did not add substantially to the prediction of recovery (10). Similarly, a secondary analysis of a randomized controlled trial published in 2018 showed that high levels of fear-avoidance beliefs measured by the Fear-Avoidance Beliefs Questionnaire in patients with LBP were only weakly associated with worse outcomes in LBP and disability at 12 months, yet the association was much stronger for sick leave (31). However, both the IPQ and Fear-Avoidance Beliefs Questionnaire cover more domains than the BBQ and the results are therefore not directly comparable.

It is questionable as to whether the observed association between positive back beliefs and the reduction in LBP intensity is clinically relevant. There is not a generic meaningful minimal clinically important change for pain scores, as it is always content-specific (32, 33), but a change of 2 points on the NRS has been proposed to be clinically significant in people with long-lasting LBP (34). In our study, a 10-points higher

score on the BBQ translated into an expected additional reduction in LBP intensity of 0.3 points which we doubt to be clinically relevant. However, as LBP is complex and many factors are considered important contributors, it is unlikely that the BBQ score would be able to independently predict future LBP intensity with high precision in a one-size-fits-all model. BBQ scores were generally high (mean BBQ sum-score=32) indicating overall positive beliefs, and more important associations can perhaps be demonstrated in populations with a larger variation in back beliefs.

In our sample, the associations between back beliefs and LBP intensity and disability were not influenced by the number of previous pain episodes and the duration of pain. This finding contradicts the theory that the association between beliefs and disability is most relevant for those with persistent pain (16). This is important as it implies that when clinicians discuss beliefs with a patient, it should not be based on the duration of pain or number of previous LBP episodes.

Overall beliefs about LBP seem to be associated with pain intensity and disability at a cross-sectional level, but the longitudinal relationship remains unclear (8, 9, 11-15). Due to only weak associations between beliefs and reduction of LBP intensity, and uncertainty regarding the domains of beliefs measured, the BBQ does not seem suitable for predicting or explaining the course of LBP in our setting. However, based on the cross-sectional association, and as other domains of beliefs could be relevant to patients with LBP, we still encourage clinicians to address beliefs with their patients preferably using an individual approach.

Limitations

As discussed previously, BBQ focuses on the consequence domain of beliefs. For a more thorough investigation of the association between beliefs and clinical outcomes, the use of different questionnaires could add information on beliefs from other domains, and thereby give a broader perspective on potential associations.

Before conducting the primary analyses, the construct validity and scale reliability of the BBQ was evaluated. The internal consistency and scale reliability was considered acceptable, and in line with other studies (20, 21, 24). However, other studies have found the BBQ to be unidimensional, although the fit of item 1 has been questioned, which we could not confirm (22-24). When interpreting the results, it should therefore be kept in mind that it is unclear what constructs the BBQ sum score represents in this sample. Another consideration is that the BBQ might be outdated as it was created in 1996 and a lot has happened in the field of LBP since then and perhaps in the public perception of LBP. This may explain why a questionnaire from 2014, the Back Pain Attitudes Questionnaire, which was developed based on in-depth interviews with people experiencing LBP, asks questions very different from those of BBQ (35). For future

studies investigating beliefs about LBP, we recommend researchers carefully consider the suitability of the different instruments.

This study did not account for the treatments the patients received from the chiropractor (e.g., advice, education, exercise, manual therapy), and it is unknown to what extent beliefs were discussed and addressed as part of treatment in a way that potentially affected outcomes. This could have blurred an otherwise stronger association than observed. However, BBQ sum scores were previously observed to be relatively constant over time in this sample, suggesting that negative beliefs were not effectively changed after initiating care (19).

Generalizability

Data were collected from a limited number of chiropractic clinics in Denmark, yet we have no reason to believe that data were not representative of Danish chiropractic clinics in general. Demographic baseline data were similar to a previous Danish chiropractic cohort based on a national sample (36). However, a population of patients consulting a chiropractor cannot be fairly compared to other patients in primary care (36). Further, the study sample's overall positive beliefs with a mean BBQ sum score of 32 differs from the findings from a systematic review that found the majority of mean BBQ sum scores in the general population were below 27 (8). Also, a recent study from 2021 exploring back beliefs in the general population reported a mean BBQ sum score of 27 (37).

Conclusion

Positive beliefs regarding LBP at baseline, measured by the BBQ, was weakly associated with a reduction in LBP intensity but not disability at the 2-, 13- and 52-week follow-ups in people with LBP seeking chiropractic care. Whether the association with LBP intensity was clinically relevant is questionable. The BBQ is therefore not promising for predicting or explaining the course of LBP in this setting. Future research should focus on exploring the associations between beliefs and clinical outcomes in different patient populations and with instruments covering all pain belief domains or more unambiguously covering a single domain. Furthermore, the longitudinal relationship between beliefs and levels of pain and disability should be investigated at an individual level.

Figure legends

Figure 1:

Heading: Flowchart of the study population

Explanatory text: Partly completed data on BBQ or RMDQ were filled out using chained multiple imputation

Abbreviations: BBQ: Back Belief Questionnaire, RMDQ: Roland Morris Disability Questionnaire, LBP: Low Back Pain

Figure 2:

Heading: Marginsplot of the associations between quartiles of BBQ scores at baseline and LBP intensity at follow-up

Explanatory text: The association between quartiles of BBQ scores at baseline and LBP intensity at follow-up had a *p*-value of 0.0030

Figure 3:

Heading: Marginsplot of the associations between baseline quartiles of BBQ scores at baseline and disability at follow-up

Explanatory text: The association between quartiles of BBQ scores at baseline and RMDQ scores at follow-up had a *p*-value of 0.1071

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Competing interest

The authors report the following potential conflict of interest: AK's position at the University of Southern Denmark is financially supported by an unrestricted grant from the Danish Foundation for Chiropractic Research and Postgraduate Education. The funders were not involved in defining the research question, designing the study, analyzing the data, or interpreting the results.

Author Contributions

SG conceived and planned the project, performed analysis of the data and interpretation of the results, and wrote the initial draft of the manuscript. AK made substantial contributions to study design, data analysis, interpretation of results and revised and improved the manuscript. RKJ made substantial contribution to the study design, interpretation of results and revision of the manuscript. All authors have read and approved the final manuscript.

Data availability statement

Data used and analyzed in the current study are available from the corresponding author on reasonable request. If interested in using data from the ChiCo cohort for other research projects, the Chiropractic Knowledge Hub should be contacted directly.

Ethic statement

Patient consent for publication

Not required

Ethics approval

The Health Research Ethics Committee for Southern Denmark determined (S-20,162,000-109) that the Danish Chiropractic Low Back Pain Cohort did not require ethical approval according to Danish regulations.

Abbreviations

BBQ: Back Belief Questionnaire; ChiCo: Danish Chiropractic low back pain Cohort; CI: Confidence Interval; Illness Perception Questionnaire; LBP: Low Back Pain; LOWESS: Locally Weighted Scatterplot Smoothing; MCID: Minimal Clinically Important Difference; NRS: Numerical Rating Scale; OPEN: The Odense Patient Explorative Network; REDCap: Research Electronic Data Capture; RMDQ: Roland-Morris Disability Questionnaire; SD: Standard Deviation; STROBE: Strengthening the Reporting of Observational studies in Epidemiology.

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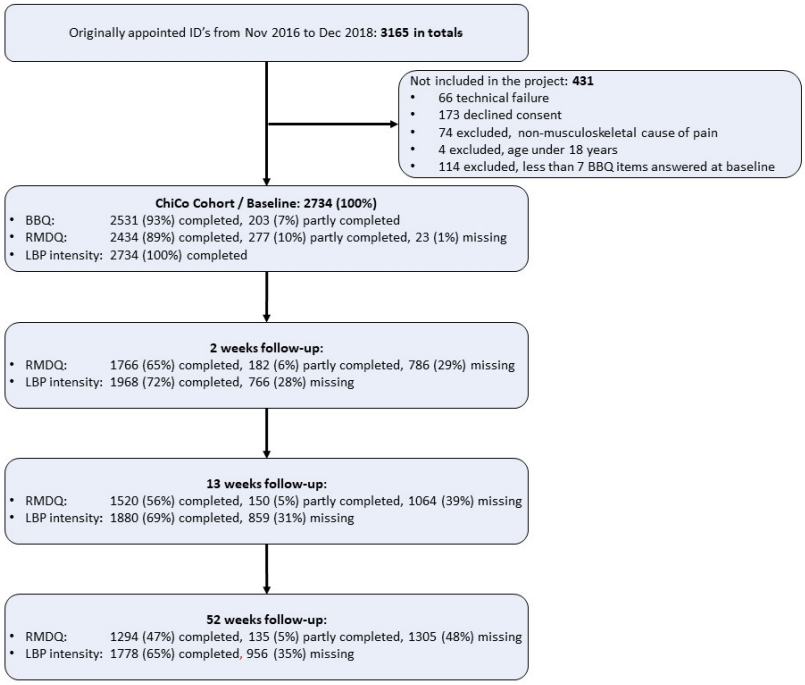

Flowchart of the study population

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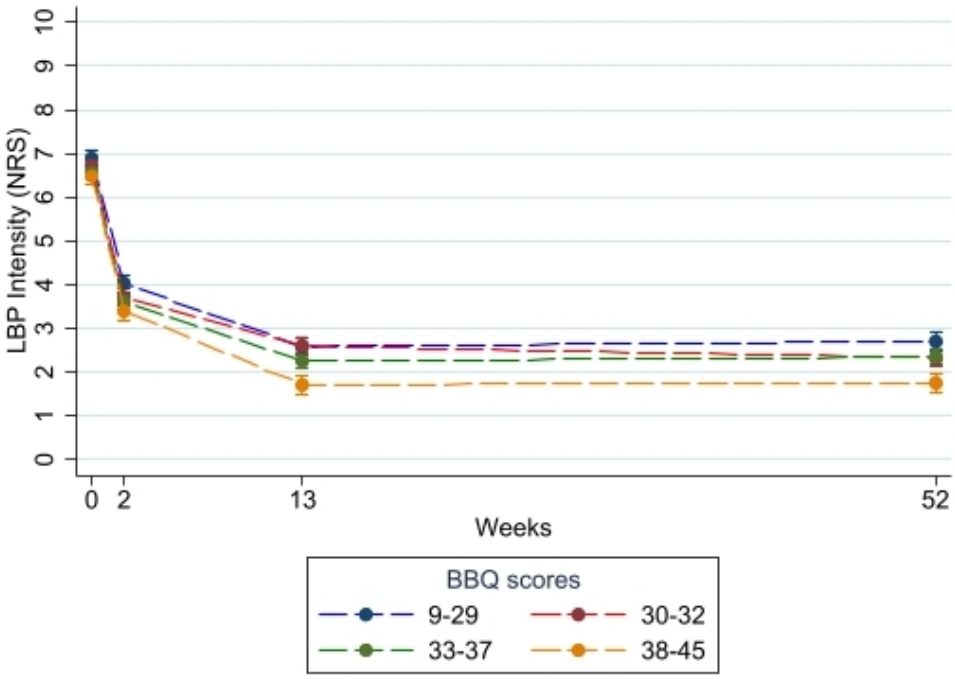

Marginsplot of the associations between quartiles of BBQ scores at baseline and LBP intensity at follow-up

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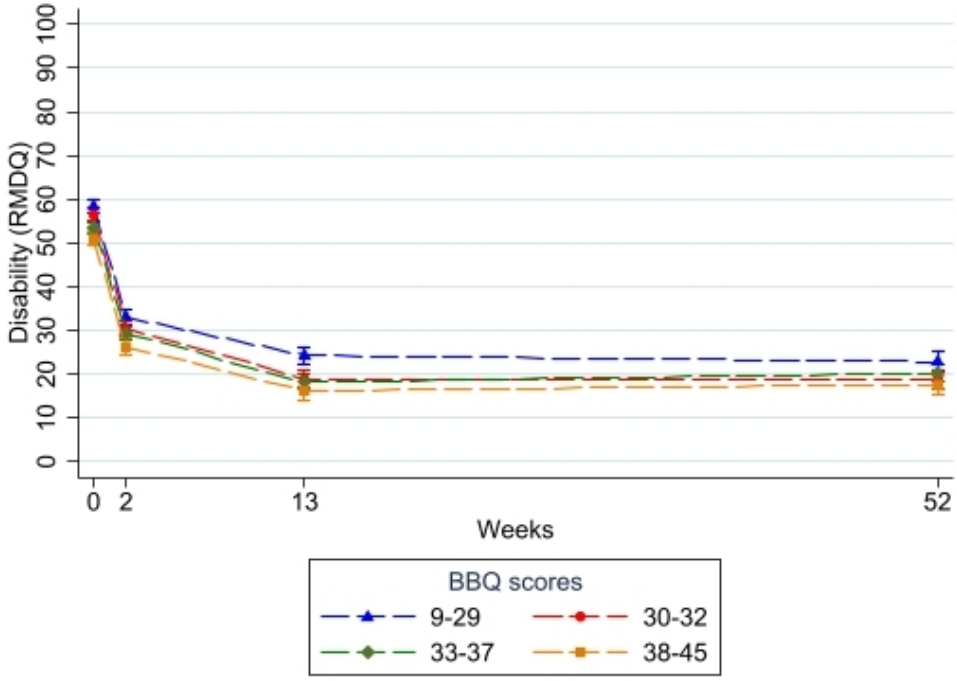

Marginsplot of the associations between baseline quartiles of BBQ scores at baseline and disability at follow-up

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Supplemental file 1 - Construct validity and scale reliability

Before conducting the primary analyses, we performed analyses on the Danish version of the BBQ to test construct validity and scale reliability. Tests were performed on the baseline population consisting only of those who had completed the BBQ (n=2531). Cronbach's alpha was used to measure internal consistency and scale reliability and showed a total alpha score of 0.77 which is considered acceptable (Table 1). Factor analysis was conducted to test if the BBQ was unidimensional (only measuring one construct as intended). The factor analysis was conducted similar to Bostick et al. (1) by first performing an Explorative factor analysis based on eigenvalues from a principal component analysis (PCA). Thereafter we performed a confirmatory factor analysis based on the results. However, the results did not support a unidimensional model and the first component of the PCA only explained 26 % of the variance. Results of the PCA and factor analyses can be found in table 2a,2b,3a and 3b, for a scree plot of eigenvalues see figure 1.

Because BBQ did not seem unidimensional, six different subscales were created and explored, and each subscale was tested for goodness of fit using a maximum likelihood approach. The subscales were: 1) the original score and 2) the original score including distractor items. Then based on the PCA we created 3) a subscale by removing item 5 and 9 because these had the lowest correlation to the first component in the PCA and a low item-rest correlation. Lastly, we used simple face validity to create three subscales based on the domains the items seemed to cover: 4) a consequence domain (item 2,3,6,8,10,12,14), 5) a control domain (item 1, 4, 5, 7,9, 11, 13), and 6) an expectation domain (item 1, 2, 3, 4, 6, 8, 10, 12, 14). These were compared on their Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR) comparative fit index (CFI) and Chi^2 (table 4).

For each subscale the explained variance was compared. The explained variance was extracted from the random effect parameters in the mixed methods longitudinal regression analyses (score of the sub-scale and the interaction between the score and time as independent variable, and LBP intensity or RMDQ scores as dependent variable). To calculate the explained variance, we subtracted unexplained variance from a model without a BBQ-subscale (time as independent variable and pain or RMDQ-scores as dependent) from a model with a subscale. No subscale outperformed the other regarding either explained variance or goodness of fit, and we therefore decided to use the original BBQ-score (Table 4 and 5).

TABLE 1

Internal consistency and scale validity measured by Cronbach's alpha

Item	Obs	Sign	Item-test correlation	Item-rest correlation	Average interitem covariance	alpha
BBQ1	2531	+	0.5150	0.4141	0.2236376	0.7505
BBQ 2	2531	+	0.6186	0.4984	0.2042338	0.7401
BBQ 3	2531	+	0.6198	0.5086	0.2064069	0.7394
BBQ 4	2531	+	0.5404	0.4139	0.2151883	0.7496
BBQ 5	2531	-	0.2231	0.1107	0.2500912	0.7737
BBQ 6	2531	+	0.5254	0.3903	0.2158778	0.7523
BBQ 7	2531	+	0.4567	0.3553	0.2299497	0.7555
BBQ 8	2531	+	0.4547	0.3086	0.2242917	0.7612
BBQ 9	2531	+	0.2907	0.1615	0.2438508	0.7720
BBQ 10	2531	+	0.6117	0.5122	0.2110727	0.7404
BBQ 11	2531	+	0.4693	0.3642	0.2279814	0.7547
BBQ 12	2531	+	0.5575	0.4397	0.2144444	0.7469
BBQ 13	2531	+	0.4749	0.3551	0.2249277	0.7553
BBQ 14	2531	+	0.5578	0.4548	0.2178	0.7463
Test scale					0.2221253	0.7666

TABLE 2a

Eigenvalues of principal component analysis on the BBQ items

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	3.63131	2.34124	0.2594	0.2594
Comp2	1.29007	0.138269	0.0921	0.3515
Comp3	1.1518	0.128742	0.0823	0.4338
Comp4	1.02306	0.0483555	0.0731	0.5069
Comp5	0.974706	0.131495	0.0696	0.5765
Comp6	0.843212	0.037967	0.0602	0.6367
Comp7	0.805245	0.0462409	0.0575	0.6942
Comp8	0.759004	0.0619936	0.0542	0.7485
Comp9	0.69701	0.0834449	0.0498	0.7982
Comp10	0.613565	0.0121034	0.0438	0.8421
Comp11	0.601462	0.018122	0.0430	0.8850
Comp12	0.58334	0.0432221	0.0417	0.9267
Comp13	0.540118	0.0540251	0.0386	0.9653
Comp14	0.486093	.	0.0347	1.0000

TABLE 2b Eigenvectors

Loading of individual items on components

Item	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7	Comp8	Comp9	Comp 10	Comp 11	Comp 12	Comp 13	Comp 14	Unexplained
BBQ1	0.2838	-0.4219	0.1169	-0.1238	0.0267	-0.0704	0.2928	-0.1954	0.1624	0.1682	0.2213	0.6832	0.0402	0.1045	0
BBQ 2	0.3288	0.0826	0.0477	-0.3702	0.1163	0.0299	-0.0240	-0.3759	0.0155	0.5127	0.2269	0.0206	0.3879	0.3521	0
BBQ 3	0.3406	-0.2507	0.2497	-0.0748	-0.1480	-0.2252	0.0257	-0.0222	0.0320	0.0490	0.2869	0.3854	0.0933	0.6607	0
BBQ 4	0.2835	-0.4162	0.2556	-0.0715	0.2303	0.1693	-0.0387	-0.0294	0.1320	0.2889	0.0820	0.4322	0.3187	0.4427	0
BBQ 5	-0.0852	0.3240	0.5973	0.1027	-0.2102	0.2509	0.5973	0.0023	0.0899	0.1288	0.0531	0.0397	0.1494	0.0711	0
BBQ 6	0.2701	0.2558	0.1726	-0.1123	0.0885	0.6410	-0.2895	0.1618	0.0634	0.2706	0.1793	0.1008	0.3309	0.2480	0
BBQ 7	0.2436	-0.0268	-0.4483	-0.0383	-0.0987	0.1201	0.5263	0.2213	0.6155	0.0166	0.0071	0.0462	0.0722	0.0297	0
BBQ 8	0.2187	0.4125	-0.0689	-0.3510	0.1451	-0.4325	0.2205	0.2576	0.3204	0.4198	0.0411	0.1230	0.1242	0.1405	0
BBQ 9	0.1145	0.1192	0.1329	0.4850	0.7882	-0.1572	0.1012	0.0547	0.1288	0.1184	0.0704	0.0844	0.0603	0.1194	0
BBQ 10	0.3284	0.3261	-0.1041	-0.2213	0.0547	0.0288	-0.1928	0.0429	0.0316	0.2612	0.0201	0.1473	0.7514	0.1652	0

BBQ 11	0.2464	-0.1290	-0.4109	0.2858	0.0193	0.3344	0.1805	0.0894	0.6546	0.2109	0.0707	0.2033	0.0005	0.0091	0
BBQ 12	0.3015	-0.0803	0.1339	0.2967	-0.2912	-0.0893	-0.2108	0.5152	0.0047	0.0041	0.4590	0.2926	0.0499	0.3087	0
BBQ 13	0.2467	0.2833	-0.1689	0.3878	-0.1983	-0.0014	-0.0232	-0.6320	0.0533	0.4216	0.2361	0.0032	0.0521	0.0403	0
BBQ 14	0.3070	0.1177	0.1424	0.2912	-0.2814	-0.3067	-0.1427	-0.0021	0.1114	0.2285	0.7050	0.1130	0.1088	0.0833	0

Figure 1
Screeplot of eigenvalues after principal component analysis of the BBQ items

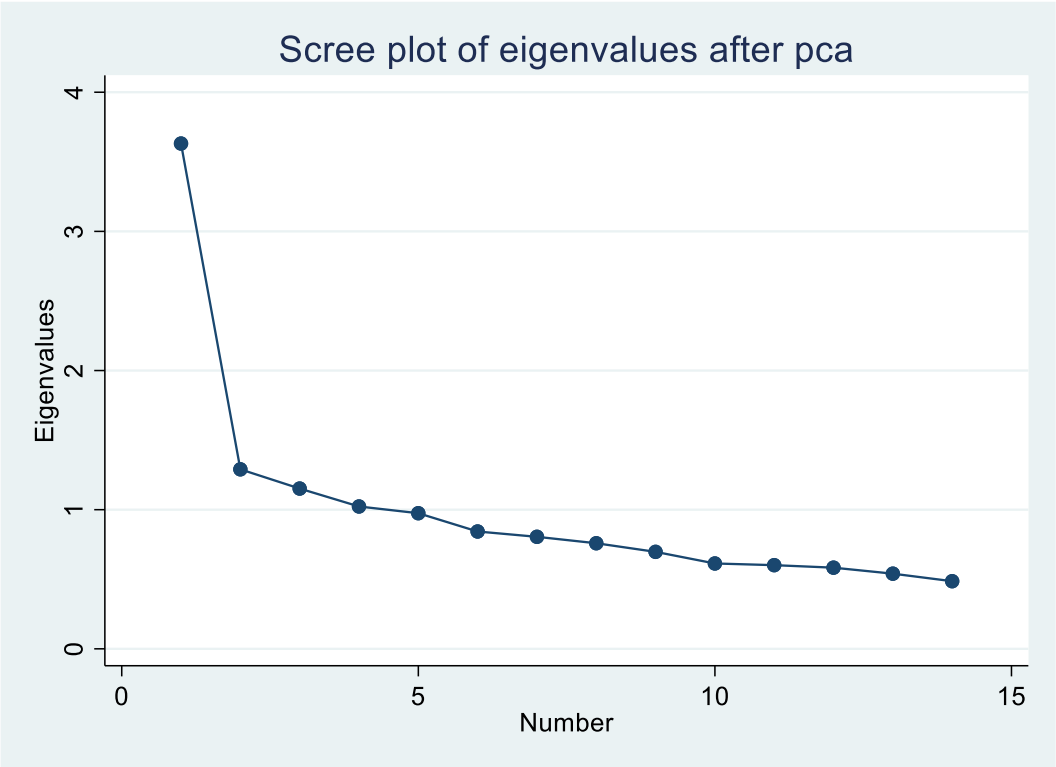

TABLE 3a
Rotated factor loadings

Item	Factor1	Factor2	Factor3	Factor4	Uniqueness
BBQ1	**0.7148**	0.0757	0.0102	0.1914	0.4465
BBQ 2	0.3986	**0.6153**	0.0097	0.0814	0.4558
BBQ 3	**0.7109**	0.2200	0.1600	0.0210	0.4202
BBQ 4	**0.7668**	0.0401	0.0569	0.0541	0.4042
BBQ 5	-0.0795	0.0295	**0.1221**	-0.7493	0.4164
BBQ 6	0.2257	**0.5214**	0.2330	-0.1393	0.6035
BBQ 7	0.1090	0.3040	0.1735	**0.5612**	0.5506
BBQ 8	-0.0295	**0.7228**	0.0362	0.0102	0.4753
BBQ 9	0.0465	-0.0660	**0.5516**	-0.1269	0.6731
BBQ 10	0.1312	**0.7151**	0.2147	0.1295	0.4086

BBQ 11	0.1625	0.0567	0.4155	**0.5637**	0.4800
BBQ 12	0.4391	0.1025	**0.4939**	0.0427	0.5510
BBQ 13	-0.0421	0.2694	**0.6403**	0.1640	0.4888
BBQ 14	0.3050	0.2486	**0.5601**	-0.0417	0.5297

Bold indicates the highest factor loading for each item

TABLE 3b Factor rotation matrix

	Factor1	Factor2	Factor3	Factor4
Factor1	0.6220	0.5749	0.4692	0.2499
Factor2	-0.6454	0.6122	0.2923	-0.3509
Factor3	0.4247	-0.0726	0.0065	-0.9024
Factor4	-0.1272	-0.5379	0.8333	-0.0105

TABLE 4
Comparison of subscales based on Goodness of fit

Subscale	RMSEA	SRMR	CFI	Chi^2	Alpha
1)Original score	0.088	0.053	0.859	555.00	0.7478
2) Full score	0.075	0.054	0.801	1176.37	0.7666
3) score without item 5 and 9	0.083	0.057	0.820	1002.15	0.7800
4) Consequence domain	0.097	0.052	0.883	344.14	0.7213
5) Control domain	0.080	0.049	0.813	241.45	0.5395
6) Expectations domain	0.102	0.063	0.828	736.53	0.7559

Items in subscales: 1) 1,2,3,6,8,10,12,13,14; 2) 1,2,3,4,5,6,7,8,9,10,11,12,13,14; 3) 1,2,3,4,6,7,8,10,11,12,13,14; 4) 2,3,6,8,10,12,14; 5) 1, 4, 5, 7,9, 11, 13; 6) 1, 2, 3, 4, 6, 8, 10, 12, 14
RMSEA: Root Mean Square Error of Approximation
SRMR: Standardized Root Mean Square Residual
CFI: comparative fit index

TABLE 5
Explained variance of subscale

Subscale	Pain unadjusted	Pain adjusted	RMDQ unadjusted	RMDQ adjusted
1)Original score	1.48%	1.24%	3.87%	1.59%
2) Full score	1.54%	1.27%	3.95%	1.71%
3) score without item 5 and 9	1.5%	1.27%	3.99%	1.68%
4) Consequence domain	1.34%	1.12%	3.53%	1.47%
5) Control domain	0.96%	0.73%	2.26%	0.99%
6) Expectations domain	1.47%	1.32%	3.60%	1.65%

Items in subscales: 1) 1,2,3,6,8,10,12,13,14; 2) 1,2,3,4,5,6,7,8,9,10,11,12,13,14; 3) 1,2,3,4,6,7,8,10,11,12,13,14; 4) 2,3,6,8,10,12,14; 5) 1, 4, 5, 7,9, 11, 13; 6) 1, 2, 3, 4, 6, 8, 10, 12, 14
Adjusted analyses were controlled for: age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment

References

1. Bostick GP, Schopflocher D, Gross DP. Validity evidence for the back beliefs questionnaire in the general population. European journal of pain (London, England). 2013;17(7):1074-81.

Supplemental file 2

Association between BBQ scores at baseline and LBP intensity and disability at 2, 13 and 52 weeks stratified by LBP history

	Acute new (n=209)			Acute episodic (n=932)			Sub acute (n=615)			Persistent (n=473)		
LBP intensity (NRS)												
	Coefficient	*p*	95%CI	Coefficient	*p*	95%CI	Coefficient	*p*	95%CI	Coefficient	*p*	95%CI
Time												
2 weeks	-3.82	<0.001	-5.75 -1.89	-2.76	<0.001	-3.76 -1.76	-2.26	0.001	-3.55 -0.97	-2.04	0.104	-2.35 0.34
13 weeks	-4.58	<0.001	-6.65 -2.52	-3.59	<0.001	-4.62 -2.57	-3.64	<0.001	-4.96 -2.32	-1.80	0.009	-3.17 -0.44
52 weeks	-6.73	<0.001	-8.8 -4.67	-3.48	<0.001	-4.53 -2.43	-3.12	<0.001	-4.45 -1.8	-1.73	0.024	-3.22 -0.23
BBQ	-0.02	0.407	-0.06 0.02	-0.02	0.153	-0.04 0.01	-0.02	0.082	-0.05 0.003	-0.04	0.009	-0.07 -0.01
Interaction between BBQ and time												
2 weeks	-0.01	0.686	-0.07 0.05	-0.03	0.087	-0.06 0.004	0.002	0.919	-0.04 0.04	-0.02	0.330	-0.06 0.02
13 weeks	-0.04	0.223	-0.1 0.02	-0.05	0.002	-0.08 -0.02	0.01	0.753	-0.03 0.05	-0.02	0.342	-0.06 0.02
52 weeks	0.03	0.334	-0.03 0.09	-0.05	0.001	-0.09 -0.02	-0.01	0.580	-0.05 0.03	-0.02	0.329	-0.07 0.02
Interaction term		0.2262			0.0025			0.8756			0.6618	
DISABILITY (RMDQ)												
Time												
2 weeks	-38.65	<0.001	-58.85 -18.44	-34.47	<0.001	-44.33 -24.60	-18.83	0.002	-30.52 -7.13	-2.08	0.722	-13.51 9.36
13 weeks	-49.42	<0.001	-71.46 -27.38	-44.11	<0.001	-54.47 -33.76	-34.83	<0.001	-47.1 -22.56	-16.21	0.009	-28.41 -4.0
52 weeks	-47.51	<0.001	-70.78 -24.24	-46.19	<0.001	-57.07 -35.31	-40.62	<0.001	-53.65 -27.6	-3.88	0.590	-17.97 10.22
BBQ	-0.35	0.127	-0.81 0.10	-0.56	<0.001	-0.79 -0.34	-0.41	0.001	-0.67 -0.16	-0.4	0.002	-0.65 -0.15
Interaction between BBQ and time												
2 weeks	0.05	0.875	-0.55 0.65	0.07	0.635	-0.23 0.37	0.07	0.696	-0.28 0.42	0.29	0.110	-0.64 0.07
13 weeks	-0.07	0.838	-0.71 0.58	0.02	0.912	-0.3 0.33	0.22	0.235	-0.14 0.59	0.02	0.912	-0.36 0.4
52 weeks	-0.01	0.983	-0.69 0.67	0.1	0.554	-0.23 0.43	0.43	0.031	0.04 0.82	0.35	0.114	-0.78 0.08
Interaction term		0.9895			0.9258			0.1571			0.1792	

BBQ: Back Belief Questionnaire, CI: Confidence Interval, LBP: Low Back Pain, RMDQ: Roland Morris Disability Questionnaire
Analyses were controlled for age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6*
Bias	9	Describe any efforts to address potential sources of bias	5 "setting and procedures"
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8 and figure 1
		(b) Give reasons for non-participation at each stage	Figure 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8 and table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1 + figure 1
		(c) Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
		(*b*) Report category boundaries when continuous variables were categorized	Figure 2 +3
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Beliefs about back pain and associations with clinical outcomes: a primary care cohort study

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Beliefs about back pain and associations with clinical outcomes: a primary care cohort study

Søren Grøn[1], Rikke Krüger Jensen[1 2], Alice Kongsted [1 2]

1: Chiropractic Knowledge Hub, Campusvej 55, 5230 Odense M, Denmark
2: Department of Sports Science and Clinical Biomechanics, University of Southern Denmark, Campusvej 55, 5230 Odense M, Denmark.

Correspondence to Søren Grøn sgron@health.sdu.dk

Abstract

Objective: To investigate associations between beliefs about low back pain (LBP) at baseline and pain intensity and disability for one year.

Design: An observational cohort study.

Setting: Primary care private chiropractic clinics in Denmark.

Participants: A total of 2734 adults consulting a chiropractor for a new episode of LBP, with follow-up data available from 71%, 61% and 52% of the participants at 2, 13 and 52 weeks, respectively.

Outcome measures: Beliefs about LBP were measured by the Back Belief Questionnaire (BBQ) before consulting the chiropractor. Pain (Numerical Rating Scale 0-10) and (the Roland Morris Disability Questionnaire) were measured at baseline and after 2-, 13- and 52-weeks. Associations were explored using longitudinal linear mixed models estimating interactions between BBQ and time, and by estimating associations between single items of BBQ and 13 weeks outcomes.

Results: More positive beliefs about LBP were weakly associated with a reduction in pain at 2 weeks (β interaction BBQ#Time = -0.02 (95% CI -0.04; -0.001)), at 13 weeks -0.03 (95% CI -0.05; -0.01), and at 52 weeks follow-up, -0.03 (95% CI -0.05; -0.01) (p=0.003). For disability, the association was uncertain (p=0.7). The item "*Back trouble means periods of pain for the rest of one's life*" had the strongest association with both reduction in pain (-0.29, 95% CI -0.4; -0.19, p=<0.001) and disability (-2.42, 95% CI -3.52; -1.33, p=<0.001) at 13 weeks follow-up.

Conclusion: Positive beliefs regarding LBP, measured by the BBQ, were associated with a reduction in pain intensity at both short- and long-term follow-up. However, the association was weak, and the clinical relevance is therefore questionable. No clear association was demonstrated between beliefs and disability. This study did not show promise that back beliefs as measured by the BBQ were helpful for predicting or explaining the course of LBP in this setting.

Keywords:

Low back pain, beliefs, attitudes, health knowledge, primary care

Article Summary

Strengths and limitations of this study

- This longitudinal observational study was the largest cohort to date investigating beliefs about LBP (n=2,734)
- The cohort provided an opportunity to investigate associations in acute episodes of LBP as well as in long-lasting LBP.
- The BBQ is a widely used questionnaire that has previously shown good reliability but has not been tested in the Danish version, so we assessed its construct validity and scale reliability before conducting the primary analysis.
- The BBQ mainly measures beliefs regarding negative consequences of LBP, thus neglecting other potentially relevant aspects of beliefs.
- The cohort only consisted of chiropractic patients with generally positive beliefs and is thus not generalizable to all LBP patients.

Introduction

Low back pain (LBP) is a common condition that is mostly nonspecific, which means no single structure can be identified as the cause of the pain (1). Both biophysical, psychological, and social factors are recognized to contribute to pain perception and disability (2). Among these biopsychosocial factors, one aspect that is considered important in relation to both disability and recovery is what people think and believe about their back and LBP (3). This could involve beliefs that LBP is a sign of structural damage and, consequently, the back is fragile and needs protection. Such beliefs can affect the behavior of a person with LBP, and thereby influence recovery if a person adopts unhelpful behavior such as fear-avoidance behavior or over-protective behavior (3-7).

Multiple questionnaires have been developed to measure beliefs about pain and investigate the association between beliefs and LBP. A systematic review of back beliefs in the general population from 2018 found that negative beliefs, measured using the Back Belief Questionnaire (BBQ), were cross-sectionally associated with higher levels of pain and disability (8). Similarly, a systematic review from 2018 found a moderate level of evidence for a cross-sectional association between maladaptive illness perceptions, measured by the illness perception questionnaire (IPQ), and pain intensity and disability in patients with musculoskeletal pain(9). The evidence regarding the prognostic value of illness beliefs was inconclusive due to lack of longitudinal studies (9). However, a recent longitudinal study from 2021 found that the IPQ only added a small and non-substantial predictive value for poor recovery at 3 months in people with musculoskeletal pain (10). For recovery expectations as a prognostic factor for LBP, a Cochrane review from 2019 concluded that having positive expectations towards recovery might be associated with a reduction in pain and disability, although the evidence was of low quality (11). In general, there is evidence supporting a cross-sectional association between negative beliefs regarding LBP and higher levels of pain and disability. However, as longitudinal studies are few and of low quality and mostly investigate recovery expectations, the relationship between other aspects of beliefs and clinical outcomes over time is uncertain (8, 9, 11-15). Longitudinal studies can help to determine if specific beliefs are associated with clinical outcomes, which is relevant as beliefs are potentially modifiable and could therefore be targets for clinical interventions. It has been proposed that the association between psychological factors, such as beliefs, and long-term disability might be more relevant for those with persistent pain compared to those with subacute pain (16). A verification of this theory would be clinically relevant as it could help clinicians prioritize when to address beliefs.

The objectives of this study were therefore to investigate if back beliefs at baseline, measured by the BBQ, were associated with pain intensity and disability at the 2-, 13-, and 52 -week follow-ups in patients with

LBP who consulted a chiropractor, and whether the association differed according to pain duration. Also, we assessed if any items of the BBQ had a stronger association with pain intensity and disability at the 13-week follow-up compared to the other items.

Methods

Study design

This study was an observational cohort study based on data from The Danish Chiropractic Low Back Pain Cohort (ChiCo) (17). The study was reported according to the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) cohort reporting guidelines and a STROBE checklist has been completed (18).

Patient and public involvement

Patients were not involved in designing the study or interpreting the results.

Setting and procedures

Participants were recruited from 10 chiropractic clinics in Denmark between November 2016 and December 2018. At the initial visit to the chiropractor, the patient filled out a baseline questionnaire, divided into two parts. The first part included items that might be influenced by consulting the chiropractor and was therefore filled out before the initial consultation (Baseline 1). The second part was filled out after the initial consultation and included demographic and background data less likely to be influenced by the consultation (Baseline 2). Follow-up questionnaires were obtained at 2, 13 and 52 weeks after inclusion. Participants who did not respond to the follow-up questionnaires at 13 and 52 weeks received a phone call for a structured interview on a limited number of questions from the survey. Data were collected electronically and stored using the online system REDCap (Research Electronic Data Capture) hosted and supported by the Odense Patient data Explorative Network (OPEN). Further details on the data collection procedure have been described elsewhere (17), as have cross-sectional data from the BBQ in some of the study sample (19).

Participants

To be enrolled in the study, the patient needed to be 18 years of age or older, be seeking a consultation with the chiropractor with a new onset of LBP with or without leg pain, and be able to complete electronic questionnaires in Danish. A new onset of LBP was defined as a new or recurring LBP problem for which the

patient was not currently receiving treatment or long-term management. Patients referred for acute surgical assessment or patients with suspicion of pathology leading to referral for further diagnostic assessment were not enrolled in the study (17).

Variables

Primary measures

Beliefs about LBP were measured at Baseline 1, before consulting the chiropractor, using a Danish version of the BBQ. The BBQ consists of 14 statements regarding inevitable negative consequences of LBP that are scored on a 5-point Likert scale. Five statements are not included in the final score, and thus the score ranges from 9 to 45. The scores are reversed so that higher scores indicate positive beliefs (20). The translation process has been described in a previous paper (19). The questionnaire has been widely used in research and has previously been validated and translated into multiple languages, showing good test-retest reliability and demonstrating good construct validity (measuring only one construct) (21-25).

Disability was measured by the 23-item Danish version of the Roland-Morris Disability Questionnaire (RMDQ) (0-100, higher scores indicating higher levels of disability) (26), and LBP intensity on a Numerical Rating Scale (NRS) examining typical LBP intensity during the previous week (0 = no pain to 10 = worst imaginable pain) (24-25). Both disability and LBP intensity were measured at Baseline 1 (before the consultation), and at the 2-, 13-, and 52-week follow-ups. Only LBP intensity was part of the telephone interview with non-respondents.

Additional baseline variables

Baseline 1: Age and sex (derived from the patient's personal identification (social security) number); duration of current pain episode (1–2 days, 3–7 days, 1–2 weeks, 2–4 weeks, 1–3 months, 3–12 months, more than a year).

Baseline 2: Previous treatment for LBP (yes/no); previous episodes of LBP (none, 1, 2–3, more than 3); number of days with LBP last year (≤30 days, > 30 days).

Statistical methods

Missing responses on the BBQ and previous treatment for LBP were imputed using chained multiple imputations. For BBQ, we excluded participants who answered 6 or fewer items at baseline, and then used imputation for the remaining incomplete questionnaires. For both BBQ and previous treatment for LBP, the imputations were informed by age, sex, RMDQ scores, LBP intensity at baseline, duration of current pain

episode, previous treatment, and number of days with pain last year. Multiple imputations of missing RMDQ sum scores were performed as part of the standard preparation of ChiCo cohort data (17).

Construct validity and scale reliability

Before conducting the analyses, we tested the construct validity and scale reliability of the Danish version of the BBQ. The scale showed acceptable reliability (Cronbach's alpha= 0.77), but our findings did not support a unidimensional structure of the scale. However, as we were unable to detect a better factor structure of the scale, we decided to use the scale as originally intended and as it had been applied in previous studies. The process is described in Supplemental File 1.

Data analysis

Baseline characteristics were presented as means with standard deviations (SD) or proportions.

To estimate associations between BBQ and outcomes, we used a linear mixed model with random intercept (taking repeated measures into account) to conduct longitudinal regression analysis with baseline BBQ score, follow-up time point (categorical), and the interaction between the BBQ score and follow-up time point as independent variables. This model was used for both LBP intensity and RMDQ score as the dependent outcome variable. We performed unadjusted analyses and adjusted analyses controlling for age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment. Variables controlled for were chosen as they have been shown in a previous study on the same population to be associated with baseline BBQ scores (19). Results were presented as coefficients with p-values and 95 % confidence intervals. P-values for the interaction term were based on ANOVA tests using the 'contrast' command in STATA. A linear relationship was assumed between baseline BBQ and both LBP intensity and RMDQ score at follow-up, based on inspection of a Locally Weighted Scatterplot Smoothing (LOWESS) plot. For visualization of the findings, the adjusted analyses were repeated with BBQ scores divided into quartiles, which were used to create a marginsplot for the association. The quartiles of BBQ scores had the following division: scores from 9-29 (n=846), 28-32 (n=525), 33-37 (n=823) and 38-45 (n=540). Results were presented as regression coefficients with 95% confidence intervals and p-values.

To investigate if the association differed according to pain duration, the analyses with the outcomes on the original scales were repeated, stratified on the following four groups categorized by duration of the current episode and number of previous LBP episodes: Group 1 (Acute new): Onset within 2 weeks and no previous LBP episodes; Group 2 (Acute episodic): Onset within 2 weeks but with one or more previous LBP episodes; Group 3 (Subacute): Pain for more than 2 weeks but less than 3 months; and Group 4 (Long-lasting): Pain for more than 3 months.

To explore the association between single items of the BBQ and LBP intensity and RMDQ, we performed a linear regression analysis with LBP intensity or RMDQ at the 13-week follow-up as the dependent variable and each BBQ item at baseline as independent variables, controlling for age, sex, baseline LBP intensity, baseline RMDQ-score and previous treatment. The 13-week follow-up was chosen based on inspection of the overall change in LBP intensity and disability at follow-up, as most of the change had occurred by 13 weeks. All items were included in one model for each outcome and results were presented as regression coefficients with 95% confidence intervals and p-values. Variance inflation factors (VIF) were calculated to check the influence on estimates from multicollinearity. With LBP intensity as the dependent variable, the mean VIF was 1.28 (range 1.06 to 1.57) and with RMDQ score as the dependent variable, the mean VIF was 1.27 (range 1.06 to 1.56). Thus, both models indicated no sign of multicollinearity.

The impact of single items on the amount of variance explained was explored by noting the reduction in the R^2-value obtained from the linear regression model with a single item removed from the model at a time compared to a model with all items.

All analyses were performed using Stata/MP 16 (StataCorp LLC, TX 77845, USA).

Results

A total of 3165 participants were included in the ChiCo cohort and, of those, 2734 were included in the current study (Figure 1). Mean age was 44 years and 41% were female. The mean baseline score of LBP intensity was 6.7 and the mean RMDQ score was 55 (Table 1). Follow-up data on LBP intensity were available for 72%, 69% and 65% (at 2, 13, 52 weeks respectively) of the participants, and data on disability were available for 71%, 61% and 52% (at 2, 13, 52 weeks respectively) (Figure 1). Baseline characteristics were similar regarding pain intensity, RMDQ scores and BBQ scores between participants who completed the 52-week follow up and those who were lost to follow-up, but those not completing the follow-up were younger than those who did (Table 1).

TABLE 1
Characteristics of study population

	Baseline (n=2734)	52 weeks drop out [a] (n=952)	52 weeks completed (n=1782)
Age in years, mean (SD)	44 (14)	41 (14)	46 (13)
Age range in years	18 – 87	18 – 81	18 – 87
Females	41%	40%	42%
Time since start of current episode of LBP			
1 – 2 days	18%	20%	17%
3 – 7 days	29%	27%	30%

1 – 2 weeks	13%	13%	13%
2 – 4 weeks	11%	10%	11%
1 – 3 months	12%	10%	13%
3 – 12 months	7%	8%	7%
More than a year	10%	12%	9%
Missing (n)	0.5% (14)	0.4% (4)	0.6% (10)
LBP intensity (NRS 0 – 10), mean (SD)			
Baseline	6.7 (2.0)	6.7 (2.0)	6.7 (2.0)
Missing (n)	2% (46)	2% (16)	2% (30)
2 weeks	3.7 (2.3)	3.8 (2.3)	3.7 (2.3)
Missing (n)	28% (766)	58% (550)	12% (216)
13 weeks	2.3 (2.3)	2.6 (2.4)	2.3 (2.3)
Missing (n)	31% (854)	66% (632)	12% (222)
52 weeks	2.3 (2.4)	-	2.3 (2.4)
Missing(n)	35% (956)	-	0.2% (4)
Disability (RMDQ 0 – 100), mean (SD)			
Baseline	55 (24)	55 (25)	55 (23)
Missing (n)	1% (23)	2% (17)	0.3% (6)
2 weeks	30 (26)	32 (27)	29 (26)
Missing (n)	29% (786)	57% (545)	12% (211)
13 weeks	19 (23)	24 (27)	19 (23)
Missing (n)	39% (1064)	66% (628)	12% (219)
52 weeks	20 (23)	-	21 (23)
Missing (n)	48% (1305)	-	-
Back beliefs (BBQ 9 – 45), mean (SD)	32 (6)	32 (6)	33 (6)

[a] Missing data on both RMDQ and LBP intensity at the 52-week follow-up

SD: standard deviation, LBP: Low back pain, NRS: numerical rating scale, RMDQ: Roland Morris Disability Questionnaire, BBQ: Back Belief Questionnaire

-----Insert Figure 1 here-----

The association between BBQ scores at baseline and LBP intensity and disability after 2, 13 and 52 weeks

Higher BBQ scores at baseline, indicating positive back beliefs, were weakly associated with lower LBP intensity at follow-up in both unadjusted and adjusted analyses (Table 2).

The coefficient of the interaction between BBQ and LBP intensity over time denotes the additional reduction in LBP intensity for each additional point on the BBQ scale. This means that if two participants are alike on all parameters except that one scores 10 points higher on the BBQ at baseline, then that patient would be expected to have an additional reduction in LBP intensity at 13 weeks of -0.3 points (10 x-0.03 (13-week coefficient)) compared to the other participant.

The association between quartiles of BBQ at baseline and LBP intensity at follow-up indicated higher reduction of LBP intensity for patients with the most positive beliefs compared to those with more negative beliefs (Figure 2).

Associations between BBQ at baseline and disability at follow-up were weak and had large p-values (Table 2). The association is visualized in a marginsplot in Figure 3.

TABLE 2
Association between back beliefs at baseline and LBP intensity and disability at follow-up

	Unadjusted			Adjusted		
LBP Intensity (NRS)	Coefficient	*p*	95% CI	Coefficient	*p*	95% CI
Follow-up time point						
2 weeks	-2.50	<0.001	-3.15; -1.86	-2.34	<0.001	-3.01; -1.76
13 weeks	-3.52	<0.001	-4.18; -2.87	-3.43	<0.001	-4.07; -2.79
52 weeks	-3.39	<0.001	-4.06; -2.71	-3.27	<0.001	-3.93; -2.61
BBQ	-0.04	<0.001	-0.06; -0.03	-0.03	<0.001	-0.04; -0.01
Interaction between BBQ and follow up time point						
2 weeks	-0.01	0.148	-0.03; -0.01	-0.02	0.061	-0.04; -0.001
13 weeks	-0.03	0.011	-0.05; -0.01	-0.03	0.004	-0.05; -0.01
52 weeks	-0.03	0.004	-0.05; -0.01	-0.03	0.001	-0.05; -0.01
Interaction term		0.014			0.003	
DISABILITY (RMDQ)	Unadjusted			Adjusted		
	Coefficient	*p*	95% CI	Coefficient	*p*	95% CI
Follow-up time point						
2 weeks	-23.92	<0.001	-30.19; -17.65	-24.13	<0.001	-30.14; -18.12
13 weeks	-34.45	<0.001	-41.08; -27.81	-33.87	<0.001	-40.21; -27.53
52 weeks	-37.38	<0.001	-44.53; -30.22	-37.54	<0.001	-44.36; -30.72
BBQ	-1.05	<0.001	-1.2; -0.9	-0.48	<0.001	-0.61; -0.35
Interaction between BBQ and follow up time point						
2 weeks	-0.02	0.802	-0.21; 0.17	-0.03	0.760	-0.21; 0.15
13 weeks	-0.02	0.839	-0.22; 0.18	-0.05	0.604	-0.24; 0.14
52 weeks	0.09	0.393	-0.12; 0.31	0.08	0.449	-0.13; 0.28
Interaction term		0.7			0.7	

Adjusted analyses were controlled for: age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment
Coefficients for the interaction between BBQ and time explain additional changes in LBP intensity or RMDQ scores accounting for the increase of one point on the BBQ score compared to a BBQ score of 9
BBQ: Back Belief Questionnaire, CI: Confidence Interval, LBP: Low Back Pain, RMDQ: Roland Morris Disability Questionnaire,

-----Insert Figure 2 here-----

-----Insert Figure 3 here-----

The association between BBQ -scores and LBP intensity and disability stratified by LBP history

Dividing the populations into groups based on episode duration and number of previous episodes ('Acute new' n=209, 'Acute episodic' n=932, 'Subacute' n=615 and 'Long-lasting' n=473) did not show any substantial difference between the groups in the associations between BBQ at baseline and LBP intensity or disability at follow-up. The results are shown in Supplementary File 2.

TABLE 3
Single item association with LBP intensity or disability at 13 weeks

	LBP INTENSITY				DISABILITY			
Item	Coefficient	*p*	95% CI		Coefficient	*p*	95% CI	
1) There is no real treatment for back trouble.	-0.08	0.184	-0.21;	0.04	-0.80	0.230	-2.12;	0.51
2) Back trouble will eventually stop you from working.	0.07	0.155	-0.03;	0.17	0.12	0.816	-0.9;	1.14
3) Back trouble means periods of pain for the rest of one's life.	-0.31	<0.001	-0.41;	-0.2	-2.55	<0.001	-3.66;	-1.44
4) Doctors cannot do anything for back trouble.	-0.01	0.913	-0.10;	0.09	-0.24	0.649	-1.27;	0.79
5) A bad back should be exercised.	-0.12	0.051	-0.24;	0.001	-0.87	0.180	-2.14;	0.40
6) Back trouble makes everything in life worse.	-0.04	0.423	-0.13;	0.05	-1.05	0.031	-2.01;	-0.09
7) Surgery is the most effective	0.05	0.426	-0.07;	0.18	0.07	0.918	-1.25;	1.39

The association between single items on the BBQ and LBP intensity and disability at 13 weeks

Higher scores on an item (more positive beliefs on a scale from 1 to 5) were generally associated with slightly lower LBP intensity and disability scores at 13 weeks (Table 3).

Item 3 "*Back trouble means periods of pain for the rest of one's life*" had the strongest association with a reduction in both LBP intensity and disability at 13 weeks. For LBP intensity, the coefficient was -0.29 (95% CI -0.4; -0.19, *p*=<0.001) and for disability, -2.42 (95% CI -3.52; -1.33, *p*=<0.001).

For LBP intensity, the second strongest association was with item 11 "*Medication is the only way of relieving back trouble*" (coef. -0.16, 95% CI -0.28; -0.04, *p*=<0.007). For disability, the second strongest association was with item 9 "*Alternative treatments are the answer to back trouble*" (-1.31, 95% CI -2.36; -0.26, *p*=0.015) (Table 3).

way to treat back trouble.								
8) Back trouble may mean you end up in a wheelchair.	-0.03	0.489	-0.12;	0.06	-0.48	0.310	-1.41;	0.45
9) Alternative treatments are the answer for back trouble.	-0.05	0.288	-0.15;	0.05	-1.62	0.003	-2.68;	-0.56
10) Back trouble means long periods of time off work.	-0.04	0.448	-0.16;	0.07	-0.19	0.764	-1.41;	1.04
11) Medication is the only way of relieving back trouble.	-0.15	0.013	-0.27;	-0.03	-0.65	0.312	-1,91;	0.61
12) Once you have had back trouble there is always a weakness.	-0.04	0.495	-0.14;	0.07	-0.73	0.187	-1.81;	0.35
13) Back trouble must be rested.	0.04	0.506	-0.07;	0.14	-0.74	0.196	-1.87;	0.38
14) Later in life back trouble gets progressively worse.	-0.13	0.029	-0.24;	-0.01	-0.62	0.314	-1.83;	0.59

Score ranges from 1 to 5. With higher scores indicating positive beliefs (disagreeing with the statement), except item 5 where higher scores indicate agreeing with the statement.
Linear multivariate regression analysis adjusted for: age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment
BBQ: Back Belief Questionnaire, CI: Confidence Interval

When removing one item at a time from the model, the reduction in R^2 was low for all items. Item 3 showed the greatest reduction in R^2 accounting for 1.5% of the explained variance in the association with LBP intensity and 1% in the association with disability. Among the other items, the variance explained ranged from 0% to 0.35%.

Discussion

Main findings

To our knowledge, this is the first study using longitudinal data to investigate if back beliefs, measured by the BBQ, are associated with LBP intensity and disability at follow-up in patients with LBP who consult a chiropractor. Overall, we found that more positive beliefs at baseline were associated with decreasing LBP intensity at follow-up. However, the coefficients were small, and thus might not be of clinical relevance. There was no certain association between back beliefs and disability outcomes. The associations were not substantially different between groups with different LBP history. Assessment of the individual BBQ items showed that the item *"Back trouble means periods of pain for the rest of one's life"* had the strongest association with a reduction in both disability and LBP intensity at 13 weeks.

Interpretation

The BBQ is designed to measure beliefs regarding negative consequences of LBP (20). Based on the Common-Sense Model (CSM) beliefs regarding consequences represents one particular type of health-beliefs. The CSM depicts how beliefs about LBP potentially affect disability as it explains how individuals respond to and manage health threats based on the way pain or stimuli related to illness is understood. The representation of health threats is described in five different domains: identity (what is this pain?), cause (what caused this pain?), consequence (what consequences will this pain have?), control (how can I control this pain?), and timeline (how long will this pain last?) (3, 4, 6, 27). It is our interpretation that the questions in BBQ, primarily reflect the consequence domain, yet not entirely. Our findings indicated that perceptions related to consequences are not strongly related to outcomes in this population, whereas one item related to timeline (*"Back trouble means periods of pain for the rest of one's life"*) had a noticeably stronger association with LBP intensity and disability at the 13-week follow-up compared to the other items. This might imply that recovery expectations are an important subdomain in the BBQ, which is in line with the finding from other studies reporting that recovery expectations are a predictor of prognosis for LBP (11).

The consequence domain was reported in a systematic review to be a prognostic factor for pain outcomes in people with musculoskeletal pain (9). The review investigated relationships of illness perceptions, pain intensity and disability in people with musculoskeletal pain. However, only two of the included studies focused on LBP in a longitudinal design and both these studies only investigated outcomes of disability (9). Nevertheless, both studies found maladaptive illness perceptions to be associated with worse outcomes regarding pain-related disability at follow-up, whereas our findings did not provide such evidence (28, 29). Similar to our findings, a prospective cohort study (2020) of people with acute LBP found that maladaptive illness perceptions measured by IPQ were predictive of pain but not disability at 12-weeks although the predictive value was low (30). The same trend was seen for musculoskeletal pain, where IPQ did not add substantially to the prediction of recovery (10). Similarly, a secondary analysis of a randomized controlled trial published in 2018 showed that high levels of fear-avoidance beliefs measured by the Fear-Avoidance Beliefs Questionnaire in patients with LBP were only weakly associated with worse outcomes in LBP and disability at 12 months, yet the association was much stronger for sick leave (31). However, both the IPQ and Fear-Avoidance Beliefs Questionnaire cover more domains than the BBQ and the results are therefore not directly comparable.

It is questionable as to whether the observed association between positive back beliefs and the reduction in LBP intensity is clinically relevant. There is not a generic meaningful minimal clinically important change for pain scores, as it is always content-specific (32, 33), but a change of 2 points on the NRS has been

proposed to be clinically significant in people with long-lasting LBP (34). In our study, a 10-points higher score on the BBQ translated into an expected additional reduction in LBP intensity of 0.3 points which we doubt to be clinically relevant. However, as LBP is complex and many factors are considered important contributors, it is unlikely that the BBQ score would be able to independently predict future LBP intensity with high precision in a one-size-fits-all model. BBQ scores were generally high (mean BBQ sum-score=32) indicating overall positive beliefs, and more important associations can perhaps be demonstrated in populations with a larger variation in back beliefs.

Overall beliefs about LBP seem to be associated with pain intensity and disability at a cross-sectional level, but the longitudinal relationship remains unclear (8, 9, 11-15). Due to only weak associations between beliefs and reduction of LBP intensity, and uncertainty regarding the domains of beliefs measured, the BBQ does not seem suitable for predicting or explaining the course of LBP in our setting. However, based on the cross-sectional association, and as other domains of beliefs could be relevant to patients with LBP, we still encourage clinicians to address beliefs with their patients preferably using an individual approach.

In our sample, the associations between back beliefs and LBP intensity and disability were not influenced by the number of previous pain episodes and the duration of pain. This finding contradicts the theory that the association between beliefs and disability is most relevant for those with persistent pain (16). This is important as it implies that the decision to discuss beliefs with a patient, should not be based on the duration of pain or number of previous LBP episodes.

Limitations

As discussed previously, BBQ focuses on the consequence domain of beliefs. For a more thorough investigation of the association between beliefs and clinical outcomes, the use of different questionnaires could add information on beliefs from other domains, and thereby give a broader perspective on potential associations.

Before conducting the primary analyses, the construct validity and scale reliability of the BBQ was evaluated. The internal consistency and scale reliability was considered acceptable, and in line with other studies (20, 21, 24). However, other studies have found the BBQ to be unidimensional, although the fit of item 1 has been questioned, which we could not confirm (22-24). When interpreting the results, it should therefore be kept in mind that it is unclear what constructs the BBQ sum score represents in this sample. Another consideration is that the BBQ might be outdated as it was created in 1996 and a lot has happened in the field of LBP since then and perhaps in the public perception of LBP. This may explain why a questionnaire from 2014, the Back Pain Attitudes Questionnaire, which was developed based on in-depth

interviews with people experiencing LBP, asks questions very different from those of BBQ (35). For future studies investigating beliefs about LBP, we recommend researchers carefully consider the suitability of the different instruments.

This study did not account for the treatments the patients received from the chiropractor (e.g., advice, education, exercise, manual therapy), and it is unknown to what extent beliefs were discussed and addressed as part of treatment in a way that potentially affected outcomes. This could have blurred an otherwise stronger association than observed. However, BBQ sum scores were previously observed to be relatively constant over time in this sample, suggesting that negative beliefs were not effectively changed after initiating care (19).

In this study we explored the prognostic effect of baseline beliefs. In addition, it would be relevant investigating if changes in beliefs as a result of a health care consultation mediates treatment effects. However, our sample would not be very suitable for this purpose as beliefs were generally positive at baseline, and optimally it would require a randomized design.

Generalizability

Data were collected from a limited number of chiropractic clinics in Denmark, yet we have no reason to believe that data were not representative of Danish chiropractic clinics in general. Demographic baseline data were similar to a previous Danish chiropractic cohort based on a national sample (36). However, a population of patients consulting a chiropractor cannot be fairly compared to other patients in primary care (36). Further, the study sample's overall positive beliefs with a mean BBQ sum score of 32 differs from the findings from a systematic review that found the majority of mean BBQ sum scores in the general population were below 27 (8). Also, a recent study from 2021 exploring back beliefs in the general population reported a mean BBQ sum score of 27 (37).

Conclusion

Positive beliefs regarding LBP at baseline, measured by the BBQ, were weakly associated with a reduction in LBP intensity but not disability at the 2-, 13- and 52-week follow-ups in people with LBP seeking chiropractic care. Whether the association with LBP intensity was clinically relevant is questionable. The BBQ is therefore not promising for predicting or explaining the course of LBP in this setting. Future research should focus on exploring the associations between beliefs and clinical outcomes in different patient populations and with instruments covering all pain belief domains or more unambiguously covering a single domain.

Figure legends

Figure 1:

Heading: Flowchart of the study population

Explanatory text: Partly completed data on BBQ or RMDQ were filled out using chained multiple imputation

Abbreviations: BBQ: Back Belief Questionnaire, RMDQ: Roland Morris Disability Questionnaire, LBP: Low Back Pain

Figure 2:

Heading: Marginsplot of the associations between quartiles of BBQ scores at baseline and LBP intensity at follow-up

Explanatory text: The association between quartiles of BBQ scores at baseline and LBP intensity at follow-up had a *p*-value of 0.0030

Figure 3:

Heading: Marginsplot of the associations between baseline quartiles of BBQ scores at baseline and disability at follow-up

Explanatory text: The association between quartiles of BBQ scores at baseline and RMDQ scores at follow-up had a *p*-value of 0.1071

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Competing interest

The authors report the following potential conflict of interest: AK's position at the University of Southern Denmark is financially supported by an unrestricted grant from the Danish Foundation for Chiropractic Research and Postgraduate Education. The funders were not involved in defining the research question, designing the study, analyzing the data, or interpreting the results.

Author Contributions

SG conceived and planned the project, performed analysis of the data and interpretation of the results, and wrote the initial draft of the manuscript. AK made substantial contributions to study design, data analysis, interpretation of results and revised and improved the manuscript. RKJ made substantial contribution to the study design, interpretation of results and revision of the manuscript. All authors have read and approved the final manuscript.

Data availability statement

Data used and analyzed in the current study are available from the corresponding author on reasonable request. If interested in using data from the ChiCo cohort for other research projects, the Chiropractic Knowledge Hub should be contacted directly.

Ethic statement

Patient consent for publication

Not required

Ethics approval

The Health Research Ethics Committee for Southern Denmark determined (S-20,162,000-109) that the Danish Chiropractic Low Back Pain Cohort did not require ethical approval according to Danish regulations.

Abbreviations

BBQ: Back Belief Questionnaire; ChiCo: Danish Chiropractic low back pain Cohort; CI: Confidence Interval; Illness Perception Questionnaire; LBP: Low Back Pain; LOWESS: Locally Weighted Scatterplot Smoothing; MCID: Minimal Clinically Important Difference; NRS: Numerical Rating Scale; OPEN: The Odense Patient Explorative Network; REDCap: Research Electronic Data Capture; RMDQ: Roland-Morris Disability Questionnaire; SD: Standard Deviation; STROBE: Strengthening the Reporting of Observational studies in Epidemiology.

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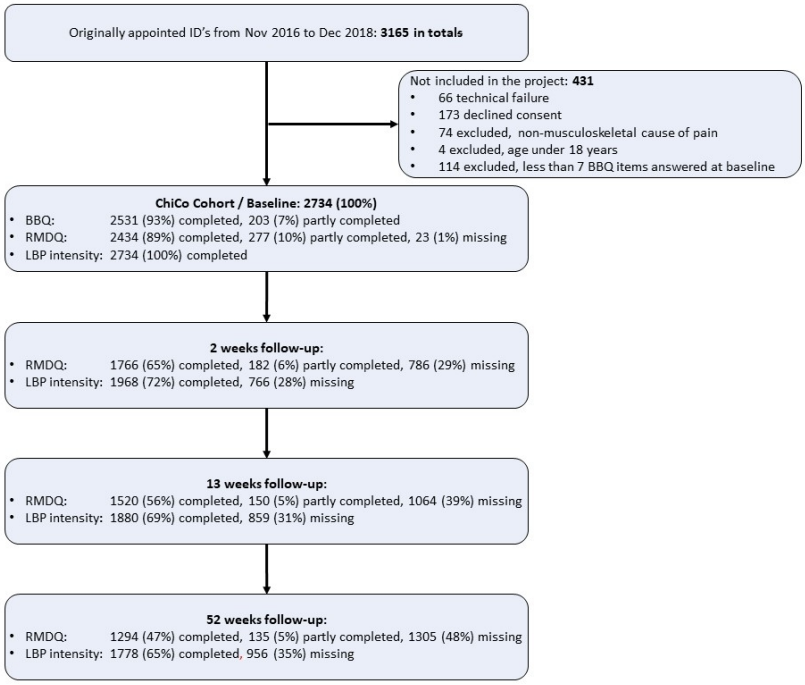

Flowchart of the study population

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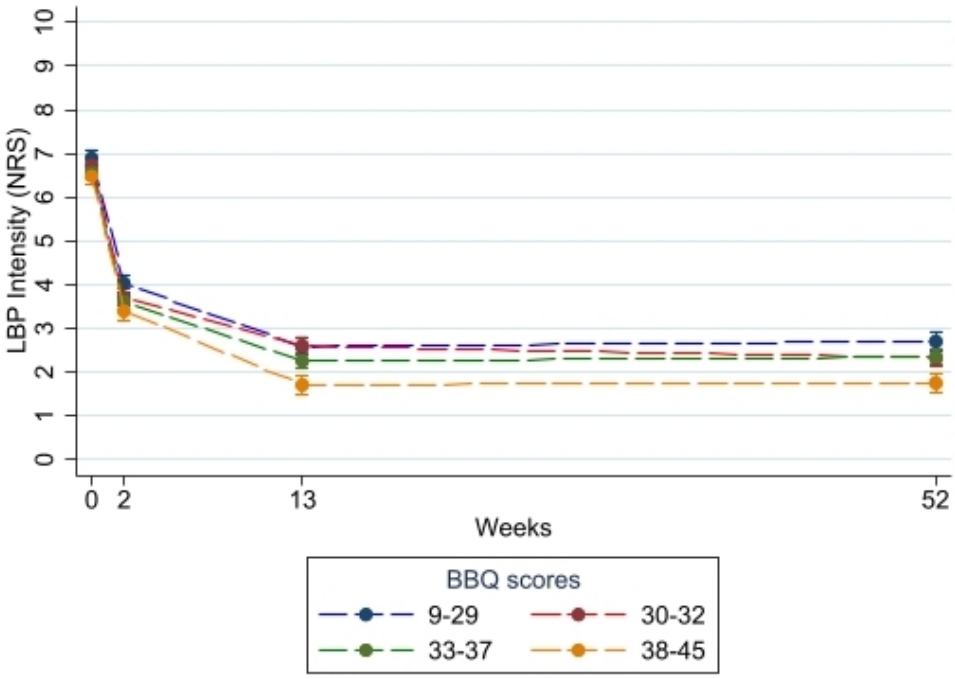
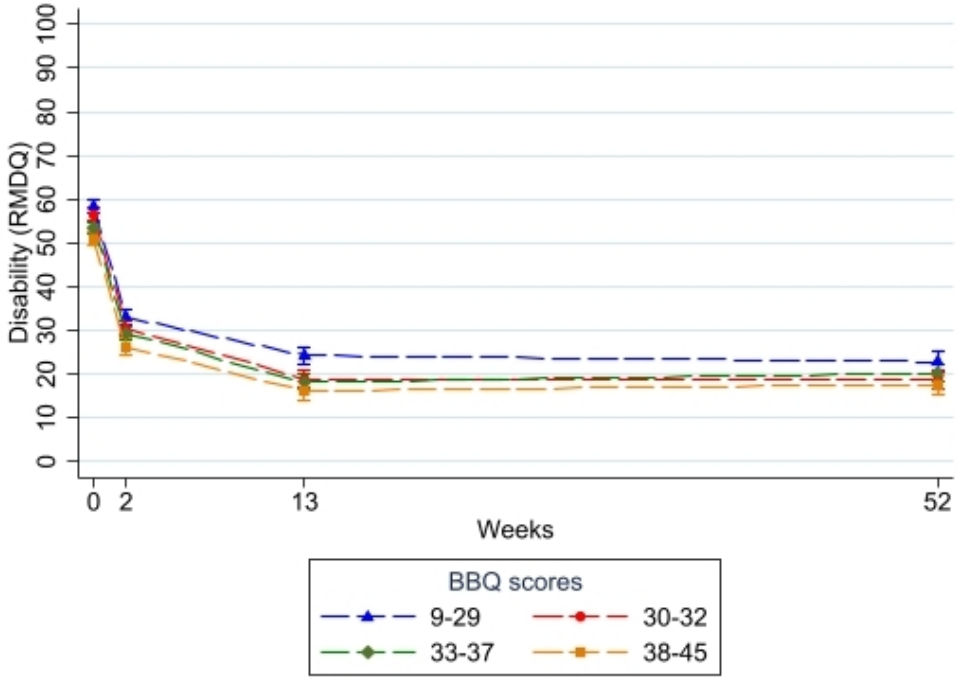


Marginsplot of the associations between quartiles of BBQ scores at baseline and LBP intensity at follow-up

139x101mm (96 x 96 DPI)



Marginsplot of the associations between baseline quartiles of BBQ scores at baseline and disability at follow-up

139x101mm (96 x 96 DPI)

Supplemental file 1 - Construct validity and scale reliability

Before conducting the primary analyses, we performed analyses on the Danish version of the BBQ to test construct validity and scale reliability. Tests were performed on the baseline population consisting only of those who had completed the BBQ (n=2531). Cronbach's alpha was used to measure internal consistency and scale reliability and showed a total alpha score of 0.77 which is considered acceptable (Table 1). Factor analysis was conducted to test if the BBQ was unidimensional (only measuring one construct as intended). The factor analysis was conducted similar to Bostick et al. (1) by first performing an Explorative factor analysis based on eigenvalues from a principal component analysis (PCA). Thereafter we performed a confirmatory factor analysis based on the results. However, the results did not support a unidimensional model and the first component of the PCA only explained 26 % of the variance. Results of the PCA and factor analyses can be found in table 2a,2b,3a and 3b, for a scree plot of eigenvalues see figure 1.

Because BBQ did not seem unidimensional, six different subscales were created and explored, and each subscale was tested for goodness of fit using a maximum likelihood approach. The subscales were: 1) the original score and 2) the original score including distractor items. Then based on the PCA we created 3) a subscale by removing item 5 and 9 because these had the lowest correlation to the first component in the PCA and a low item-rest correlation. Lastly, we used simple face validity to create three subscales based on the domains the items seemed to cover: 4) a consequence domain (item 2,3,6,8,10,12,14), 5) a control domain (item 1, 4, 5, 7,9, 11, 13), and 6) an expectation domain (item 1, 2, 3, 4, 6, 8, 10, 12, 14). These were compared on their Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR) comparative fit index (CFI) and Chi^2 (table 4).

For each subscale the explained variance was compared. The explained variance was extracted from the random effect parameters in the mixed methods longitudinal regression analyses (score of the sub-scale and the interaction between the score and time as independent variable, and LBP intensity or RMDQ scores as dependent variable). To calculate the explained variance, we subtracted unexplained variance from a model without a BBQ-subscale (time as independent variable and pain or RMDQ-scores as dependent) from a model with a subscale. No subscale outperformed the other regarding either explained variance or goodness of fit, and we therefore decided to use the original BBQ-score (Table 4 and 5).

TABLE 1

Internal consistency and scale validity measured by Cronbach's alpha

Item	Obs	Sign	Item-test correlation	Item-rest correlation	Average interitem covariance	alpha
BBQ1	2531	+	0.5150	0.4141	0.2236376	0.7505
BBQ 2	2531	+	0.6186	0.4984	0.2042338	0.7401
BBQ 3	2531	+	0.6198	0.5086	0.2064069	0.7394
BBQ 4	2531	+	0.5404	0.4139	0.2151883	0.7496
BBQ 5	2531	-	0.2231	0.1107	0.2500912	0.7737
BBQ 6	2531	+	0.5254	0.3903	0.2158778	0.7523
BBQ 7	2531	+	0.4567	0.3553	0.2299497	0.7555
BBQ 8	2531	+	0.4547	0.3086	0.2242917	0.7612
BBQ 9	2531	+	0.2907	0.1615	0.2438508	0.7720
BBQ 10	2531	+	0.6117	0.5122	0.2110727	0.7404
BBQ 11	2531	+	0.4693	0.3642	0.2279814	0.7547
BBQ 12	2531	+	0.5575	0.4397	0.2144444	0.7469
BBQ 13	2531	+	0.4749	0.3551	0.2249277	0.7553
BBQ 14	2531	+	0.5578	0.4548	0.2178	0.7463
Test scale					0.2221253	0.7666

TABLE 2a

Eigenvalues of principal component analysis on the BBQ items

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	3.63131	2.34124	0.2594	0.2594
Comp2	1.29007	0.138269	0.0921	0.3515
Comp3	1.1518	0.128742	0.0823	0.4338
Comp4	1.02306	0.0483555	0.0731	0.5069
Comp5	0.974706	0.131495	0.0696	0.5765
Comp6	0.843212	0.037967	0.0602	0.6367
Comp7	0.805245	0.0462409	0.0575	0.6942
Comp8	0.759004	0.0619936	0.0542	0.7485
Comp9	0.69701	0.0834449	0.0498	0.7982
Comp10	0.613565	0.0121034	0.0438	0.8421
Comp11	0.601462	0.018122	0.0430	0.8850
Comp12	0.58334	0.0432221	0.0417	0.9267
Comp13	0.540118	0.0540251	0.0386	0.9653
Comp14	0.486093	.	0.0347	1.0000

TABLE 2b Eigenvectors

Loading of individual items on components

Item	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7	Comp8	Comp9	Comp 10	Comp 11	Comp 12	Comp 13	Comp 14	Unexplained
BBQ1	0.2838	-0.4219	0.1169	-0.1238	0.0267	-0.0704	0.2928	-0.1954	0.1624	0.1682	0.2213	0.6832	0.0402	0.1045	0
BBQ 2	0.3288	0.0826	0.0477	-0.3702	0.1163	0.0299	-0.0240	-0.3759	0.0155	0.5127	0.2269	0.0206	0.3879	0.3521	0
BBQ 3	0.3406	-0.2507	0.2497	-0.0748	-0.1480	-0.2252	0.0257	-0.0222	0.0320	0.0490	0.2869	0.3854	0.0933	0.6607	0
BBQ 4	0.2835	-0.4162	0.2556	-0.0715	0.2303	0.1693	-0.0387	-0.0294	0.1320	0.2889	0.0820	0.4322	0.3187	0.4427	0
BBQ 5	-0.0852	0.3240	0.5973	0.1027	-0.2102	0.2509	0.5973	0.0023	0.0899	0.1288	0.0531	0.0397	0.1494	0.0711	0
BBQ 6	0.2701	0.2558	0.1726	-0.1123	0.0885	0.6410	-0.2895	0.1618	0.0634	0.2706	0.1793	0.1008	0.3309	0.2480	0
BBQ 7	0.2436	-0.0268	-0.4483	-0.0383	-0.0987	0.1201	0.5263	0.2213	0.6155	0.0166	0.0071	0.0462	0.0722	0.0297	0
BBQ 8	0.2187	0.4125	-0.0689	-0.3510	0.1451	-0.4325	0.2205	0.2576	0.3204	0.4198	0.0411	0.1230	0.1242	0.1405	0
BBQ 9	0.1145	0.1192	0.1329	0.4850	0.7882	-0.1572	0.1012	0.0547	0.1288	0.1184	0.0704	0.0844	0.0603	0.1194	0
BBQ 10	0.3284	0.3261	-0.1041	-0.2213	0.0547	0.0288	-0.1928	0.0429	0.0316	0.2612	0.0201	0.1473	0.7514	0.1652	0

BBQ 11	0.2464	-0.1290	-0.4109	0.2858	0.0193	0.3344	0.1805	0.0894	0.6546	0.2109	0.0707	0.2033	0.0005	0.0091	0
BBQ 12	0.3015	-0.0803	0.1339	0.2967	-0.2912	-0.0893	-0.2108	0.5152	0.0047	0.0041	0.4590	0.2926	0.0499	0.3087	0
BBQ 13	0.2467	0.2833	-0.1689	0.3878	-0.1983	-0.0014	-0.0232	-0.6320	0.0533	0.4216	0.2361	0.0032	0.0521	0.0403	0
BBQ 14	0.3070	0.1177	0.1424	0.2912	-0.2814	-0.3067	-0.1427	-0.0021	0.1114	0.2285	0.7050	0.1130	0.1088	0.0833	0

Figure 1
Screeplot of eigenvalues after principal component analysis of the BBQ items

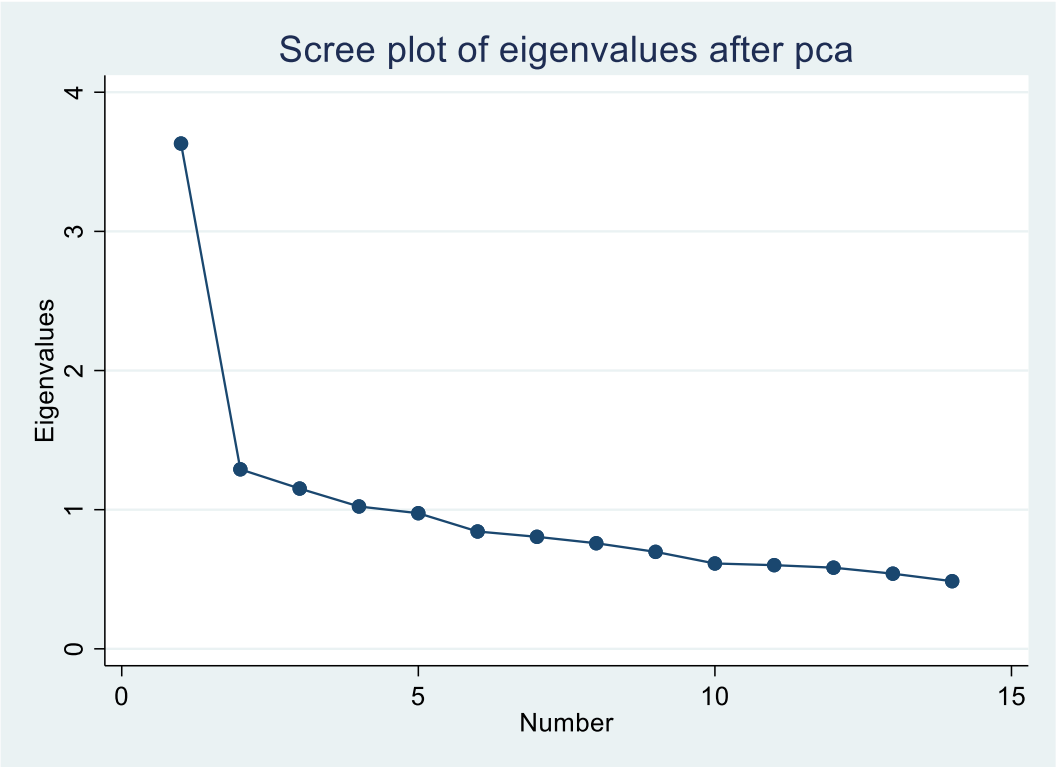


TABLE 3a
Rotated factor loadings

Item	Factor1	Factor2	Factor3	Factor4	Uniqueness
BBQ1	**0.7148**	0.0757	0.0102	0.1914	0.4465
BBQ 2	0.3986	**0.6153**	0.0097	0.0814	0.4558
BBQ 3	**0.7109**	0.2200	0.1600	0.0210	0.4202
BBQ 4	**0.7668**	0.0401	0.0569	0.0541	0.4042
BBQ 5	-0.0795	0.0295	**0.1221**	-0.7493	0.4164
BBQ 6	0.2257	**0.5214**	0.2330	-0.1393	0.6035
BBQ 7	0.1090	0.3040	0.1735	**0.5612**	0.5506
BBQ 8	-0.0295	**0.7228**	0.0362	0.0102	0.4753
BBQ 9	0.0465	-0.0660	**0.5516**	-0.1269	0.6731
BBQ 10	0.1312	**0.7151**	0.2147	0.1295	0.4086

BBQ 11	0.1625	0.0567	0.4155	**0.5637**	0.4800
BBQ 12	0.4391	0.1025	**0.4939**	0.0427	0.5510
BBQ 13	-0.0421	0.2694	**0.6403**	0.1640	0.4888
BBQ 14	0.3050	0.2486	**0.5601**	-0.0417	0.5297

Bold indicates the highest factor loading for each item

TABLE 3b Factor rotation matrix

	Factor1	Factor2	Factor3	Factor4
Factor1	0.6220	0.5749	0.4692	0.2499
Factor2	-0.6454	0.6122	0.2923	-0.3509
Factor3	0.4247	-0.0726	0.0065	-0.9024
Factor4	-0.1272	-0.5379	0.8333	-0.0105

TABLE 4
Comparison of subscales based on Goodness of fit

Subscale	RMSEA	SRMR	CFI	Chi^2	Alpha
1)Original score	0.088	0.053	0.859	555.00	0.7478
2) Full score	0.075	0.054	0.801	1176.37	0.7666
3) score without item 5 and 9	0.083	0.057	0.820	1002.15	0.7800
4) Consequence domain	0.097	0.052	0.883	344.14	0.7213
5) Control domain	0.080	0.049	0.813	241.45	0.5395
6) Expectations domain	0.102	0.063	0.828	736.53	0.7559

Items in subscales: 1) 1,2,3,6,8,10,12,13,14; 2) 1,2,3,4,5,6,7,8,9,10,11,12,13,14; 3) 1,2,3,4,6,7,8,10,11,12,13,14; 4) 2,3,6,8,10,12,14; 5) 1, 4, 5, 7,9, 11, 13; 6) 1, 2, 3, 4, 6, 8, 10, 12, 14
RMSEA: Root Mean Square Error of Approximation
SRMR: Standardized Root Mean Square Residual
CFI: comparative fit index

TABLE 5
Explained variance of subscale

Subscale	Pain unadjusted	Pain adjusted	RMDQ unadjusted	RMDQ adjusted
1)Original score	1.48%	1.24%	3.87%	1.59%
2) Full score	1.54%	1.27%	3.95%	1.71%
3) score without item 5 and 9	1.5%	1.27%	3.99%	1.68%
4) Consequence domain	1.34%	1.12%	3.53%	1.47%
5) Control domain	0.96%	0.73%	2.26%	0.99%
6) Expectations domain	1.47%	1.32%	3.60%	1.65%

Items in subscales: 1) 1,2,3,6,8,10,12,13,14; 2) 1,2,3,4,5,6,7,8,9,10,11,12,13,14; 3) 1,2,3,4,6,7,8,10,11,12,13,14; 4) 2,3,6,8,10,12,14; 5) 1, 4, 5, 7,9, 11, 13; 6) 1, 2, 3, 4, 6, 8, 10, 12, 14
Adjusted analyses were controlled for: age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment

References

1. Bostick GP, Schopflocher D, Gross DP. Validity evidence for the back beliefs questionnaire in the general population. European journal of pain (London, England). 2013;17(7):1074-81.

Supplemental file 2

Association between BBQ scores at baseline and LBP intensity and disability at 2, 13 and 52 weeks stratified by LBP history

	Acute new (n=209)			Acute episodic (n=932)			Sub acute (n=615)			Persistent (n=473)		
LBP intensity (NRS)												
	Coefficient	*p*	95%CI	Coefficient	*p*	95%CI	Coefficient	*p*	95%CI	Coefficient	*p*	95%CI
Time												
2 weeks	-3.82	<0.001	-5.75 -1.89	-2.76	<0.001	-3.76 -1.76	-2.26	0.001	-3.55 -0.97	-2.04	0.104	-2.35 0.34
13 weeks	-4.58	<0.001	-6.65 -2.52	-3.59	<0.001	-4.62 -2.57	-3.64	<0.001	-4.96 -2.32	-1.80	0.009	-3.17 -0.44
52 weeks	-6.73	<0.001	-8.8 -4.67	-3.48	<0.001	-4.53 -2.43	-3.12	<0.001	-4.45 -1.8	-1.73	0.024	-3.22 -0.23
BBQ	-0.02	0.407	-0.06 0.02	-0.02	0.153	-0.04 0.01	-0.02	0.082	-0.05 0.003	-0.04	0.009	-0.07 -0.01
Interaction between BBQ and time												
2 weeks	-0.01	0.686	-0.07 0.05	-0.03	0.087	-0.06 0.004	0.002	0.919	-0.04 0.04	-0.02	0.330	-0.06 0.02
13 weeks	-0.04	0.223	-0.1 0.02	-0.05	0.002	-0.08 -0.02	0.01	0.753	-0.03 0.05	-0.02	0.342	-0.06 0.02
52 weeks	0.03	0.334	-0.03 0.09	-0.05	0.001	-0.09 -0.02	-0.01	0.580	-0.05 0.03	-0.02	0.329	-0.07 0.02
Interaction term		0.2262			0.0025			0.8756			0.6618	
DISABILITY (RMDQ)												
Time												
2 weeks	-38.65	<0.001	-58.85 -18.44	-34.47	<0.001	-44.33 -24.60	-18.83	0.002	-30.52 -7.13	-2.08	0.722	-13.51 9.36
13 weeks	-49.42	<0.001	-71.46 -27.38	-44.11	<0.001	-54.47 -33.76	-34.83	<0.001	-47.1 -22.56	-16.21	0.009	-28.41 -4.0
52 weeks	-47.51	<0.001	-70.78 -24.24	-46.19	<0.001	-57.07 -35.31	-40.62	<0.001	-53.65 -27.6	-3.88	0.590	-17.97 10.22
BBQ	-0.35	0.127	-0.81 0.10	-0.56	<0.001	-0.79 -0.34	-0.41	0.001	-0.67 -0.16	-0.4	0.002	-0.65 -0.15
Interaction between BBQ and time												
2 weeks	0.05	0.875	-0.55 0.65	0.07	0.635	-0.23 0.37	0.07	0.696	-0.28 0.42	0.29	0.110	-0.64 0.07
13 weeks	-0.07	0.838	-0.71 0.58	0.02	0.912	-0.3 0.33	0.22	0.235	-0.14 0.59	0.02	0.912	-0.36 0.4
52 weeks	-0.01	0.983	-0.69 0.67	0.1	0.554	-0.23 0.43	0.43	0.031	0.04 0.82	0.35	0.114	-0.78 0.08
Interaction term		0.9895			0.9258			0.1571			0.1792	

BBQ: Back Belief Questionnaire, CI: Confidence Interval, LBP: Low Back Pain, RMDQ: Roland Morris Disability Questionnaire
Analyses were controlled for age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6*
Bias	9	Describe any efforts to address potential sources of bias	5 "setting and procedures"
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8 and figure 1
		(b) Give reasons for non-participation at each stage	Figure 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8 and table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1 + figure 1
		(c) Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
		(*b*) Report category boundaries when continuous variables were categorized	Figure 2 +3
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Beliefs about back pain and associations with clinical outcomes: a primary care cohort study

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Beliefs about back pain and associations with clinical outcomes: a primary care cohort study

Søren Grøn[1], Rikke Krüger Jensen[1 2], Alice Kongsted [1 2]

1: Chiropractic Knowledge Hub, Campusvej 55, 5230 Odense M, Denmark
2: Department of Sports Science and Clinical Biomechanics, University of Southern Denmark, Campusvej 55, 5230 Odense M, Denmark.

Correspondence to Søren Grøn sgron@health.sdu.dk

Abstract

Objective: To investigate associations between beliefs about low back pain (LBP) at baseline and pain intensity and disability at 2-, 13- and 52-weeks follow-up.

Design: Observational cohort study.

Setting: Primary care private chiropractic clinics in Denmark.

Participants: A total of 2734 adults consulting a chiropractor for a new episode of LBP, with follow-up data available from 71%, 61% and 52% of the participants at 2, 13 and 52 weeks, respectively.

Outcome measures: Beliefs about LBP were measured by the Back Belief Questionnaire (BBQ) before consulting the chiropractor. Pain (Numerical Rating Scale 0-10) and disability (the Roland Morris Disability Questionnaire) were measured at baseline and after 2-, 13- and 52-weeks. Associations were explored using longitudinal linear mixed models estimating interactions between BBQ and time, and by estimating associations between single items of BBQ and 13 weeks outcomes.

Results: More positive beliefs about LBP were weakly associated with a reduction in pain at 2 weeks (β interaction BBQ#Time = -0.02 (95% CI -0.04; -0.001)), at 13 weeks -0.03 (95% CI -0.05; -0.01), and at 52 weeks follow-up, -0.03 (95% CI -0.05; -0.01) (p=0.003). For disability, the association was uncertain (p=0.7). The item "*Back trouble means periods of pain for the rest of one's life*" had the strongest association with both reduction in pain (-0.29, 95% CI -0.4; -0.19, p=<0.001) and disability (-2.42, 95% CI -3.52; -1.33, p=<0.001) at 13 weeks follow-up.

Conclusion: Positive beliefs regarding LBP, measured by the BBQ, were associated with a reduction in pain intensity at both short- and long-term follow-up. However, the association was weak, and the clinical relevance is therefore questionable. No clear association was demonstrated between beliefs and disability. This study did not show promise that back beliefs as measured by the BBQ were helpful for predicting or explaining the course of LBP in this setting.

Keywords:

Low back pain, beliefs, attitudes, health knowledge, primary care

Article Summary

Strengths and limitations of this study

- This longitudinal observational study was the largest cohort to date investigating beliefs about LBP (n=2,734)
- The cohort provided an opportunity to investigate associations in acute episodes of LBP as well as in long-lasting LBP.
- The BBQ is a widely used questionnaire that has previously shown good reliability but has not been tested in the Danish version, so we assessed its construct validity and scale reliability before conducting the primary analysis.
- The BBQ mainly measures beliefs regarding negative consequences of LBP, thus neglecting other potentially relevant aspects of beliefs.
- The cohort only consisted of chiropractic patients with generally positive beliefs and is thus not generalizable to all LBP patients.

Introduction

Low back pain (LBP) is a common condition that is mostly nonspecific, which means no single structure can be identified as the cause of the pain (1). Both biophysical, psychological, and social factors are recognized to contribute to pain perception and disability (2). Among these biopsychosocial factors, one aspect that is considered important in relation to both disability and recovery is what people think and believe about their back and LBP (3). This could involve beliefs that LBP is a sign of structural damage and, consequently, the back is fragile and needs protection. Such beliefs can affect the behavior of a person with LBP, and thereby influence recovery if a person adopts unhelpful behavior such as fear-avoidance behavior or over-protective behavior (3-7).

Multiple questionnaires have been developed to measure beliefs about pain and investigate the association between beliefs and LBP. A systematic review of back beliefs in the general population from 2018 found that negative beliefs, measured using the Back Belief Questionnaire (BBQ), were cross-sectionally associated with higher levels of pain and disability (8). Similarly, a systematic review from 2018 found a moderate level of evidence for a cross-sectional association between maladaptive illness perceptions, measured by the illness perception questionnaire (IPQ), and pain intensity and disability in patients with musculoskeletal pain(9). The evidence regarding the prognostic value of illness beliefs was inconclusive due to lack of longitudinal studies (9). However, a recent longitudinal study from 2021 found that the IPQ only added a small and non-substantial predictive value for poor recovery at 3 months in people with musculoskeletal pain (10). For recovery expectations as a prognostic factor for LBP, a Cochrane review from 2019 concluded that having positive expectations towards recovery might be associated with a reduction in pain and disability, although the evidence was of low quality (11). In general, there is evidence supporting a cross-sectional association between negative beliefs regarding LBP and higher levels of pain and disability. However, as longitudinal studies are few and of low quality and mostly investigate recovery expectations, the relationship between other aspects of beliefs and clinical outcomes over time is uncertain (8, 9, 11-15). Longitudinal studies can help to determine if specific beliefs are associated with clinical outcomes, which is relevant as beliefs are potentially modifiable and could therefore be targets for clinical interventions. It has been proposed that the association between psychological factors, such as beliefs, and long-term disability might be more relevant for those with persistent pain compared to those with subacute pain (16). A verification of this theory would be clinically relevant as it could help clinicians prioritize when to address beliefs.

The objectives of this study were therefore to investigate if back beliefs at baseline, measured by the BBQ, were associated with pain intensity and disability at the 2-, 13-, and 52 -week follow-ups in patients with

LBP who consulted a chiropractor, and whether the association differed according to pain duration. Also, we assessed if any items of the BBQ had a stronger association with pain intensity and disability at the 13-week follow-up compared to the other items.

Methods

Study design

This study was an observational cohort study based on data from The Danish Chiropractic Low Back Pain Cohort (ChiCo) (17). The study was reported according to the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) cohort reporting guidelines and a STROBE checklist has been completed (18).

Patient and public involvement

Patients were not involved in designing the study or interpreting the results.

Setting and procedures

Participants were recruited from 10 chiropractic clinics in Denmark between November 2016 and December 2018. At the initial visit to the chiropractor, the patient filled out a baseline questionnaire, divided into two parts. The first part included items that might be influenced by consulting the chiropractor and was therefore filled out before the initial consultation (Baseline 1). The second part was filled out after the initial consultation and included demographic and background data less likely to be influenced by the consultation (Baseline 2). Follow-up questionnaires were obtained at 2, 13 and 52 weeks after inclusion. Participants who did not respond to the follow-up questionnaires at 13 and 52 weeks received a phone call for a structured interview on a limited number of questions from the survey. Data were collected electronically and stored using the online system REDCap (Research Electronic Data Capture) hosted and supported by the Odense Patient data Explorative Network (OPEN). Further details on the data collection procedure have been described elsewhere (17), as have cross-sectional data from the BBQ in some of the study sample (19).

Participants

To be enrolled in the study, the patient needed to be 18 years of age or older, be seeking a consultation with the chiropractor with a new onset of LBP with or without leg pain, and be able to complete electronic questionnaires in Danish. A new onset of LBP was defined as a new or recurring LBP problem for which the

patient was not currently receiving treatment or long-term management. Patients referred for acute surgical assessment or patients with suspicion of pathology leading to referral for further diagnostic assessment were not enrolled in the study (17).

Variables

Primary measures

Beliefs about LBP were measured at Baseline 1, before consulting the chiropractor, using a Danish version of the BBQ. The BBQ consists of 14 statements regarding inevitable negative consequences of LBP that are scored on a 5-point Likert scale. Five statements are not included in the final score, and thus the score ranges from 9 to 45. The scores are reversed so that higher scores indicate positive beliefs (20). The translation process has been described in a previous paper (19). The questionnaire has been widely used in research and has previously been validated and translated into multiple languages, showing good test-retest reliability and demonstrating good construct validity (measuring only one construct) (21-25).

Disability was measured by the 23-item Danish version of the Roland-Morris Disability Questionnaire (RMDQ) (0-100, higher scores indicating higher levels of disability) (26), and LBP intensity on a Numerical Rating Scale (NRS) examining typical LBP intensity during the previous week (0 = no pain to 10 = worst imaginable pain) (24-25). Both disability and LBP intensity were measured at Baseline 1 (before the consultation), and at the 2-, 13-, and 52-week follow-ups. Only LBP intensity was part of the telephone interview with non-respondents.

Additional baseline variables

Baseline 1: Age and sex (derived from the patient's personal identification (social security) number); duration of current pain episode (1–2 days, 3–7 days, 1–2 weeks, 2–4 weeks, 1–3 months, 3–12 months, more than a year).

Baseline 2: Previous treatment for LBP (yes/no); previous episodes of LBP (none, 1, 2–3, more than 3); number of days with LBP last year (≤30 days, > 30 days).

Statistical methods

Missing responses on the BBQ and previous treatment for LBP were imputed using chained multiple imputations. For BBQ, we excluded participants who answered 6 or fewer items at baseline, and then used imputation for the remaining incomplete questionnaires. For both BBQ and previous treatment for LBP, the imputations were informed by age, sex, RMDQ scores, LBP intensity at baseline, duration of current pain

episode, previous treatment, and number of days with pain last year. Multiple imputations of missing RMDQ sum scores were performed as part of the standard preparation of ChiCo cohort data (17).

Construct validity and scale reliability

Before conducting the analyses, we tested the construct validity and scale reliability of the Danish version of the BBQ. The scale showed acceptable reliability (Cronbach's alpha= 0.77), but our findings did not support a unidimensional structure of the scale. However, as we were unable to detect a better factor structure of the scale, we decided to use the scale as originally intended and as it had been applied in previous studies. The process is described in Supplemental File 1.

Data analysis

Baseline characteristics were presented as means with standard deviations (SD) or proportions.

To estimate associations between BBQ and outcomes, we used a linear mixed model with random intercept (taking repeated measures into account) to conduct longitudinal regression analysis with baseline BBQ score, follow-up time point (categorical), and the interaction between the BBQ score and follow-up time point as independent variables. This model was used for both LBP intensity and RMDQ score as the dependent outcome variable. We performed unadjusted analyses and adjusted analyses controlling for age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment. Variables controlled for were chosen as they have been shown in a previous study on the same population to be associated with baseline BBQ scores (19). Results were presented as coefficients with p-values and 95 % confidence intervals. P-values for the interaction term were based on ANOVA tests using the 'contrast' command in STATA. A linear relationship was assumed between baseline BBQ and both LBP intensity and RMDQ score at follow-up, based on inspection of a Locally Weighted Scatterplot Smoothing (LOWESS) plot. For visualization of the findings, the adjusted analyses were repeated with BBQ scores divided into quartiles, which were used to create a marginsplot for the association. The quartiles of BBQ scores had the following division: scores from 9-29 (n=846), 28-32 (n=525), 33-37 (n=823) and 38-45 (n=540). Results were presented as regression coefficients with 95% confidence intervals and p-values.

To investigate if the association differed according to pain duration, the analyses with the outcomes on the original scales were repeated, stratified on the following four groups categorized by duration of the current episode and number of previous LBP episodes: Group 1 (Acute new): Onset within 2 weeks and no previous LBP episodes; Group 2 (Acute episodic): Onset within 2 weeks but with one or more previous LBP episodes; Group 3 (Subacute): Pain for more than 2 weeks but less than 3 months; and Group 4 (Long-lasting): Pain for more than 3 months.

To explore the association between single items of the BBQ and LBP intensity and RMDQ, we performed a linear regression analysis with LBP intensity or RMDQ at the 13-week follow-up as the dependent variable and each BBQ item at baseline as independent variables, controlling for age, sex, baseline LBP intensity, baseline RMDQ-score and previous treatment. The 13-week follow-up was chosen based on inspection of the overall change in LBP intensity and disability at follow-up, as most of the change had occurred by 13 weeks. All items were included in one model for each outcome and results were presented as regression coefficients with 95% confidence intervals and p-values. Variance inflation factors (VIF) were calculated to check the influence on estimates from multicollinearity. With LBP intensity as the dependent variable, the mean VIF was 1.28 (range 1.06 to 1.57) and with RMDQ score as the dependent variable, the mean VIF was 1.27 (range 1.06 to 1.56). Thus, both models indicated no sign of multicollinearity.

The impact of single items on the amount of variance explained was explored by noting the reduction in the R^2-value obtained from the linear regression model with a single item removed from the model at a time compared to a model with all items.

All analyses were performed using Stata/MP 16 (StataCorp LLC, TX 77845, USA).

Results

A total of 3165 participants were included in the ChiCo cohort and, of those, 2734 were included in the current study (Figure 1). Mean age was 44 years and 41% were female. The mean baseline score of LBP intensity was 6.7 and the mean RMDQ score was 55 (Table 1). Follow-up data on LBP intensity were available for 72%, 69% and 65% (at 2, 13, 52 weeks respectively) of the participants, and data on disability were available for 71%, 61% and 52% (at 2, 13, 52 weeks respectively) (Figure 1). Baseline characteristics were similar regarding pain intensity, RMDQ scores and BBQ scores between participants who completed the 52-week follow up and those who were lost to follow-up, but those not completing the follow-up were younger than those who did (Table 1).

TABLE 1
Characteristics of study population

	Baseline (n=2734)	52 weeks drop out [a] (n=952)	52 weeks completed (n=1782)
Age in years, mean (SD)	44 (14)	41 (14)	46 (13)
Age range in years	18 – 87	18 – 81	18 – 87
Females	41%	40%	42%
Time since start of current episode of LBP			
1 – 2 days	18%	20%	17%
3 – 7 days	29%	27%	30%

1 – 2 weeks	13%	13%	13%
2 – 4 weeks	11%	10%	11%
1 – 3 months	12%	10%	13%
3 – 12 months	7%	8%	7%
More than a year	10%	12%	9%
Missing (n)	0.5% (14)	0.4% (4)	0.6% (10)
LBP intensity (NRS 0 – 10), mean (SD)			
Baseline	6.7 (2.0)	6.7 (2.0)	6.7 (2.0)
Missing (n)	2% (46)	2% (16)	2% (30)
2 weeks	3.7 (2.3)	3.8 (2.3)	3.7 (2.3)
Missing (n)	28% (766)	58% (550)	12% (216)
13 weeks	2.3 (2.3)	2.6 (2.4)	2.3 (2.3)
Missing (n)	31% (854)	66% (632)	12% (222)
52 weeks	2.3 (2.4)	-	2.3 (2.4)
Missing(n)	35% (956)	-	0.2% (4)
Disability (RMDQ 0 – 100), mean (SD)			
Baseline	55 (24)	55 (25)	55 (23)
Missing (n)	1% (23)	2% (17)	0.3% (6)
2 weeks	30 (26)	32 (27)	29 (26)
Missing (n)	29% (786)	57% (545)	12% (211)
13 weeks	19 (23)	24 (27)	19 (23)
Missing (n)	39% (1064)	66% (628)	12% (219)
52 weeks	20 (23)	-	21 (23)
Missing (n)	48% (1305)	-	-
Back beliefs (BBQ 9 – 45), mean (SD)	32 (6)	32 (6)	33 (6)

[a] Missing data on both RMDQ and LBP intensity at the 52-week follow-up

SD: standard deviation, LBP: Low back pain, NRS: numerical rating scale, RMDQ: Roland Morris Disability Questionnaire, BBQ: Back Belief Questionnaire

-----Insert Figure 1 here-----

The association between BBQ scores at baseline and LBP intensity and disability after 2, 13 and 52 weeks

Higher BBQ scores at baseline, indicating positive back beliefs, were weakly associated with lower LBP intensity at follow-up in both unadjusted and adjusted analyses (Table 2).

The coefficient of the interaction between BBQ and LBP intensity over time denotes the additional reduction in LBP intensity for each additional point on the BBQ scale. This means that if two participants are alike on all parameters except that one scores 10 points higher on the BBQ at baseline, then that patient would be expected to have an additional reduction in LBP intensity at 13 weeks of -0.3 points (10 x-0.03 (13-week coefficient)) compared to the other participant.

The association between quartiles of BBQ at baseline and LBP intensity at follow-up indicated higher reduction of LBP intensity for patients with the most positive beliefs compared to those with more negative beliefs (Figure 2).

Associations between BBQ at baseline and disability at follow-up were weak and had large p-values (Table 2). The association is visualized in a marginsplot in Figure 3.

TABLE 2
Association between back beliefs at baseline and LBP intensity and disability at follow-up

	Unadjusted			Adjusted		
LBP Intensity (NRS)	Coefficient	*p*	95% CI	Coefficient	*p*	95% CI
Follow-up time point						
2 weeks	-2.50	<0.001	-3.15; -1.86	-2.34	<0.001	-3.01; -1.76
13 weeks	-3.52	<0.001	-4.18; -2.87	-3.43	<0.001	-4.07; -2.79
52 weeks	-3.39	<0.001	-4.06; -2.71	-3.27	<0.001	-3.93; -2.61
BBQ	-0.04	<0.001	-0.06; -0.03	-0.03	<0.001	-0.04; -0.01
Interaction between BBQ and follow up time point						
2 weeks	-0.01	0.148	-0.03; -0.01	-0.02	0.061	-0.04; -0.001
13 weeks	-0.03	0.011	-0.05; -0.01	-0.03	0.004	-0.05; -0.01
52 weeks	-0.03	0.004	-0.05; -0.01	-0.03	0.001	-0.05; -0.01
Interaction term		0.014			0.003	
DISABILITY (RMDQ)	Unadjusted			Adjusted		
	Coefficient	*p*	95% CI	Coefficient	*p*	95% CI
Follow-up time point						
2 weeks	-23.92	<0.001	-30.19; -17.65	-24.13	<0.001	-30.14; -18.12
13 weeks	-34.45	<0.001	-41.08; -27.81	-33.87	<0.001	-40.21; -27.53
52 weeks	-37.38	<0.001	-44.53; -30.22	-37.54	<0.001	-44.36; -30.72
BBQ	-1.05	<0.001	-1.2; -0.9	-0.48	<0.001	-0.61; -0.35
Interaction between BBQ and follow up time point						
2 weeks	-0.02	0.802	-0.21; 0.17	-0.03	0.760	-0.21; 0.15
13 weeks	-0.02	0.839	-0.22; 0.18	-0.05	0.604	-0.24; 0.14
52 weeks	0.09	0.393	-0.12; 0.31	0.08	0.449	-0.13; 0.28
Interaction term		0.7			0.7	

Adjusted analyses were controlled for: age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment
Coefficients for the interaction between BBQ and time explain additional changes in LBP intensity or RMDQ scores accounting for the increase of one point on the BBQ score compared to a BBQ score of 9
BBQ: Back Belief Questionnaire, CI: Confidence Interval, LBP: Low Back Pain, RMDQ: Roland Morris Disability Questionnaire,

-----Insert Figure 2 here-----

-----Insert Figure 3 here-----

The association between BBQ -scores and LBP intensity and disability stratified by LBP history

Dividing the populations into groups based on episode duration and number of previous episodes ('Acute new' n=209, 'Acute episodic' n=932, 'Subacute' n=615 and 'Long-lasting' n=473) did not show any substantial difference between the groups in the associations between BBQ at baseline and LBP intensity or disability at follow-up. The results are shown in Supplementary File 2.

TABLE 3
Single item association with LBP intensity or disability at 13 weeks

	LBP INTENSITY				DISABILITY			
Item	Coefficient	*p*	95% CI		Coefficient	*p*	95% CI	
1) There is no real treatment for back trouble.	-0.08	0.184	-0.21;	0.04	-0.80	0.230	-2.12;	0.51
2) Back trouble will eventually stop you from working.	0.07	0.155	-0.03;	0.17	0.12	0.816	-0.9;	1.14
3) Back trouble means periods of pain for the rest of one's life.	-0.31	<0.001	-0.41;	-0.2	-2.55	<0.001	-3.66;	-1.44
4) Doctors cannot do anything for back trouble.	-0.01	0.913	-0.10;	0.09	-0.24	0.649	-1.27;	0.79
5) A bad back should be exercised.	-0.12	0.051	-0.24;	0.001	-0.87	0.180	-2.14;	0.40
6) Back trouble makes everything in life worse.	-0.04	0.423	-0.13;	0.05	-1.05	0.031	-2.01;	-0.09
7) Surgery is the most effective	0.05	0.426	-0.07;	0.18	0.07	0.918	-1.25;	1.39

The association between single items on the BBQ and LBP intensity and disability at 13 weeks

Higher scores on an item (more positive beliefs on a scale from 1 to 5) were generally associated with slightly lower LBP intensity and disability scores at 13 weeks (Table 3).

Item 3 "*Back trouble means periods of pain for the rest of one's life*" had the strongest association with a reduction in both LBP intensity and disability at 13 weeks. For LBP intensity, the coefficient was -0.29 (95% CI -0.4; -0.19, *p*=<0.001) and for disability, -2.42 (95% CI -3.52; -1.33, *p*=<0.001).

For LBP intensity, the second strongest association was with item 11 "*Medication is the only way of relieving back trouble*" (coef. -0.16, 95% CI -0.28; -0.04, *p*=<0.007). For disability, the second strongest association was with item 9 "*Alternative treatments are the answer to back trouble*" (-1.31, 95% CI -2.36; -0.26, *p*=0.015) (Table 3).

way to treat back trouble.								
8) Back trouble may mean you end up in a wheelchair.	-0.03	0.489	-0.12;	0.06	-0.48	0.310	-1.41;	0.45
9) Alternative treatments are the answer for back trouble.	-0.05	0.288	-0.15;	0.05	-1.62	0.003	-2.68;	-0.56
10) Back trouble means long periods of time off work.	-0.04	0.448	-0.16;	0.07	-0.19	0.764	-1.41;	1.04
11) Medication is the only way of relieving back trouble.	-0.15	0.013	-0.27;	-0.03	-0.65	0.312	-1,91;	0.61
12) Once you have had back trouble there is always a weakness.	-0.04	0.495	-0.14;	0.07	-0.73	0.187	-1.81;	0.35
13) Back trouble must be rested.	0.04	0.506	-0.07;	0.14	-0.74	0.196	-1.87;	0.38
14) Later in life back trouble gets progressively worse.	-0.13	0.029	-0.24;	-0.01	-0.62	0.314	-1.83;	0.59

Score ranges from 1 to 5. With higher scores indicating positive beliefs (disagreeing with the statement), except item 5 where higher scores indicate agreeing with the statement.
Linear multivariate regression analysis adjusted for: age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment
BBQ: Back Belief Questionnaire, CI: Confidence Interval

When removing one item at a time from the model, the reduction in R^2 was low for all items. Item 3 showed the greatest reduction in R^2 accounting for 1.5% of the explained variance in the association with LBP intensity and 1% in the association with disability. Among the other items, the variance explained ranged from 0% to 0.35%.

Discussion

Main findings

To our knowledge, this is the first study using longitudinal data to investigate if back beliefs, measured by the BBQ, are associated with LBP intensity and disability at follow-up in patients with LBP who consult a chiropractor. Overall, we found that more positive beliefs at baseline were associated with decreasing LBP intensity at follow-up. However, the coefficients were small, and thus might not be of clinical relevance. There was no certain association between back beliefs and disability outcomes. The associations were not substantially different between groups with different LBP history. Assessment of the individual BBQ items showed that the item *"Back trouble means periods of pain for the rest of one's life"* had the strongest association with a reduction in both disability and LBP intensity at 13 weeks.

Interpretation

The BBQ is designed to measure beliefs regarding negative consequences of LBP (20). Based on the Common-Sense Model (CSM) beliefs regarding consequences represent one particular type of health-beliefs. The CSM depicts how beliefs about LBP potentially affect disability as it explains how individuals respond to and manage health threats based on the way pain or stimuli related to illness is understood. The representation of health threats is described in five different domains: identity (what is this pain?), cause (what caused this pain?), consequence (what consequences will this pain have?), control (how can I control this pain?), and timeline (how long will this pain last?) (3, 4, 6, 27). It is our interpretation that the questions in BBQ, primarily reflect the consequence domain, yet not entirely. Our findings indicated that perceptions related to consequences are not strongly related to outcomes in this population, whereas one item related to timeline (*"Back trouble means periods of pain for the rest of one's life"*) had a noticeably stronger association with LBP intensity and disability at the 13-week follow-up compared to the other items. This might imply that recovery expectations are an important subdomain in the BBQ, which is in line with the finding from other studies reporting that recovery expectations are a predictor of prognosis for LBP (11).

The consequence domain was reported in a systematic review to be a prognostic factor for pain outcomes in people with musculoskeletal pain (9). The review investigated relationships of illness perceptions, pain intensity and disability in people with musculoskeletal pain. However, only two of the included studies focused on LBP in a longitudinal design and both these studies only investigated outcomes of disability (9). Nevertheless, both studies found maladaptive illness perceptions to be associated with worse outcomes regarding pain-related disability at follow-up, whereas our findings did not provide such evidence (28, 29). Similar to our findings, a prospective cohort study (2020) of people with acute LBP found that maladaptive illness perceptions measured by IPQ were predictive of pain but not disability at 12-weeks although the predictive value was low (30). The same trend was seen for musculoskeletal pain, where IPQ did not add substantially to the prediction of recovery (10). Similarly, a secondary analysis of a randomized controlled trial published in 2018 showed that high levels of fear-avoidance beliefs measured by the Fear-Avoidance Beliefs Questionnaire in patients with LBP were only weakly associated with worse outcomes in LBP and disability at 12 months, yet the association was much stronger for sick leave (31). However, both the IPQ and Fear-Avoidance Beliefs Questionnaire cover more domains than the BBQ and the results are therefore not directly comparable.

It is questionable as to whether the observed association between positive back beliefs and the reduction in LBP intensity is clinically relevant. There is not a generic meaningful minimal clinically important change for pain scores, as it is always content-specific (32, 33), but a change of 2 points on the NRS has been

proposed to be clinically significant in people with long-lasting LBP (34). In our study, a 10-points higher score on the BBQ translated into an expected additional reduction in LBP intensity of 0.3 points which we doubt to be clinically relevant. However, as LBP is complex and many factors are considered important contributors, it is unlikely that the BBQ score would be able to independently predict future LBP intensity with high precision in a one-size-fits-all model. BBQ scores were generally high (mean BBQ sum-score=32) indicating overall positive beliefs, and more important associations can perhaps be demonstrated in populations with a larger variation in back beliefs.

Overall beliefs about LBP seem to be associated with pain intensity and disability at a cross-sectional level, but the longitudinal relationship remains unclear (8, 9, 11-15). Due to only weak associations between beliefs and reduction of LBP intensity, and uncertainty regarding the domains of beliefs measured, the BBQ does not seem suitable for predicting or explaining the course of LBP in our setting. However, based on the cross-sectional association, and as other domains of beliefs could be relevant to patients with LBP, we still encourage clinicians to address beliefs with their patients preferably using an individual approach.

In our sample, the associations between back beliefs and LBP intensity and disability were not influenced by the number of previous pain episodes and the duration of pain. This finding contradicts the theory that the association between beliefs and disability is most relevant for those with persistent pain (16). This is important as it implies that the decision to discuss beliefs with a patient, should not be based on the duration of pain or number of previous LBP episodes.

Limitations

As discussed previously, BBQ focuses on the consequence domain of beliefs. For a more thorough investigation of the association between beliefs and clinical outcomes, the use of different questionnaires could add information on beliefs from other domains, and thereby give a broader perspective on potential associations.

Before conducting the primary analyses, the construct validity and scale reliability of the BBQ was evaluated. The internal consistency and scale reliability was considered acceptable, and in line with other studies (20, 21, 24). However, other studies have found the BBQ to be unidimensional, although the fit of item 1 has been questioned, which we could not confirm (22-24). When interpreting the results, it should therefore be kept in mind that it is unclear what constructs the BBQ sum score represents in this sample. Another consideration is that the BBQ might be outdated as it was created in 1996 and a lot has happened in the field of LBP since then and perhaps in the public perception of LBP. This may explain why a questionnaire from 2014, the Back Pain Attitudes Questionnaire, which was developed based on in-depth

interviews with people experiencing LBP, asks questions very different from those of BBQ (35). For future studies investigating beliefs about LBP, we recommend researchers carefully consider the suitability of the different instruments.

This study did not account for the treatments the patients received from the chiropractor (e.g., advice, education, exercise, manual therapy), and it is unknown to what extent beliefs were discussed and addressed as part of treatment in a way that potentially affected outcomes. This could have blurred an otherwise stronger association than observed. However, BBQ sum scores were previously observed to be relatively constant over time in this sample, suggesting that negative beliefs were not effectively changed after initiating care (19).

In this study we explored the prognostic effect of baseline beliefs. In addition, it would be relevant investigating if changes in beliefs as a result of a health care consultation mediates treatment effects. However, our sample would not be very suitable for this purpose as beliefs were generally positive at baseline, and optimally it would require a randomized design.

Generalizability

Data were collected from a limited number of chiropractic clinics in Denmark, yet we have no reason to believe that data were not representative of Danish chiropractic clinics in general. Demographic baseline data were similar to a previous Danish chiropractic cohort based on a national sample (36). However, a population of patients consulting a chiropractor cannot be fairly compared to other patients in primary care (36). Further, the study sample's overall positive beliefs with a mean BBQ sum score of 32 differs from the findings from a systematic review that found the majority of mean BBQ sum scores in the general population were below 27 (8). Also, a recent study from 2021 exploring back beliefs in the general population reported a mean BBQ sum score of 27 (37).

Conclusion

Positive beliefs regarding LBP at baseline, measured by the BBQ, were weakly associated with a reduction in LBP intensity but not disability at the 2-, 13- and 52-week follow-ups in people with LBP seeking chiropractic care. Whether the association with LBP intensity was clinically relevant is questionable. The BBQ is therefore not promising for predicting or explaining the course of LBP in this setting. Future research should focus on exploring the associations between beliefs and clinical outcomes in different patient populations and with instruments covering all pain belief domains or more unambiguously covering a single domain.

Figure legends

Figure 1:

Heading: Flowchart of the study population

Explanatory text: Partly completed data on BBQ or RMDQ were filled out using chained multiple imputation

Abbreviations: BBQ: Back Belief Questionnaire, RMDQ: Roland Morris Disability Questionnaire, LBP: Low Back Pain

Figure 2:

Heading: Marginsplot of the associations between quartiles of BBQ scores at baseline and LBP intensity at follow-up

Explanatory text: The association between quartiles of BBQ scores at baseline and LBP intensity at follow-up had a *p*-value of 0.0030

Figure 3:

Heading: Marginsplot of the associations between baseline quartiles of BBQ scores at baseline and disability at follow-up

Explanatory text: The association between quartiles of BBQ scores at baseline and RMDQ scores at follow-up had a *p*-value of 0.1071

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Competing interest

The authors report the following potential conflict of interest: AK's position at the University of Southern Denmark is financially supported by an unrestricted grant from the Danish Foundation for Chiropractic Research and Postgraduate Education. The funders were not involved in defining the research question, designing the study, analyzing the data, or interpreting the results.

Author Contributions

SG conceived and planned the project, performed analysis of the data and interpretation of the results, and wrote the initial draft of the manuscript. AK made substantial contributions to study design, data analysis, interpretation of results and revised and improved the manuscript. RKJ made substantial contribution to the study design, interpretation of results and revision of the manuscript. All authors have read and approved the final manuscript.

Data availability statement

Data used and analyzed in the current study are available from the corresponding author on reasonable request. If interested in using data from the ChiCo cohort for other research projects, the Chiropractic Knowledge Hub should be contacted directly.

Ethic statement

Patient consent for publication

Not required

Ethics approval

The Health Research Ethics Committee for Southern Denmark determined (S-20,162,000-109) that the Danish Chiropractic Low Back Pain Cohort did not require ethical approval according to Danish regulations.

Abbreviations

BBQ: Back Belief Questionnaire; ChiCo: Danish Chiropractic low back pain Cohort; CI: Confidence Interval; Illness Perception Questionnaire; LBP: Low Back Pain; LOWESS: Locally Weighted Scatterplot Smoothing; MCID: Minimal Clinically Important Difference; NRS: Numerical Rating Scale; OPEN: The Odense Patient Explorative Network; REDCap: Research Electronic Data Capture; RMDQ: Roland-Morris Disability Questionnaire; SD: Standard Deviation; STROBE: Strengthening the Reporting of Observational studies in Epidemiology.

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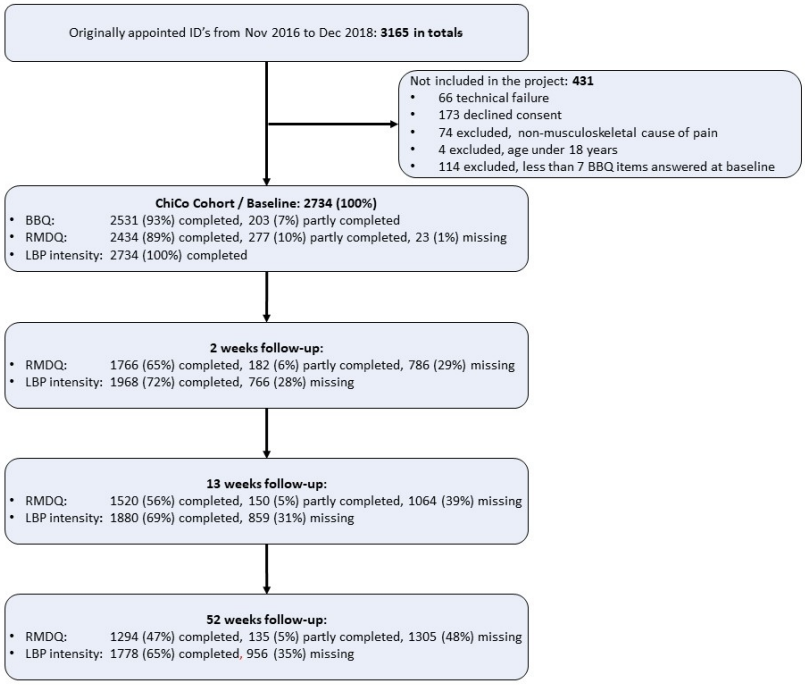

Flowchart of the study population

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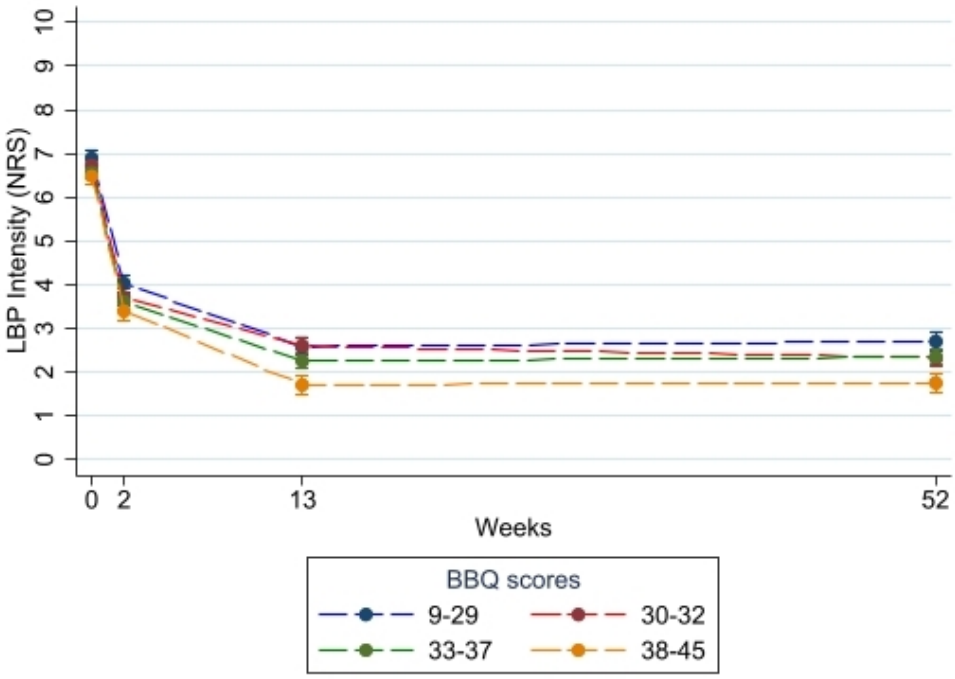

Marginsplot of the associations between quartiles of BBQ scores at baseline and LBP intensity at follow-up

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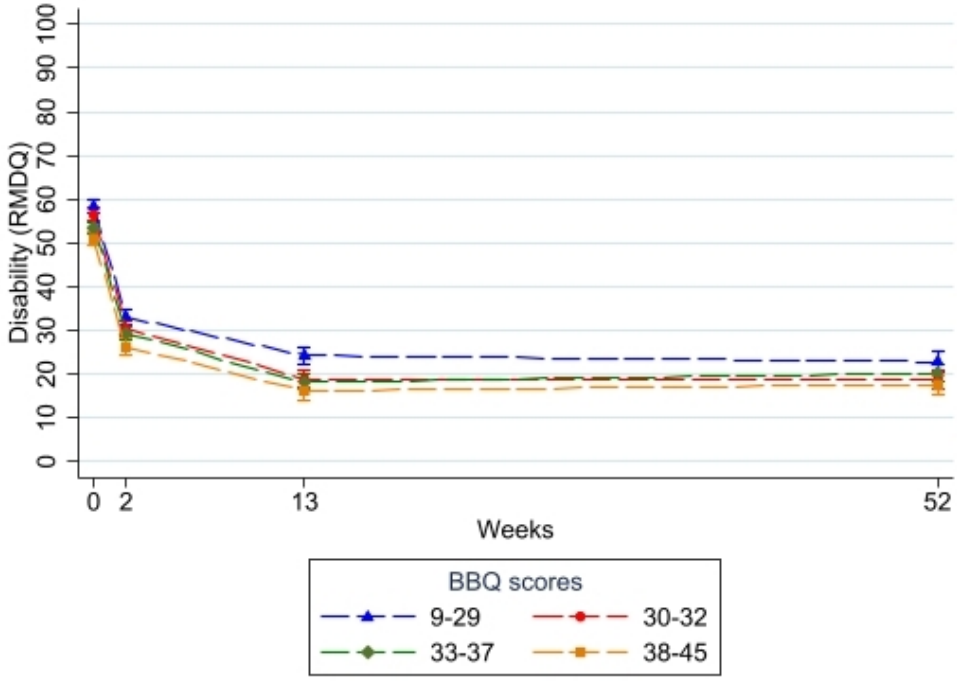

Marginsplot of the associations between baseline quartiles of BBQ scores at baseline and disability at follow-up

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Supplemental file 1 - Construct validity and scale reliability

Before conducting the primary analyses, we performed analyses on the Danish version of the BBQ to test construct validity and scale reliability. Tests were performed on the baseline population consisting only of those who had completed the BBQ (n=2531). Cronbach's alpha was used to measure internal consistency and scale reliability and showed a total alpha score of 0.77 which is considered acceptable (Table 1). Factor analysis was conducted to test if the BBQ was unidimensional (only measuring one construct as intended). The factor analysis was conducted similar to Bostick et al. (1) by first performing an Explorative factor analysis based on eigenvalues from a principal component analysis (PCA). Thereafter we performed a confirmatory factor analysis based on the results. However, the results did not support a unidimensional model and the first component of the PCA only explained 26 % of the variance. Results of the PCA and factor analyses can be found in table 2a,2b,3a and 3b, for a scree plot of eigenvalues see figure 1.

Because BBQ did not seem unidimensional, six different subscales were created and explored, and each subscale was tested for goodness of fit using a maximum likelihood approach. The subscales were: 1) the original score and 2) the original score including distractor items. Then based on the PCA we created 3) a subscale by removing item 5 and 9 because these had the lowest correlation to the first component in the PCA and a low item-rest correlation. Lastly, we used simple face validity to create three subscales based on the domains the items seemed to cover: 4) a consequence domain (item 2,3,6,8,10,12,14), 5) a control domain (item 1, 4, 5, 7,9, 11, 13), and 6) an expectation domain (item 1, 2, 3, 4, 6, 8, 10, 12, 14). These were compared on their Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR) comparative fit index (CFI) and Chi^2 (table 4).

For each subscale the explained variance was compared. The explained variance was extracted from the random effect parameters in the mixed methods longitudinal regression analyses (score of the sub-scale and the interaction between the score and time as independent variable, and LBP intensity or RMDQ scores as dependent variable). To calculate the explained variance, we subtracted unexplained variance from a model without a BBQ-subscale (time as independent variable and pain or RMDQ-scores as dependent) from a model with a subscale. No subscale outperformed the other regarding either explained variance or goodness of fit, and we therefore decided to use the original BBQ-score (Table 4 and 5).

TABLE 1

Internal consistency and scale validity measured by Cronbach's alpha

Item	Obs	Sign	Item-test correlation	Item-rest correlation	Average interitem covariance	alpha
BBQ1	2531	+	0.5150	0.4141	0.2236376	0.7505
BBQ 2	2531	+	0.6186	0.4984	0.2042338	0.7401
BBQ 3	2531	+	0.6198	0.5086	0.2064069	0.7394
BBQ 4	2531	+	0.5404	0.4139	0.2151883	0.7496
BBQ 5	2531	-	0.2231	0.1107	0.2500912	0.7737
BBQ 6	2531	+	0.5254	0.3903	0.2158778	0.7523
BBQ 7	2531	+	0.4567	0.3553	0.2299497	0.7555
BBQ 8	2531	+	0.4547	0.3086	0.2242917	0.7612
BBQ 9	2531	+	0.2907	0.1615	0.2438508	0.7720
BBQ 10	2531	+	0.6117	0.5122	0.2110727	0.7404
BBQ 11	2531	+	0.4693	0.3642	0.2279814	0.7547
BBQ 12	2531	+	0.5575	0.4397	0.2144444	0.7469
BBQ 13	2531	+	0.4749	0.3551	0.2249277	0.7553
BBQ 14	2531	+	0.5578	0.4548	0.2178	0.7463
Test scale					0.2221253	0.7666

TABLE 2a

Eigenvalues of principal component analysis on the BBQ items

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	3.63131	2.34124	0.2594	0.2594
Comp2	1.29007	0.138269	0.0921	0.3515
Comp3	1.1518	0.128742	0.0823	0.4338
Comp4	1.02306	0.0483555	0.0731	0.5069
Comp5	0.974706	0.131495	0.0696	0.5765
Comp6	0.843212	0.037967	0.0602	0.6367
Comp7	0.805245	0.0462409	0.0575	0.6942
Comp8	0.759004	0.0619936	0.0542	0.7485
Comp9	0.69701	0.0834449	0.0498	0.7982
Comp10	0.613565	0.0121034	0.0438	0.8421
Comp11	0.601462	0.018122	0.0430	0.8850
Comp12	0.58334	0.0432221	0.0417	0.9267
Comp13	0.540118	0.0540251	0.0386	0.9653
Comp14	0.486093	.	0.0347	1.0000

TABLE 2b Eigenvectors

Loading of individual items on components

Item	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7	Comp8	Comp9	Comp 10	Comp 11	Comp 12	Comp 13	Comp 14	Unexplained
BBQ1	0.2838	-0.4219	0.1169	-0.1238	0.0267	-0.0704	0.2928	-0.1954	0.1624	0.1682	0.2213	0.6832	0.0402	0.1045	0
BBQ 2	0.3288	0.0826	0.0477	-0.3702	0.1163	0.0299	-0.0240	-0.3759	0.0155	0.5127	0.2269	0.0206	0.3879	0.3521	0
BBQ 3	0.3406	-0.2507	0.2497	-0.0748	-0.1480	-0.2252	0.0257	-0.0222	0.0320	0.0490	0.2869	0.3854	0.0933	0.6607	0
BBQ 4	0.2835	-0.4162	0.2556	-0.0715	0.2303	0.1693	-0.0387	-0.0294	0.1320	0.2889	0.0820	0.4322	0.3187	0.4427	0
BBQ 5	-0.0852	0.3240	0.5973	0.1027	-0.2102	0.2509	0.5973	0.0023	0.0899	0.1288	0.0531	0.0397	0.1494	0.0711	0
BBQ 6	0.2701	0.2558	0.1726	-0.1123	0.0885	0.6410	-0.2895	0.1618	0.0634	0.2706	0.1793	0.1008	0.3309	0.2480	0
BBQ 7	0.2436	-0.0268	-0.4483	-0.0383	-0.0987	0.1201	0.5263	0.2213	0.6155	0.0166	0.0071	0.0462	0.0722	0.0297	0
BBQ 8	0.2187	0.4125	-0.0689	-0.3510	0.1451	-0.4325	0.2205	0.2576	0.3204	0.4198	0.0411	0.1230	0.1242	0.1405	0
BBQ 9	0.1145	0.1192	0.1329	0.4850	0.7882	-0.1572	0.1012	0.0547	0.1288	0.1184	0.0704	0.0844	0.0603	0.1194	0
BBQ 10	0.3284	0.3261	-0.1041	-0.2213	0.0547	0.0288	-0.1928	0.0429	0.0316	0.2612	0.0201	0.1473	0.7514	0.1652	0

BBQ 11	0.2464	-0.1290	-0.4109	0.2858	0.0193	0.3344	0.1805	0.0894	0.6546	0.2109	0.0707	0.2033	0.0005	0.0091	0
BBQ 12	0.3015	-0.0803	0.1339	0.2967	-0.2912	-0.0893	-0.2108	0.5152	0.0047	0.0041	0.4590	0.2926	0.0499	0.3087	0
BBQ 13	0.2467	0.2833	-0.1689	0.3878	-0.1983	-0.0014	-0.0232	-0.6320	0.0533	0.4216	0.2361	0.0032	0.0521	0.0403	0
BBQ 14	0.3070	0.1177	0.1424	0.2912	-0.2814	-0.3067	-0.1427	-0.0021	0.1114	0.2285	0.7050	0.1130	0.1088	0.0833	0

Figure 1
Screeplot of eigenvalues after principal component analysis of the BBQ items

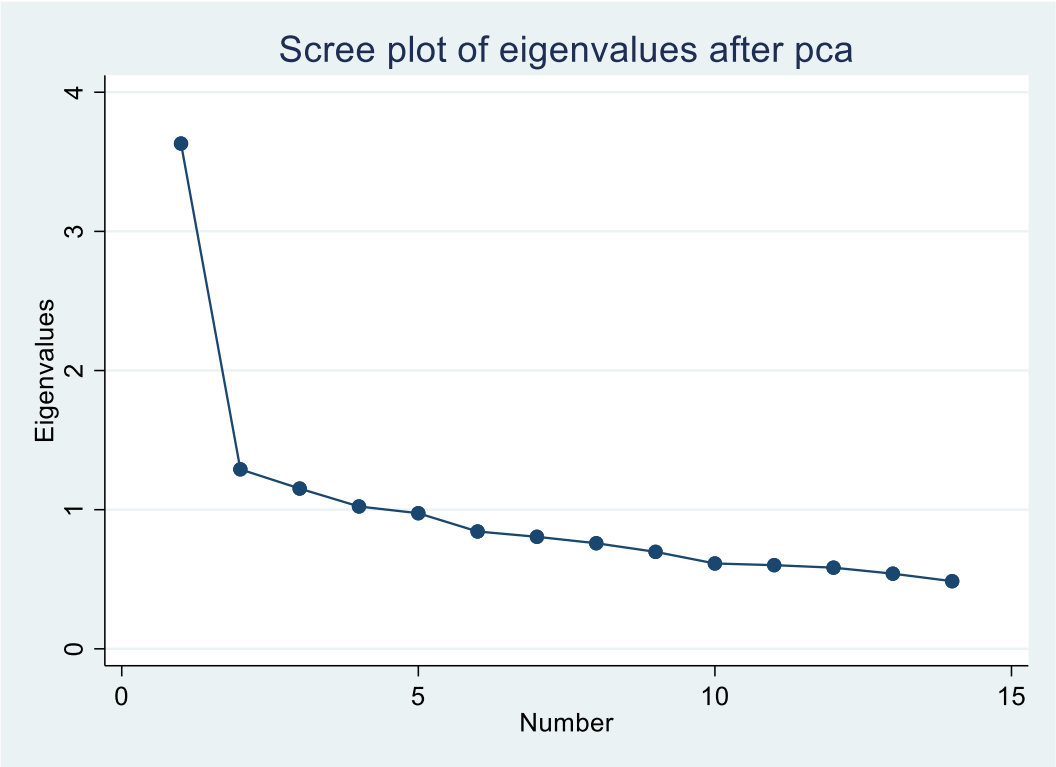

TABLE 3a
Rotated factor loadings

Item	Factor1	Factor2	Factor3	Factor4	Uniqueness
BBQ1	**0.7148**	0.0757	0.0102	0.1914	0.4465
BBQ 2	0.3986	**0.6153**	0.0097	0.0814	0.4558
BBQ 3	**0.7109**	0.2200	0.1600	0.0210	0.4202
BBQ 4	**0.7668**	0.0401	0.0569	0.0541	0.4042
BBQ 5	-0.0795	0.0295	**0.1221**	-0.7493	0.4164
BBQ 6	0.2257	**0.5214**	0.2330	-0.1393	0.6035
BBQ 7	0.1090	0.3040	0.1735	**0.5612**	0.5506
BBQ 8	-0.0295	**0.7228**	0.0362	0.0102	0.4753
BBQ 9	0.0465	-0.0660	**0.5516**	-0.1269	0.6731
BBQ 10	0.1312	**0.7151**	0.2147	0.1295	0.4086

BBQ 11	0.1625	0.0567	0.4155	**0.5637**	0.4800
BBQ 12	0.4391	0.1025	**0.4939**	0.0427	0.5510
BBQ 13	-0.0421	0.2694	**0.6403**	0.1640	0.4888
BBQ 14	0.3050	0.2486	**0.5601**	-0.0417	0.5297

Bold indicates the highest factor loading for each item

TABLE 3b Factor rotation matrix

	Factor1	Factor2	Factor3	Factor4
Factor1	0.6220	0.5749	0.4692	0.2499
Factor2	-0.6454	0.6122	0.2923	-0.3509
Factor3	0.4247	-0.0726	0.0065	-0.9024
Factor4	-0.1272	-0.5379	0.8333	-0.0105

TABLE 4
Comparison of subscales based on Goodness of fit

Subscale	RMSEA	SRMR	CFI	Chi^2	Alpha
1)Original score	0.088	0.053	0.859	555.00	0.7478
2) Full score	0.075	0.054	0.801	1176.37	0.7666
3) score without item 5 and 9	0.083	0.057	0.820	1002.15	0.7800
4) Consequence domain	0.097	0.052	0.883	344.14	0.7213
5) Control domain	0.080	0.049	0.813	241.45	0.5395
6) Expectations domain	0.102	0.063	0.828	736.53	0.7559

Items in subscales: 1) 1,2,3,6,8,10,12,13,14; 2) 1,2,3,4,5,6,7,8,9,10,11,12,13,14; 3) 1,2,3,4,6,7,8,10,11,12,13,14; 4) 2,3,6,8,10,12,14; 5) 1, 4, 5, 7,9, 11, 13; 6) 1, 2, 3, 4, 6, 8, 10, 12, 14
RMSEA: Root Mean Square Error of Approximation
SRMR: Standardized Root Mean Square Residual
CFI: comparative fit index

TABLE 5
Explained variance of subscale

Subscale	Pain unadjusted	Pain adjusted	RMDQ unadjusted	RMDQ adjusted
1)Original score	1.48%	1.24%	3.87%	1.59%
2) Full score	1.54%	1.27%	3.95%	1.71%
3) score without item 5 and 9	1.5%	1.27%	3.99%	1.68%
4) Consequence domain	1.34%	1.12%	3.53%	1.47%
5) Control domain	0.96%	0.73%	2.26%	0.99%
6) Expectations domain	1.47%	1.32%	3.60%	1.65%

Items in subscales: 1) 1,2,3,6,8,10,12,13,14; 2) 1,2,3,4,5,6,7,8,9,10,11,12,13,14; 3) 1,2,3,4,6,7,8,10,11,12,13,14; 4) 2,3,6,8,10,12,14; 5) 1, 4, 5, 7,9, 11, 13; 6) 1, 2, 3, 4, 6, 8, 10, 12, 14
Adjusted analyses were controlled for: age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment

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Supplemental file 2

Association between BBQ scores at baseline and LBP intensity and disability at 2, 13 and 52 weeks stratified by LBP history

	Acute new (n=209)			Acute episodic (n=932)			Sub acute (n=615)			Persistent (n=473)		
LBP intensity (NRS)												
	Coefficient	*p*	95%CI	Coefficient	*p*	95%CI	Coefficient	*p*	95%CI	Coefficient	*p*	95%CI
Time												
2 weeks	-3.82	<0.001	-5.75 -1.89	-2.76	<0.001	-3.76 -1.76	-2.26	0.001	-3.55 -0.97	-2.04	0.104	-2.35 0.34
13 weeks	-4.58	<0.001	-6.65 -2.52	-3.59	<0.001	-4.62 -2.57	-3.64	<0.001	-4.96 -2.32	-1.80	0.009	-3.17 -0.44
52 weeks	-6.73	<0.001	-8.8 -4.67	-3.48	<0.001	-4.53 -2.43	-3.12	<0.001	-4.45 -1.8	-1.73	0.024	-3.22 -0.23
BBQ	-0.02	0.407	-0.06 0.02	-0.02	0.153	-0.04 0.01	-0.02	0.082	-0.05 0.003	-0.04	0.009	-0.07 -0.01
Interaction between BBQ and time												
2 weeks	-0.01	0.686	-0.07 0.05	-0.03	0.087	-0.06 0.004	0.002	0.919	-0.04 0.04	-0.02	0.330	-0.06 0.02
13 weeks	-0.04	0.223	-0.1 0.02	-0.05	0.002	-0.08 -0.02	0.01	0.753	-0.03 0.05	-0.02	0.342	-0.06 0.02
52 weeks	0.03	0.334	-0.03 0.09	-0.05	0.001	-0.09 -0.02	-0.01	0.580	-0.05 0.03	-0.02	0.329	-0.07 0.02
Interaction term		0.2262			0.0025			0.8756			0.6618	
DISABILITY (RMDQ)												
Time												
2 weeks	-38.65	<0.001	-58.85 -18.44	-34.47	<0.001	-44.33 -24.60	-18.83	0.002	-30.52 -7.13	-2.08	0.722	-13.51 9.36
13 weeks	-49.42	<0.001	-71.46 -27.38	-44.11	<0.001	-54.47 -33.76	-34.83	<0.001	-47.1 -22.56	-16.21	0.009	-28.41 -4.0
52 weeks	-47.51	<0.001	-70.78 -24.24	-46.19	<0.001	-57.07 -35.31	-40.62	<0.001	-53.65 -27.6	-3.88	0.590	-17.97 10.22
BBQ	-0.35	0.127	-0.81 0.10	-0.56	<0.001	-0.79 -0.34	-0.41	0.001	-0.67 -0.16	-0.4	0.002	-0.65 -0.15
Interaction between BBQ and time												
2 weeks	0.05	0.875	-0.55 0.65	0.07	0.635	-0.23 0.37	0.07	0.696	-0.28 0.42	0.29	0.110	-0.64 0.07
13 weeks	-0.07	0.838	-0.71 0.58	0.02	0.912	-0.3 0.33	0.22	0.235	-0.14 0.59	0.02	0.912	-0.36 0.4
52 weeks	-0.01	0.983	-0.69 0.67	0.1	0.554	-0.23 0.43	0.43	0.031	0.04 0.82	0.35	0.114	-0.78 0.08
Interaction term		0.9895			0.9258			0.1571			0.1792	

BBQ: Back Belief Questionnaire, CI: Confidence Interval, LBP: Low Back Pain, RMDQ: Roland Morris Disability Questionnaire
Analyses were controlled for age, sex, baseline LBP intensity, baseline RMDQ score and previous treatment.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6*
Bias	9	Describe any efforts to address potential sources of bias	5 "setting and procedures"
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8 and figure 1
		(b) Give reasons for non-participation at each stage	Figure 1
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8 and table 1
		(b) Indicate number of participants with missing data for each variable of interest	Table 1 + figure 1
		(c) Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 1
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
		(*b*) Report category boundaries when continuous variables were categorized	Figure 2 +3
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.