Musculoskeletal
Research Paper

PAIN REPORTS

Fear-avoidance beliefs are associated with changes of back shape and function

Nima Taheri[a,b], Luis Becker[a,b], Lena Fleig[c], Karolina Kolodziejczak[c], Lea Cordes[b], Bernhard U. Hoehl[a,b], Ulrike Grittner[c], Lukas Mödl[c], Hendrik Schmidt[b], Matthias Pumberger[a]

Introduction: Psychosocial function in people with chronic low back pain (cLBP) is often impaired, indicating poor well-being. Fear-avoidance beliefs (FAB) are common concomitants of cLBP. Fear-avoidance beliefs are gaining attention as a potential prognostic factor for chronification and resulting disability in cLBP. This article aims to examine the associations of back function with FAB.
Methods: This study presents data from a cohort study (DRKS00027907). In the present cross-sectional analyses, we included 914 participants (480 nonchronic LBP [ncLBP], 227 cLBP, 207 asymptomatic). Fear-avoidance beliefs were assessed using the fear-avoidance belief questionnaire (FABQ). The association between the FAB and clinical measures (Ott and Schober test, the sit-to-stand test [STS], and the finger-floor distance [FFD]) were analyzed. Back shape and function were also measured using a noninvasive device. The association between FABQ scores and clinical measures was assessed using age, body mass index, sex, and pain intensity–adjusted multiple linear regression models.
Results: Associations between FAB and both clinical (Ott, Schober, STS, FFD) and noninvasive device measures were small. All relevant clinical measures were attenuated in individuals with elevated FAB.
Discussion: We were able to demonstrate the association of both back shape and function in both clinical tests and noninvasive device measurements with self-reported fear-avoidance beliefs. However, the effect sizes were small. This may be attributed to the different assessment methods (objective vs self-report), resulting in reduced common method variance. In addition to the FAB, there may be other factors (eg, altered neuronal pathways; actual avoidance behavior such as reduced physical activity) that contribute to functional impairment.

Keywords: Back function, Chronic low back pain, Fear-avoidance beliefs, FABQ, Schober test, Finger-floor-distance, MediMouse

1. Introduction

Chronic low back pain (cLBP) is of great importance due to its high prevalence, substantial healthcare costs, and adverse effect on individuals' quality of life. It is estimated that up to 20% of the global population experiences cLBP, making it one of the most prevalent musculoskeletal disorders.[15] The socioeconomic burden is substantial, with direct healthcare costs, productivity losses, and disability claims.[15] Therefore, gaining a deeper understanding of its etiology is essential for effective prevention and management strategies.

Although structural abnormalities such as disk degeneration may cause cLBP in a certain proportion of participants, the majority of participants do not show associations between radiological abnormalities and reported pain.[10,11] By now, cLBP is seen as the consequence of a complex interplay of various factors, including biological, psychosocial, and environmental factors.[18,27,38] As part of the yellow flag concept, maladaptive coping strategies and other risk factors such as perceived stress may increase the risk of pain chronification and increase the severity of the symptoms.[18,27,38]

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

[a] Center for Musculoskeletal Surgery, Charité—Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin, Humboldt-Universität zu Berlin, Berlin, Germany, [b] Berlin Institute of Health, Julius Wolff Institute for Biomechanics and Musculoskeletal Regeneration, Charité-Universitätsmedizin Berlin, Berlin, Germany, [c] Department of Psychology, MSB Medical School Berlin, Berlin, Germany

**Corresponding author. Address: Center for Musculoskeletal Surgery, Charité—Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin, Humboldt-Universität zu Berlin, Luisenstraße 64, 10117 Berlin, Germany. Tel.: +4930/450652294; fax +4930/450652294. E-mail address: nima.taheri@charite.de (N. Taheri).*

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.painrpts.com).

PR9 10 (2025) e1249

http://dx.doi.org/10.1097/PR9.0000000000001249

Among the psychosocial risk factors, fear-avoidance beliefs (FAB) have gained considerable attention in the context of cLBP. Based on the fear-avoidance model,[7,9,36] fear-avoidance beliefs refer to an individual's belief that physical activity or movement will cause pain or further harm, leading to avoidance and functional impairment.[13,24] Fear-avoidance beliefs can be physical activity related or work- related.[22,35] It has been proposed that FAB contribute to the development of chronic pain and disability by facilitating a vicious cycle of fear, avoidance, and deconditioning.[8] Research has consistently demonstrated that higher levels of FAB are associated with greater pain intensity, disability, and reduced physical functioning in individuals with cLBP.[9,31] Furthermore, FAB are a prognostic factor for work loss and delayed recovery from back in general and especially cLBP.[28,35]

Despite the well-documented relationship between FAB- and cLBP-related disability, limited research has examined the actual impairment of spinal function associated with FAB. Some of the existing evidence shows an association of FAB with reduced spinal velocity during flexion,[19] spinal isometric strength,[1] and lumbar range of flexion.[5,20] Understanding the association between FAB and spinal function is crucial for a better diagnostic algorithm and more personalized therapies for cLBP, as reducing FAB may be helpful in gaining higher functionality and avoiding chronification and delayed recovery.[36] Therefore, the purpose of this study is to further quantify the association of both back shape and function with FAB. To do that, we examined FAB and both clinical and noninvasive device measures of back shape and function in people with cLBP. Furthermore, as FAB are also a prognostic factor for delayed recovery from back pain in general, we examined the association of FAB with back shape and function in participants with nonchronic LBP (ncLBP). Finally, we conducted identical analyses with a comparison group of asymptomatic participants. We hypothesized that for both cLBP and ncLBP participants, more severe alterations in back shape and function will be associated with higher levels of FAB. Furthermore, we hypothesized that asymptomatic participants report lower levels of FAB.

2. Materials and methods

2.1. Ethical approval

Ethical approval for this study was granted by the Ethics Committee of the Charité—Universitätsmedizin Berlin (EA4/011/10). This study is part of an interdisciplinary, multicomponent, research project that examines associations between biomechanics, psychosocial risk factors, and radiological factors on the etiology and persistence of cLBP- and cLBP-related disability. The research project is funded by the German Research Foundation (FOR 5177). Furthermore, the study was preregistered at the German national trial registry (DRKS00027907).

2.2. Study design, and inclusion and exclusion criteria

The study was conducted in according to the STROBE guidelines for cross-sectional studies. Written informed consent was obtained from all participants. Asymptomatic participants and participants with cLBP and ncLBP aged between 18 and 64 years with sufficient knowledge of the German language were eligible for participation. Participants are recruited through local promotion at Charité-Universitätsmedizin Berlin (through mailed flyers, notice boards, online platforms, and social media), through public outreach (through newspapers, magazines, podcasts, and TV), or through partnerships with local businesses and administrative bodies, and word of mouth.

Exclusion criteria were as follows: neurological movement disorders, radiculopathies, and systemic diseases requiring immunosuppressive medication (eg, axial spondylarthritis, rheumatoid arthritis), malignant diseases, and body mass index (BMI) $>$ 28 kg/m^2. This strict cutoff for the BMI resulted from the objective measurement by the Idiag M360 (MediMouse, Idiag AG, Fehraltorf, Switzerland) as agreement between x-rays and noninvasive device measurement were insufficient in overweight persons.

2.3. Definition of subgroups

Chronic low back pain was defined as persistent pain in the lumbar spine lasting longer than 12 weeks and occurring every day. Nonchronic low back pain was defined as lumbar pain lasting $\leq$12 weeks and/or defined by intermittent periods of pain. Asymptomatic participants did not report any episodes of low back pain.

2.4. Measurement protocol

The measurement protocol of the study was divided into 3 phases. After enrollment, participants were asked to complete several standardized and validated Patient-Reported Outcome Measures (PROMs) including the German version of the fear-avoidance belief questionnaire (FABQ).[12] Subsequently, participants were clinically examined by a resident of orthopedic surgery with several years of clinical experience. The clinical examination included a standardized anamnesis and extensive clinical measurements of back, hip, and hamstring mobility and range of motion (RoM). The third part of the measurement protocol was conducted by a healthcare professional who measured back shape and function using the Idiag M360 (MediMouse, Idiag AG).

2.5. Fear-avoidance belief questionnaire

To measure fear-avoidance beliefs, we used the validated German version of the FABQ,[21] the FABQ-D.[22] The FABQ contains 16 items and is divided into 2 dimensions: physical-activity FABQ (PA-FABQ; item 1–5; range 0–30) and work-related FABQ (W-FABQ; 6–16; range 0–66). The PA subscale assesses whether participants believe that physical activity can worsen their pain, whereas the WA subscale refers to work-related activity that can contribute to more pain. Higher scores indicate more pronounced FAB. According to the German validation study in cLBP patients conducted by Pfingsten et al. in the year 2000, the PA subscale shows a modest internal consistency (Cronbach α = 0.64), whereas the FA subscale showed a good internal consistency (Cronbach α = 0.92). Test-retest reliability was fair to good for the whole scale (r = 0.87).[20] The questionnaire's specific questions for each subscale are mentioned in **Table 1**.

2.6. Characteristic pain intensity

To evaluate self-reported pain intensity, we calculated the characteristic pain intensity (CPI) of the participants using the Von Korff "Chronic Pain Grade Questionnaire.[33] Characteristic pain intensity from the Von Korff questionnaire is calculated by averaging the responses to 3 questions: (1) current pain, (2) worst pain, and (3) average pain in the past 6 months or a specified time period. Each question is rated on a scale from 0 (no pain) to 10 (pain as bad as it could be). The CPI score is the mean of these 3 values multiplied by

Table 1

Items and subscales of the Fear Avoidance Belief Questionnaire.

Subscale	Disagreement			Uncertain			Agreement
PA-FABQ							
My pain was caused by physical activity	0	1	2	3	4	5	6
Physical activity makes my pain worse	0	1	2	3	4	5	6
Physical activity might harm my back	0	1	2	3	4	5	6
I should not do physical activities which (might) make my pain worse	0	1	2	3	4	5	6
I cannot do physical activities which (might) make my pain worse	0	1	2	3	4	5	6
WA-FABQ							
My pain was caused by my work or by an accident at work	0	1	2	3	4	5	6
My work aggravated my pain	0	1	2	3	4	5	6
I have a claim for compensation for my pain	0	1	2	3	4	5	6
My work is too heavy for me	0	1	2	3	4	5	6
My work makes or would make my pain worse	0	1	2	3	4	5	6
My work might harm my back	0	1	2	3	4	5	6
I should not do my normal work with my present pain	0	1	2	3	4	5	6
I cannot do my normal work with my present pain	0	1	2	3	4	5	6
I cannot do my normal work till my pain is treated	0	1	2	3	4	5	6
I do not think that I will be back to my normal work within 3 mo	0	1	2	3	4	5	6
I do not think that I will ever be able to go back to that work	0	1	2	3	4	5	6

PA-FABQ, physical activity subscale of FABQ; WA-FABQ, work-activity subscale of FABQ.

10 to produce a 0 to 100 scale. A validation study of the German version of the Von Korff "Chronic Pain Grade Questionnaire" showed modest internal consistency for the CPI ($\alpha = 0.68$).[9]

2.7. Clinical tests

2.7.1. Ott test

Participants were asked to stand straight. The physician marked the spinous process of the seventh cervical vertebra and 30 cm more caudal at the height of the 12th thoracic vertebra. Participants were then asked to perform full flexion while the physician measured the distance traveled between the 2 marked points.

2.7.2. Schober test

Participants were asked to stand straight. The physician marked the lumbosacral junction and a point 10 cm above it. Participants performed full flexion, and the physician measured the change of the distance between the 2 points.

2.7.3. Finger-floor distance test

The standing participants were asked to touch the floor with their fingers. The physician measured the distance between the fingers and the floor. In cases of high mobility, participants were asked to repeat the test standing on an 11-cm elevated platform. Therefore, maximum value of finger-floor distance test (FFD) was 11 cm within our study.

2.7.4. Sit-to-stand test

During the sit-to-stand test (STS), participants were asked to sit down on a chair and stand up again within 30 seconds while the physician counted the repetitions performed by the participant.

Table 2

Demographics of the total participants; chronic low back pain, nonchronic low back pain, and asymptomatic participants.

	Total Mean ± SD (n = 914)	cLBP Mean ± SD (n = 227)	ncLBP Mean ± SD (n = 480)	Asymptomatic Mean ± SD (n = 207)
Female	493	123	260	110
Male	421	104	220	97
BMI (kg/m^2)	23.66 ± 2.97	23.66 ± 2.85	23.56 ± 3.1	23.87 ± 2.89
Age (y)	41.93 ± 12.4	44.45 ± 11.73	41.28 ± 12.41	40.18 ± 12.92
Occupational status				
Employed	892	226	473	203
Unemployed	22	11	7	4
Marital status				
Married	619	154	179	119
Single	295	73	301	88
Pain status				
Characteristic pain intensity	37.2 ± 1.83	45.7 ± 1.70	41.3 ± 1.77	/

BMI, body mass index; cLBP, chronic low back pain; ncLBP, nonchronic low back pain; SD, standard deviation.

Table 3

Descriptive statistics for the variables under study presented by group.

	cLBP Mean ± SD (n = 227)	ncLBP Mean ± SD (n = 480)	Asymptomatic Mean ± SD (n = 207)
Ott	2.4 ± 1.0	2.6 ± 1.2	2.6 ± 1.1
Schober	4.3 ± 1.3	4.6 ± 1.2	4.8 ± 1.2
FFD	5.0 ± 13.4	2.7 ± 11.5	1.0 ± 11.9
STS	21.0 ± 5.5	22.9 ± 6.1	24.0 ± 6.0
PA-FABQ	10.3 ± 6.2	4.8 ± 6.0	2.9 ± 5.0
W-FABQ	11.1 ± 8.7	5.5 ± 7.7	3.6 ± 6.2
Thoracic Cobb	4.2 ± 6.4°	3.0 ± 6.5°	−2.4 ± 6.2°
Thoracic bending left	38.8 ± 12.5°	39.8 ± 11.3°	39.3 ± 11.9°
Thoracic bending right	36.2 ± 10.4°	36.5 ± 9.7°	37.1 ± 10.1°
Lumbar Cobb	3.4 ± 5.1°	2.4 ± 5.5°	2.3 ± 5.2°
Lumbar bending left	15.4 ± 8.0°	16.2 ± 7.2°	16.0 ± 7.2°
Lumbar bending right	16.6 ± 7.9°	17.4 ± 7.3°	17.8 ± 7.2°
Thoracic kyphosis	44.8 ± 10.3°	43.4 ± 10.6°	43.5 ± 1.0°
Thoracic extension	16.1 ± 10.0	13.8 ± 9.4°	15.1 ± 10.2°
Thoracic flexion	24.5 ± 11.0°	24.5 ± 11.7°	23.1 ± 11.1°
Lumbar lordosis	24.5 ± 8.4°	24.4 ± 8.3°	25.7 ± 7.4°
Lumbar extension	7.4 ± 5.7°	9.4 ± 6.3°	9.3 ± 6.2°
Lumbar flexion	45.9 ± 11.4°	47.0 ± 9.5°	49.4 ± 9.8°

PA-FABQ, physical-activity fear-avoidance-belief-questionnaire.

2.8. Idiag M360 measurement

The Idiag M360 (MediMouse, Idiag AG) is a handheld device that allows evaluation of back shape through 2 rolling wheels transmitting spatial data to a computer through a Bluetooth connection. The device is rolled from the spinous process of the seventh cervical vertebra through the spinous process up until the gluteal fold. For reproducible measurements, the spinous process of the seventh cervical vertebra and at a reference point 2 cm below the junction of the left and right posterior superior iliac spines were marked. Measurements are performed in the frontal plane (thoracic and lumbar Cobb angle, thoracic and lumbar bending to the left and right) and sagittal plane (thoracic kyphosis and lumbar lordosis, thoracic and lumbar extension and flexion) in both sitting and standing position. In this study, we performed measurements in standing position. Validity and reliability measurements were performed in previous studies.[2,12,27,30] Idiag M360 measurements correlated with functional x-rays of the lumbar spine, with correlation coefficients for flexion mobility of the lumbar spine (lumbar vertebrae 1 to sacral vertebrae 1, L1-S1) of 0.86.[6]

Table 4

Results from the multiple linear regression models of fear avoidance belief (independent variable) and clinical measures (dependent variables).

Independent variable	Dependent variable	Main effect			
		Estimate	95% CI		Partial η^2
PA-FABQ	Ott	−0.01	−0.03	0.00	0.00
	Schober	0.00	−0.02	0.02	0.01
	STS	−0.09	−0.17	0.00	0.00
	FFD	0.24	0.06	0.42	0.00
W-FABQ	Ott	0.00	−0.01	0.01	0.00
	Schober	0.00	−0.02	0.01	0.01
	STS	−0.09	−0.15	−0.03	0.01
	FFD	0.14	0.02	0.27	0.01

Asymp, asymptomatic (n = 207); cLBP, chronic low back pain (n = 227); ncLBP, nonchronic low back pain (n = 480); PA-FABQ, physical-activity fear-avoidance belief questionnaire; W-FABQ, work-related fear-avoidance belief questionnaire.
Separate models for each clinical measure, models with main effects (same association in each group); adjusted for group (chronic low back pain, nonchronic low back pain, asymptomatic), age, sex, and body mass index.

2.9. Statistical analysis

To determine the association between FAB (independent variables, as measured by PA-FABQ score or WA-FABQ score) and back function and shape (dependent variables, including FFD, Ott, Schober, STS, thoracic Cobb, thoracic bending to the left and right, lumbar Cobb, lumbar bending to the left and right, thoracic kyphosis, thoracic extension and flexion, lumbar lordosis, lumbar extension and flexion), we employed separate linear regression models including a nominal covariate for the respective groups (cLBP, ncLBP, asymptomatic) adjusted for age, sex (male, female), and BMI as well as CPI. Two model specifications were considered: Model A accounted only for the main effects of higher FAB on clinical and noninvasive device measurements of the respective back pain group and the PA-FABQ or W-FABQ-D score. Model B additionally accounted for the interaction between back pain group and FAB and tested different associations between FAB and functional measures in the groups. Diagnostic checks (functional form, homoscedasticity, multicollinearity, normality) were performed to check our model assumptions. The supplementary material outlines these checks in detail, http://links.lww.com/PR9/A286.

Mean differences between asymptomatic participants and the respective pain groups are reported together with 95% confidence intervals (CIs) and partial η^2 as a measure of effect size. A partial $\eta^2 < 0.01$ was considered a very small effect, a partial $\eta^2 \geq 0.01$ a small effect, a partial $\eta^2 \geq 0.06$ a moderate effect, and

Table 5

Results from the multiple linear regression models of fear avoidance belief (independent variable) and noninvasive device measurement (dependent variable).

Independent variable	Dependent variable	A (main effect)				Group	B (effects for interaction)			
		Estimate	95% CI		Partial η^2		Estimate	95% CI		Partial η^2
PA-FABQ	Thoracic Cobb	0.03	−0.07	0.13	0.00	cLBP ncLBP Asymp.				
	Thoracic bending left	−0.16	−0.34	−0.02	0.00	cLBP ncLBP Asymp.				
	Thoracic bending right	−0.22	−0.37	−0.07	0.01	cLBP ncLBP Asymp.				
	Lumbar Cobb	−0.07	−0.16	0.01	0.02	cLBP ncLBP Asymp.				
	Lumbar bending left	−0.01	−0.12	0.10	0.00	cLBP ncLBP Asymp.				
	Lumbar bending right	−0.05	−0.16	0.06	0.00	cLBP ncLBP Asymp.				
	Thoracic kyphosis	0.03	−0.12	0.18	0.00	cLBP ncLBP Asymp.				
	Thoracic extension	−0.06	−0.12	0.05	0.00	cLBP ncLBP Asymp.				
	Thoracic flexion	−0.09	−0.26	0.08	0.00	cLBP ncLBP Asymp.				
	Lumbar lordosis	0.08	−0.03	0.20	0.00	cLBP ncLBP Asymp.				
	Lumbar extension	−0.1	−0.19	−0.01	0.01	cLBP ncLBP Asymp.				
	Lumbar flexion	−0.12	−0.26	−0.13	0.00	cLBP ncLBP Asymp.				
W-FABQ	Thoracic Cobb	0.02	−0.02	0.09	0.05	cLBP ncLBP Asymp.				
	Thoracic bending left	0.05	−0.17	0.08	0.00	cLBP ncLBP Asymp.				
	Thoracic bending right	−0.09	−0.19	0.02	0.00	cLBP ncLBP Asymp.				
	Lumbar Cobb	0.00	−0.05	0.06	0.01	cLBP ncLBP Asymp.	−0.07 0.04 −0.16	−0.1 −0.04 −0.30	0.17 0.11 −0.03	0.01
	Lumbar bending left	−0.02	−0.1	0.05	0.00	cLBP ncLBP Asymp.	0.07 −0.12 0.09	−0.05 −0.22 −0.09	0.18 −0.02 0.28	0.01
	Lumbar bending right	0.02	−0.05	0.09	0.00	cLBP ncLBP Asymp.				
	Thoracic kyphosis	0.03	−0.07	0.13	0.00	cLBP ncLBP Asymp.				
	Thoracic extension	0.03	−0.07	0.13	0.00	cLBP ncLBP Asymp.				

(*continued on next page*)

Table 5 (*continued*)

Results from the multiple linear regression models of fear avoidance belief (independent variable) and noninvasive device measurement (dependent variable).

Independent variable	Dependent variable	A (main effect)				Group	B (effects for interaction)		
		Estimate	95% CI		Partial η^2		Estimate	95% CI	Partial η^2
	Thoracic flexion	0.00	0.09	0.14	0.00	cLBP ncLBP Asymp.			
	Lumbar lordosis	0.00	−0.07	0.08	0.00	cLBP ncLBP Asymp.			
	Lumbar extension	−0.06	−0.12	0.00	0.00	cLBP ncLBP Asymp.			
	Lumbar flexion	−0.09	−0.19	0.00	0.00	cLBP ncLBP Asymp.			

Asymp, asymptomatic (n = 207); cLBP, chronic low back pain (n = 227); ncLBP, nonchronic low back pain (n = 480); PA-FABQ, physical-activity fear-avoidance belief questionnaire; W-FABQ, work-related fear-avoidance belief questionnaire.
Separate model for each measure, panel A: models with main effects adjusted for group (same association in each group); panel B: models with interactions between fear-avoidance beliefs and group; only reported in case of effects (partial $\eta^2 \geq 0.01$).
All models are adjusted for age, sex, and body mass index.

a partial $\eta^2 \geq 0.14$ a large effect. R version 4.3.1 and SPSS version 27.0 were used for data analysis.

3. Results

3.1. Descriptive statistics

Nine hundred fourteen participants were included in this study. Two hundred twenty-seven presented with cLBP and 480 with ncLBP. Two hundred seven participants were asymptomatic.

Detailed demographic information on the participants is given in **Table 2**. The BMI of the participants showed significant differences in between the groups ($P > 0.038$, $\eta^2 = 0.001$). The asymptomatic participants had the highest BMI among the 3 groups. The average age of the participants was 41.9 years (±12.4). The differences of age for the respective groups were significant ($P < 0.001$; $\eta^2 = 0.02$). Characteristic pain intensity differed significantly between cLBP and ncLBP patients ($P < 0.001$, $\eta^2 = 0.001$). Mean values and standard deviations for each functional parameter are presented by group (ie, cLBP, ncLBP, asymptomatic participants) in **Table 3**. Chronic low back pain participants had mean values of 10.3 (±6.2; range 0–29) and 11.1 (±8.7; range 0–39) points on the FABQ subscales. Nonchronic low back pain participants had the average level of 2.8 (±6, range 0–24) on the PA-FABQ subscale and the average level of 5.5 (±7.7, range 0–39) on the W-FABQ subscales. Asymptomatic participants had a mean PA-FABQ score of 2.9 (±5, range 0–19) and a mean W-FABQ score of 3.6 (±6.2, range 0–28). Differences for FABQ subscales were significant ($P < 0.01$). Partial η^2 was 0.23 for differences of PA-FABQ subscale and 0.15 for W-FABQ subscale, and therefore, effect sizes were large.

3.2. Ott test, Schober test, sit-to-stand test, and finger-floor distance test

Higher FAB scores were weakly associated with lower values in Ott, Schober, and STS and with higher FFD distances (**Table 4**). Effect sizes for these associations were small ($\eta^2 \leq 0.03$). Additional tests of interaction effects, meaning differential association strength for the LBP groups, revealed no interaction effects for any of the models ($\eta^2 < 0.01$). Therefore, results of models with interactions between the FABQ-D subscales and the respective group are not reported.

3.3. Back shape und function measurements

The main effects (panel A in **Table 5**) showed that PA-FAB scores were positively associated with thoracic Cobb, thoracic kyphosis, and lumbar lordosis, as well as negatively associated with thoracic bendings to both sides, thoracic extension and flexion, lumbar Cobb, lumbar bending to the right, and lumbar flexion (**Table 4**, $\eta^2 \leq 0.02$). Work-related fear-avoidance belief was negatively associated with thoracic bending left, lumbar Cobb, and lumbar flexion (**Table 5**, $\eta^2 \leq 0.02$). Tests of interaction effects, meaning differential associations between LBP groups, revealed no effects for PA-FAB but for some measures for W-FAB. The negative association of W-FAB and lumbar Cobb was strongest for asymptomatic participants (−0.16, 95% CI: −0.30 to −0.03) and minor for the 2 LBP groups. For lumbar bending to the left, there was a positive association of W-FAB for cLBP (−0.07, 95% CI: −0.1 to 0.17) and asymptomatic participants (0.09, 95% CI: −0.09 to 0.28) and a negative association for ncLBP (−0.12, 95% CI: −0.22 to 0.02). However, the confidence intervals were large indicating weak robustness of these effects.

4. Discussion

This study aimed to examine the associations between fear-avoidance beliefs and back shape and function in participants with chronic or nonchronic low back pain in comparison to asymptomatic participants. The groups differed in regards to their FAB. Results have shown that higher levels of self-reported FAB, both physical activity and work related, were associated with worse objectively measured spinal shape and function. Effect sizes were small. An attenuation of the amplitude of clinical measures and noninvasive device measurement depending on the level of FAB was found. Furthermore, asymptomatic participants showed lower levels of FAB than cLBP or ncLBP participants. Therefore, we were able to accept the hypothesis of this study.

Fear-avoidance beliefs differed between the respective groups for both subscales. The effect sizes were large. This makes FAB

an interesting target for therapeutic approaches. Previous studies have shown the correlation of higher FAB to pain intensity and disability.[24,34] These results also support previous studies that have pointed out FAB as risk factor for chronification therefore, potentially implicating reduction of FAB as a way for individuals suffering from LBP to reduce avoidance behavior and improve back function.[1,26,29,37]

The effect of more severe FAB associated with actual back function is in line with previous research. Specifically, anticipation of pain and the consecutive avoidance of pain-triggering physical activity has been shown to correlate with reduced range of motion during leg-raising tasks, weight-bearing, or general tasks such as walking, repetitive standing up from a sitting position, and climbing stairs.[4,14,21,33] The confirmation of these previous findings is of importance in LBP as it could imply that reduction in FAB could lower pain intensity and disability and improve back function. Furthermore, this refutes prior work that had implied that FAB are only indirectly linked to functional or mood impairment due to avoidance behavior (eg, reduced physical activity).[21,22]

The role of FAB in changes of back shape and function may be the consequence of 2 adaptive mechanisms related to FAB. First, people respond to acute injuries with avoidance of pain-triggering movements to facilitate the healing process.[21] However, this can result in disuse syndrome, which in itself is associated with physical deconditioning and a high level of disability.[17] Second, expecting the occurrence of pain may potentially lead to an increased paraspinal muscle activity. Increased paraspinal muscle tone, in turn, can both enhance pain and reduce movement by favoring muscle imbalances and weakening synergistic muscle activation in flexion and extension.[3,17] As pain becomes chronic, reduced amplitudes of movement and alterations of back shape can be expected. For short-term pain avoidance (eg, acute onset of pain), the lumbar spine stiffens, whereas by mid to long term (during the chronification of pain), the thoracic spine tries to compensate with higher ranges of motion. This is consistent with previous studies that have shown associations between FAB and reduced movement amplitudes and concluded that FAB favors muscle antagonisms, which may subsequently lead to reduced range of motion and movement amplitudes.[16,32]

With respect to the frontal plane, previous findings demonstrated that spinal shape and profile only weakly correlated with Idiag M360 measures.[25] In turn, the results of the functional analysis in the sagittal profile have been validated primarily in the standing position and in some cases show excellent correlations with functional radiographs.[2,6,30] These previous studies have to be taken into account when interpreting findings of noninvasive device measurements in the frontal plane. Actual impairment in functional x-rays could potentially be more severe.

Asymptomatic participants showed the strongest association of W-FAB to measurements of back shape and function. Lumbar Cobb decreases with increasing W-FAB scores. We hypothesize that asymptomatic participants are more susceptible to work-related stressors. This could potentially activate abovementioned pathways with consecutive stiffening of spine segments. Evidence with respect to asymptomatic participants and the responses of back shape and function to stress is insufficient and should be the aim of future studies to further characterize an asymptomatic population.

Several limitations of our study are important to be mentioned here. First, our cross-sectional study design did not allow us to examine casual effects, which makes it impossible to draw temporal or casual inferences about how FAB contribute to back shape and function. Thus, we can only speculate about the possible influence of FAB on indicators of back shape and function, and any causal explanations should be treated with caution. A promising avenue for future research would be to address this gap by investigating, for example, whether FABs lead to an increase in paraspinal muscle tone and are therefore associated with changes in spinal form and function.

Second, the variance of FAB reported by the participants could have been larger (**Table 1**). This could be because of strict exclusion criteria that might have led to a selection bias of participants with—on average-lower levels of FAB. For example, the exclusion criterion of BMI > 28 kg/m^2 might have resulted in less overweight and more active sample of participants with cLBP that it might be expected in this population.

There also statistical limitations of our study. The distribution of the individual clinical tests, noninvasive device measurements, and the individual scores on the questionnaires and the values could show a potential scattering of the data. It has to be considered that the model that we have built for this analysis is not capable of sufficiently representing this scattering and consecutively weighing the changes adequately.

Furthermore, our analyses assume that the mean of the considered parameters can be expressed as a linear function of the considered covariates and that the deviations from this mean are normally distributed (normality) with a variance not depending on the considered covariates (homoscedasticity). In cases where the normality assumption fails, we can assume that approximations work because of the central limit theorem. A failure of the normality assumption should not be a cause of concern. In cases where the homoscedasticity assumption fails, the reported precision (ie, the length of the 95% confidence interval) is biased. This may lead to overestimation or underestimation depending on heteroscedasticity. We may overestimateor underestimate the precision. Finally, in cases where the functional assumption fails, our model may not be a good model for the data (depending on the degree of deviation).

Future research should investigate whether stronger associations between FAB and back shape and function may occur in a less active and more diverse sample with respect to BMI sample. However, it should be noted that the back pain groups showed a differences of large effect size, with participants with chronic low back pain showing the highest level of FAB, followed by ncLBP and asymptomatic participants.

In summary, our results indicate that especially FAB related to physical activity are associated with small changes of spinal shape and function. Fear-avoidance belief can potentially contribute to disuse syndrome and increased paraspinal muscle activity, resulting in disability, changes in back shape, and reduced back function. Identifying patients with higher levels of FAB (as particularly present in participants with back pain) can potentially advance therapeutic approaches for individuals experiencing ncLBP and cLBP. Addressing FAB as part of an intervention may also benefit the individual's back shape and function. More research is needed to corroborate the finding on the role of FAB for spinal shape and function and to examine the mechanisms underlying the association between FAB and back shape and function.

Disclosures

The authors have no conflict of interest to declare.

Acknowledgements

Availability of data: The data sets generated and analyzed during the current study are available from the corresponding author on reasonable request.

This study is part of the Research Unit 5177, which is financially supported by the German Research Foundation (DFG): PU 762/1-1, SCHM 2572/13-1, and FL 879/2-1.

Supplemental digital content

Supplemental digital content associated with this article can be found online at http://links.lww.com/PR9/A286.

Article history:
Received 26 June 2024
Received in revised form 26 November 2024
Accepted 9 December 2024
Available online 21 March 2025

References

[1] Al-Obaidi SM, Nelson RM, Al-Awadhi S, Al-Shuwaie N. The role of anticipation and fear of pain in the persistence of avoidance behavior in patients with chronic low back pain. Spine (Phila PA 1976) 2000;25:1126–31.
[2] Barrett E, McCreesh K, Lewis J. Reliability and validity of non-radiographic methods of thoracic kyphosis measurement: a systematic review. Man Ther 2014;19:10–7.
[3] Bortz WM II. The disuse syndrome. West J Med 1984;141:691–4.
[4] Geisser ME, Haig AJ, Wallbom AS, Wiggert EA. Pain-related fear, lumbar flexion, and dynamic EMG among persons with chronic musculoskeletal low back pain. Clin J Pain 2004;20:61–9.
[5] George SZ, Fritz JM, McNeil DW. Fear-avoidance beliefs as measured by the fear-avoidance beliefs questionnaire: change in fear-avoidance beliefs questionnaire is predictive of change in self-report of disability and pain intensity for patients with acute low back pain. Clin J Pain 2006;22:197–203.
[6] Guermazi M, Ghroubi S, Kassis M, Jaziri O, Keskes H, Kessomtini W, Ben Hammouda I, Elleuch MH. Validité et reproductibilité du Spinal Mouse pour l'étude de la mobilité en flexion du rachis lombaire [Validity and reliability of Spinal Mouse to assess lumbar flexion] [in French]. Ann Réadapt Méd Phys 2006;49:172–7.
[7] Hasenbring MI, Chehadi O, Titze C, Kreddig N. Fear and anxiety in the transition from acute to chronic pain: there is evidence for endurance besides avoidance. Pain Manag 2014;4:363–74.
[8] Henschke N, Maher CG, Refshauge KM, Herbert RD, Cumming RG, Bleasel J, York J, Das A, McAuley JH. Prognosis in patients with recent onset low back pain in Australian primary care: inception cohort study. BMJ 2008;337:a171.
[9] Klasen BW, Hallner D, Schaub C, Willburger R, Hasenbring M. Validation and reliability of the German version of the Chronic Pain Grade questionnaire in primary care back pain patients. Psychosoc Med 2004;1:Doc07.
[10] Kovacs FM, Arana E, Royuela A, Estremera A, Amengual G, Asenjo B, Sarasíbar H, Galarraga I, Alonso A, Casillas C, Muriel A, Martínez C, Abraira V. Disc degeneration and chronic low back pain: an association which becomes nonsignificant when endplate changes and disc contour are taken into account. Neuroradiology 2014;56:25–33.
[11] Maher C, Underwood M, Buchbinder R. Non-specific low back pain. Lancet. 2017;389:736–47.
[12] Mannion AF, Knecht K, Balaban G, Dvorak J, Grob D. A new skin-surface device for measuring the curvature and global and segmental ranges of motion of the spine: reliability of measurements and comparison with data reviewed from the literature. Eur Spine J 2004;13:122–36.
[13] Matheve T, De Baets L, Bogaerts K, Timmermans A. Lumbar range of motion in chronic low back pain is predicted by task-specific, but not by general measures of pain-related fear. Eur J Pain 2019;23:1171–84.
[14] McCracken LM, Gross RT, Sorg PJ, Edmands TA. Prediction of pain in patients with chronic low back pain: effects of inaccurate prediction and pain-related anxiety. Behav Res Ther 1993;31:647–52.
[15] Meucci RD, Fassa AG, Faria NM. Prevalence of chronic low back pain: systematic review. Rev Saude Publica 2015;49:1.
[16] Moseley GL, Nicholas MK, Hodges PW. A randomized controlled trial of intensive neurophysiology education in chronic low back pain. Clin J Pain 2004;20:324–30.
[17] Murphy D, Lindsay S, Williams AC. Chronic low back pain: predictions of pain and relationship to anxiety and avoidance. Behav Res Ther 1997;35:231–8.
[18] Nicholas MK, Linton SJ, Watson PJ, Main CJ, "Decade of the Flags" Working Group. Early identification and management of psychological risk factors ("yellow flags") in patients with low back pain: a reappraisal. Phys Ther 2011;91:737–53.
[19] Nordstoga AL, Meisingset I, Vasseljen O, Nilsen TIL, Unsgaard-Tøndel M. Longitudinal associations of kinematics and fear-avoidance beliefs with disability, work ability and pain intensity in persons with low back pain. Musculoskelet Sci Pract 2019;41:49–54.
[20] Pfingsten M, Kröner-Herwig B, Leibing E, Kronshage U, Hildebrandt J. Validation of the German version of the fear-avoidance beliefs questionnaire (FABQ). Eur J Pain 2000;4:259–66.
[21] Pfingsten M, Leibing E, Harter W, Kröner-Herwig B, Hempel D, Kronshage U, Hildebrandt J. Fear-avoidance behavior and anticipation of pain in patients with chronic low back pain: a randomized controlled study. Pain Med 2001;2:259–66.
[22] Pfingsten M. Angstvermeidungs-Uberzeugungen bei Ruckenschmerzen. Der Schmerz 2004;18:17–27.
[23] Post RB, Leferink VJ. Spinal mobility: sagittal range of motion measured with the SpinalMouse, a new non-invasive device. Arch Orthop Trauma Surg 2004;124:187–92.
[24] Ross MD. The relationship between functional levels and fear-avoidance beliefs following anterior cruciate ligament reconstruction. J Orthop Traumatol 2010;11:237–43.
[25] Ripani M, Di Cesare A, Giombini A, Agnello L, Fagnani F, Pigozzi F. Spinal curvature: comparison of frontal measurements with the Spinal Mouse and radiographic assessment. J Sports Med Phys Fitness 2008;48:488–94.
[26] Ryum T, Stiles TC. Changes in pain catastrophizing, fear-avoidance beliefs, and pain self-efficacy mediate changes in pain intensity on disability in the treatment of chronic low back pain. Pain Rep 2023;8:e1092.
[27] Serbic D, Pincus T. Diagnostic uncertainty and recall bias in chronic low back pain. PAIN 2014;155:1540–6.
[28] Staerkle R, Mannion AF, Elfering A, Junge A, Semmer NK, Jacobshagen N, Grob D, Dvorak J, Boos N. Longitudinal validation of the fear-avoidance beliefs questionnaire (FABQ) in a Swiss-German sample of low back pain patients. Eur Spine J 2004;13:332–40. Erratum in: Eur Spine J. 2007;1610:1750–1.
[29] Tagliaferri SD, Wilkin T, Angelova M, Fitzgibbon BM, Owen PJ, Miller CT, Belavy DL. Chronic back pain sub-grouped via psychosocial, brain and physical factors using machine learning. Sci Rep 2022;12:15194.
[30] Topalidou A, Tzagarakis G, Souvatzis X, Kontakis G, Katonis P. Evaluation of the reliability of a new non-invasive method for assessing the functionality and mobility of the spine. Acta Bioeng Biomech 2014;16:117–24.
[31] Thomas JS, France CR. The relationship between pain-related fear and lumbar flexion during natural recovery from low back pain. Eur Spine J 2008;17:97–103.
[32] van Dieën JH, Flor H, Hodges PW. Low-back pain patients learn to adapt motor behavior with adverse secondary consequences. Exerc Sport Sci Rev 2017;45:223–9.
[33] Vlaeyen JWS, Kole-Snijders AMJ, Boeren RGB, van Eek H. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. PAIN 1995;62:363–72.
[34] Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. PAIN 1992;50:133–49.
[35] Waddell G, Newton M, Henderson I, Somerville D, Main CJ. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. PAIN 1993;52:157–68.
[36] Wertli MM, Rasmussen-Barr E, Held U, Weiser S, Bachmann LM, Brunner F. Fear-avoidance beliefs-a moderator of treatment efficacy in patients with low back pain: a systematic review. Spine J 2014;14:2658–78.
[37] Woby SR, Watson PJ, Roach NK, Urmston M. Are changes in fear-avoidance beliefs, catastrophizing, and appraisals of control, predictive of changes in chronic low back pain and disability? Eur J Pain 2004;8:201–10.
[38] Zamri EN, Hoe VCW, Moy FM. Predictors of low back pain among secondary school teachers in Malaysia: a longitudinal study. Ind Health 2020;58:254–64.