Are fear avoidance beliefs predictors or consequences of physical activity in low back pain patients? A cross-lagged panel analysis

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Abstract (<= 150 words)

A secondary analysis served to investigate whether fear-avoidance beliefs (FABs) are predictors or consequences of the physical activity level in low back pain (LBP) patients. A total of 787 individuals were followed up over a period of one year with repeated measurements of FABs and physical activity.

Structural equation modelling in a cross-lagged panel design did not support the "deconditioning –paradigm" inherent in the FAB-model. Cross-lagged path coefficients were low (.04 and .05 respectively) and, therefore, did not allow to predict final physical activity by initial FABs or vice versa.

Consequently, due to missing links between FABs and physical activity in a longitudinal design, the assumptions of the FAB-model have to be questioned. These findings are in line with other investigations published recently. Most probably, FAB represents a cognitive scheme that does not limit activity per se, but only is directed to the avoidance of specific movements.

Key words: fear-avoidance beliefs, physical activity, low back pain, structural equation modelling, cross-lagged panel design, longitudinal study

1. Introduction

The fear-avoidance beliefs (FAB-) model explains why a minority of low back pain sufferers develop a chronic pain problem (Asmundson et al., 2004; Vlaeyen and Linton, 2000; Leeuw et al., 2007). Long-term consequences of catastrophic misinterpretations of pain initiate a vicious circle of pain-related fear, associated safety seeking behaviours, avoidance of physical activity and, finally, the emergence of a “disuse syndrome” as a consequence of long lasting avoidance behaviour (Verbunt et al., 2003). The “disuse syndrome” refers to the physiological and psychological consequences of long-term inactivity whereas the term “disuse” can be described as a behavioural component leading to physical inactivity (Verbunt et al., 2004). “Physical deconditioning” is thought to represent one aspect of disuse, namely a decreased level of physical fitness such as a reduced level of aerobic fitness, as well as a loss of muscular strength and endurance (Leeuw et al., 2007, Smeets and Wittink, 2007). Following this model, FABs should predict physical activity in the course of low back pain.

Hasenbring et al. (1994, 2006) put forward another explanation for the process of chronicity: the avoidance-endurance model. These authors found a subgroup of chronic LBP patients who, due to personal characteristics, overstrain their muscles by maintaining or even increasing the level of physical activity they used to show prior to the occurrence of pain. This way of coping will have another effect on the level of physical activity in daily life. These patients will report physical activity levels which fluctuate dramatically over time in reaction to pain in terms of “all-or-nothing-behavior”. In comparison with the FAB-coping strategy these patients could display more physical activity in daily living (Hasenbring et al., 2006). In the long run this way of coping will result in low levels of activity, too (Verbunt et al., 2004).

“Disuse” and “deconditioning” as components of the “fear-avoidance model” are not unambiguously confirmed by recent studies (Leeuw et al., 2007). In the first place, it is unclear whether a low back pain (LBP) patient´s physical fitness level really decreases after pain-onset (Bousema et al, 2007; Wittink et al, 2000). Additionally, differences between LBP patients and healthy controls in the level of physical activity measured by self report or activity monitoring have not been unambiguously confirmed. Verbunt et al. (2003) came to the conclusion that chronic LBP patients and healthy controls do not differ significantly with regard to aerobic fitness. Van den Berg-Emons et al. (2007) only found minor differences between the levels of physical activity in a sample of heterogeneous chronic pain patients and healthy controls, whereas Spenkelink et al. (2002) and Nielens and Plaghki (2001) detected lower activity patterns in patients with chronic LBP.

Verbunt et al. (2004), however, question the assumption that decreased activity patterns are a consequence of fear avoidance. These patterns may as well be explained by changes in life style due to absenteeism or loss of the work place often associated with ongoing pain. Other authors assume that possible changes in physical activity cannot be explained by changes in intensity, but by changes in the quality of the activity. Leeuw et al. (2007) propose a disordered motor coordination to be more salient than a reduced level of general fitness. Consequently, most likely patients only avoid specific activities that they believe may be related to an increased risk of pain and re-injury. This is in accordance with Pincus et al. (2006) who in a review conclude that there may be other pathways to avoidance behavior besides feelings of fear.

Smeets and Wittink (2007) discussed the assumption that the positive effect of reconditioning and functional restoration on physical activity and decreased disability are indirect proofs of the “deconditioning paradigm”. According to a review by Smeets et al. (2006) there is no strong evidence for the existence of physical deconditioning symptoms regarding cardiovascular capacity, paraspinal muscle strength and endurance in chronic LBP-patients. Although physical reconditioning (Mayer and Gatchel, 1988; Teasell and Harth, 1996) has been proposed as a major objective in the treatment of chronic low back pain patients for years, a recent review found strong evidence that there is no relationship between reduced trunk muscle endurance and the risk of low back pain (Hamberg-van Reenen et al., 2007). The “COST B13 Working group on Guidelines for Chronic Low Back Pain” conclude that there is strong evidence that reconditioning exercises are not more effective than other types of exercises for these patients (Airaksinen et al., 2006). The beneficial effects of reconditioning, therefore, cannot be used to support the deconditioning hypothesis. Most likely the positive outcomes of these studies are linked to a psychosocial reactivation of the patient inherent in these programs (Smeets et al. 2006, Hurwitz et al., 2005). According to Smeets et al. (2006), the supposed mechanisms of the training programs are the reduction of fear avoidance, depressive symptoms, pain anticipation and pain perception as well as an increase of self-efficacy.

Another reason for recent failures to support the deconditioning paradigm may be seen in methodological constraints of the studies. Originally, the FAB-model served to explain the transition from acute to chronic pain and not the course of chronic pain. In contrast, most of the studies about FABs did not include acute, but chronic LBP patients. The association between FABs and physical activity may be different in both samples. Grotle et al (2006), for example, found in a prospective cohort study over a period of one year that FABs only decreased in the acute sample, but not in the chronic one. Consequently, associations between FABs and PAL should be different dependent on the state of chronicity.

In summary, there is growing evidence that FABs do not automatically lead to decreased levels of physical activity in LBP patients, although few studies exist that use a longitudinal design. Such a design is essential to evaluate mutual causal dependencies of FAB and PAL (Verbunt et al., 2004).

Structural equation modelling is an analytic procedure which takes a confirmatory (hypothesis-testing) approach guided by existing theories or models. It combines multiple regression and factor analysis procedures (Burkholder and Harlow, 2003). Cook et al. (2006) applied this methodology in a cross-sectional analysis of a heterogeneous sample of chronic pain patients and were able to confirm relationships suggested by the FAB-model. Due to the longitudinal design, the present study holds the potential not only to present associations between the variables of the model but also to suggest causal relationships. Moreover, in contrast to the Cook et al. study, the present study only includes patients with a diagnosis of LBP. The assumptions of the study are:

1. High fear-avoidance beliefs result in low levels of physical activity at a one year follow-up.
2. Low levels of physical activity result in (due to a viscious circle) more pain and, consequently, in high fear avoidance beliefs at a one year follow-up.

3. There are differences in the associations between fear-avoidance beliefs and physical activity in acute and chronic low back pain sufferers.

2. Methods

2.1. Design

The analysis is based on data that emanate from a three-armed randomized controlled intervention study in primary care. The study design and the interventions have been described in detail previously (Becker et al., in press; Leonhardt et al., 2007b). The present cohort sample comprises all patients with complete measurement enrolled in that trial. The primary objective of the RCT was to assess the impact of guideline-based treatment and motivational counseling on functional capacity in patients with LBP. The intervention consisted of intensive seminars for general practitioners on an evidence-based LBP guideline (in both intervention arms) and of a training of practice nurses in motivational counseling to promote patients´ physical activity (in one intervention arm). The study was conducted in two centers in Germany (Marburg, Göttingen) in the period from 2003 to 2004.

We contacted 818 general practices surrounding both study centres; addresses were obtained from local health authorities. 118 practices agreed to participate. Ethical approval was obtained from both study sites.

The statistical analysis did not reveal differential effects of the interventions neither for physical activity nor fear avoidance beliefs, thus enabling inclusion of the whole sample in the present analysis (Becker et al., in press).

2.1. Inclusion criteria

During the recruitment period, practice nurses asked consecutive patients with LBP to participate in the study. All patients meeting the inclusion criteria during the recruitment period were registered. Inclusion criteria were actual LBP on the day of inclusion, age above 19, ability to read and to understand German, and written consent. Exclusion criteria were pregnancy and isolated thoracal or cervical pain.

2.2. Data collection and outcome measures

At the index visit, patients were asked to fill out two sets of questionnaires, one while waiting and another one at home (socio-demographic and disease-related data). One baseline telephone interview (within 4 weeks) and two follow-up interviews (after 6 and 12 months) were performed by specially trained study nurses.

General practitioners evaluated each patient regarding warning signs for complicated LBP ("red flags").

The following measures are included in the present analysis:

Physical activity was assessed by the Freiburger Questionnaire on Physical Activity (FQPA; Frey et al., 1999). The questionnaire uses 12 items to detect the amount of health-related physical activity. Items 9-12, which ask about sleep, recreation time and self-evaluation, were left out in the context of this study to reduce the patients' answering burdon.

Frey et al. (1999) report retest-reliability-scores between $r = .35$ and $r = .91$. The validation procedure relied on maximum oxygen uptake (VO_2max) which was used as a criterion. VO_2max is the highest value which an individual can achieve during the final minute of incremental exercise and a measure of maximal aerobic power. VO_2max correlated with the total of reported sportive activities by $r = .42$ ($p < .01$).

The FQPA has satisfactory measurement properties and allows a calculation of weighted metabolic equivalent (MET) hours/week. One MET represents the amount of oxygen used by an average seated person and increases with the intensity of exercise. The coding for the MET intensity for the different activity types is based on the compendium of physical activities from Ainsworth et al. (2000). Activities are listed in the compendium as multiples of the resting MET level and range from 0.9 (sleeping) to 18 METs (running at 10.9 mph). We calculated the total MET score for each participant by multiplying the duration of an activity by the energy expenditure listed for this activity. A principle advantage of this method is the option of incorporating different activities into one single total MET score. The scores can be summarized in MET hours /week or in kcal/week for daily activities (low to moderate intensities), leisure time physical activity, sports activity and an overall estimate of total physical activity.

For the measurement of fear-avoidance beliefs we utilized the German version of the „Fear-Avoidance-Beliefs-Questionnaire“ (FABQ; Waddell et al., 1993) by Pfingsten et al. (1997). This questionnaire assesses the cognitive aspect of pain-related fear-avoidance on 7-point Likert-scales focusing on patients' beliefs about how physical activity and work affect LBP. The German FABQ version shows a different factor structure from the original English version. The factor “physical activity” remained the same as in the English version, the second factor of the original version split into two: one related to, “work as cause of pain” and the other to “patients' assumptions of their probable return to work” (Pfingsten et al., 2000). The subscales showed modest to good internal consistencies. In the present context, the subscale “physical activity” (FABQphys; range from 0-30) was used to determine the relationship between beliefs and reported physical activity. Pfingsten et al. (2000) found a Cronbach´s $\alpha = .69$, whereas we calculated a Cronbach´s α = .73 in a sample of primary care patients (Leonhardt et al., 2007a).

A procedure suggested by von Korff (1994) served to classify the natural history of LBP. Patients were assigned to an acute status if they had experienced one single episode of LBP of less than 90 days duration within the last 12 months. Patients assigned to a chronic status indicated multiple episodes of LBP of less than 90 days duration or more than 90 consecutive days of LBP within the last 12 months.

Descriptive data are shown for functional capacity (Hannover Functional Ability Questionnaire for Measuring Back Pain-Related Functional Limitations; HFAQ, Kohlmann and Raspe, 1996), depression (CES-D, German version Kohlmann and Gerbershagen, 2006) and sociodemographic characteristics.

2.3. Statistical analyses

Preliminary and univariate analyses.

Since the distribution of the MET hours/week was highly skewed, we report mean and median values when appropriate. We also performed an outlier correction for MET hours/week by "winsorizing" the distribution (values of the 98th percentile and above were set to this value).

In a first step, descriptive data of the variables incorporated into the structural equation model (SEM) as well as bivariate correlations have been computed for the total sample and separately for acute and chronic patients utilizing the statistical package SPSS 12.0.

Structural equation modeling.

The subsequent structural equation model relied on the AMOS 6.0 computer program (Arbuckle, 2006). A two-wave cross-lagged panel analysis was conducted to examine the associations between FAB und physical activity. Panel designs are useful for assessing causality between two variables that are measured at multiple time points. Crossed lagged panel designs can be analysed by structural equation modelling. Within this approach different associations can be analysed (see figure 1). It is possible to explore the data cross-sectional and the stability of the variables over time (stability coefficients). Moreover normal causal effects can be calculated (hypothesis 1) as well as reversed effects (hypothesis 2) which can be done in a reciprocal causation model (combining regular and reverse causation).

-Figure 1: Cross-lagged panel design of FAB and activity-

Model identification

Physical activity was operationalized as a manifest variable (MET-hours/ week) in the model. It was not possible and not expedient to conceptualize physical activity as a latent variable. With the FQPA (Freiburger Questionnaire on Physical Activity) different activity types can be summarized to a total amount of physical activity in MET-hours/ week which is a valid self-assessment of physical activity. Because of the inevitable heterogeneity of this variable the specification of a latent variable was not reasonable. This was emphasized by exploratory factor analyses of the questionnaire. Due to characteristics of AMOS software we had to generate an artificial latent variable, by adding an error term to the manifest variable and fixing the error variance to 0 and the loading value to 1 in order to identify the fully cross-lagged model.

FABs were conceptualized as a latent variable represented by two item parcels (groups of items). Item parcelling has the advantage of higher reliability compared with item-level data and models based on parcelled data are more parsimonious (Little et al., 2002). We created the identical parcels for both time-points on the basis of exploratory conducted factor and reliability analyses. Variations in item-parcelling had no effect on the associations between FABs and physical activity.

Following a recommendation of Hu et al. (1992), we applied a maximum-likelihood-procedure (ML) because of its robust performance in a variety of situations. All analyses were based on the covariance matrix.

Assessment of Model fit

Fit indices indicate the extent to which the covariances among the variables are accounted for by the hypothesized model. It is recommended to include absolute and incremental fit indices. Absolute fit indices assess how well an a priori model reproduces the sample data, while incremental fit indices measure the proportionate improvement in fit by comparing a target model with a more restricted baseline model. The following criteria were used (see Byrne, 2001; Kline, 2005; McDonald and Ho, 2002; Hu and Bentler, 1999):

We report chi-square statistic test (overall fit of the model) although this index is sensitive to sample size and often inflates Type 1 error. Non-significant or small chi-square values indicate that the model fits the data well. However, in large samples even small and substantively unimportant differences between the estimated model and the "true" underlying model will result in rejection of the model that is tested (Bentler, 1990; Bentler, 2007). Therefore, other indices are more appropriate and recommended for larger samples.

The “Root-mean-square error of approximation” (RMSEA; Steiger, 1990) is a fit measure based on population error of approximation. It quantifies the divergence between the data and a proposed model per degree of freedom. Values of .05 or less indicate a close fit in large samples.

The “Comparative fit index” (CFI; Bentler, 1990) is an incremental fit-index that produces a statistic in the range between 0 and 1. It represents the proportionate improvement in model fit by comparing the fitted model with an independence model. Indices of more than .90 are considered as good and ideally they are greater than .95.

The “Standardized root mean squared residuals” (SRMR) is a global fit index and refers to the fitted residuals. Values should ideally be close to .08 (Hu and Bentler, 1999).

3. Results

Prior to the data analysis, selection bias had to be considered. While the overall drop out rate at the one year follow up was only 12 %, 43 % provided missing data in any one of the included variables at any one time. We decided to use the 57 % of the original sample with complete panel data (N = 787).

Mann-Whitney-U-tests for MET hours/ week showed significant differences at baseline (*T1: Mann-Whitney Z* = -5.27, *p*<.01) and at the 1-year-follow up (*T2: Mann-Whitney Z* = -2.61, *p*<.01) between those who were included (*T1 M*: 37.4, *SD*: 31.9; *T2 M*: 46.7, *SD*: 37.8; p< .01) and those who were excluded from the present sample (*T1 M*: 31.5, *SD*: 33.5; *T2 M*: 41.5, *SD*: 34.9). Changes in MET units over time were the same in both groups.

The sample of this secondary analysis was significant younger than that of the excluded patients (*M*: 48 years; *SD*: 12.9 versus *M*: 52 years, *SD*: 14.8; $t = 4.40$, $df = 780.2$, $p < .01$).

No differences were found for the initial values of fear-avoidance beliefs and gender.

3.1 Preliminary analyses

Sociodemographic and baseline characteristics

Of the whole sample, 57 % are female with a mean age of 48 years. The chronic sub-sample is a little older (rounded mean age 50 versus 45 years) and comprises more female LBP sufferers (64 % versus 50 %). The level of education and the employment status is lower in the chronic sub-sample in comparison to the acute LBP patients. The amount of patients who applied for a pension in the chronic group of patients (13 %) exceeds threefold the proportion in the group of acute patients (4 %). Table I presents in detail selected demographic characteristics for the sample included here.

-table I here-

At baseline, the LBP patients already reported a relatively high amount of physical activity in the questionnaires. The MET hours/ week indicated a higher activity in the chronic LBP patients (*Mean*= 41.1, *Median*= 31.9, *SD*= 34.3) compared to the acute sub-sample (*Mean*= 34.7, *Median*= 27.0, *SD*= 29.7). Both groups increased their total physical activity level significantly after one year (*Mean*= 45.3, *Median*= 37.9, *SD*= 34.1 and *Mean*= 48.6, *Median*= 36.2, *SD*= 42.3, respectively). It is striking that the

basic activity decreased in both groups (significant only in the chronic sub-sample) whereas the leisure time physical activity and sports activity increased over one year. The FABQphys-scores were higher in the chronic sub-sample and decreased less to the 12-month follow-up assessment.
Table II shows the selected descriptive characteristics and significant periodic changes for both sub-samples.

-table II here-

Bivariate Correlations between Physical Activity and Fear Avoidance Beliefs
We calculated the bivariate correlations between the physical activity level (PAL)-scores and the FABQphys-scores from both time points. Because the total physical activity scores are highly skewed we report the Spearman's rank-correlations. Overall, the correlations (displayed in table III) are unexpectedly low.

-table III here-

3.2. Structural Equation Modeling Results
Fear-Avoidance Beliefs concerning physical activity were implemented as a latent variable in the model with two parcels from the FABQphys-scale. Internal consistencies of the parcels were α= .73/ .68 at baseline and α= .78/ .65 at the 12month-measurement point.

We first tested the fit of the model with the cross-lagged coefficients of physical activity (PAL) and fear avoidance beliefs (FABphys) for the whole sample according to our hypotheses 1 and 2.

The stability coefficients for PAL and FAB phys were .42 and .66, respectively. The cross-lagged correlations were very low with .05 for the path [FABphys Time 1] → [PAL 12months] and .04 for the path [PAL time 1] → [FABphys 12months].
Figure 2 presents the result of the tested cross-lagged-panel design within a 12month time lag.
Overall, the model accounts for approximately 17 % of the variance in long-term physical activity and for 43 % of the fear-avoidance beliefs over one year.
The fit of the model was good with the following fit indices: $\chi^2(5) = 25.96$, $p< .001$; CFI = .974, RMSEA = .0209; SRMR = .021.

-Figure 2 here-

According to our hypothesis 3 we performed two separately analyses, one for the acute and one for the chronic LBP-patients. The results were similar to the SEM-result for the whole sample with slightly different fit indices. The cross-lagged correlations for the acute subgroup were: [FABphys time 1] → [PAL 12months] = .02, [PAL time 1] → [FABphys 12months] = .03; and for the chronic subgroup: [FABphys time 1] → [PAL 12months] = .08, [PAL time 1] → [FABphys 12months] = .03.
Table IV details the various fit indices for the three models tested.

-here table IV-

Discussion

The results of the structural equation analysis did not support the assumptions. There was a good fit of the model that conceptualises physical activity as a manifest variable and FAB as a latent variable represented by two parcels of the FABQ-subscale “physical activity”. Contrary to our expectations, the cross-lagged path coefficients were very low and neither allowed to predict physical activity at follow-up by initial FABs nor FABs at follow-up by initial activity. A separate analysis for acute and chronic states yielded the same results.

Inspection of the course of physical activity over a period of one year showed an increase both in the acute and in the chronic group as far as sportive and leisure time activities were concerned. The total physical activity score indicated a higher activity in the chronic LBP patients at baseline compared to the acute sub-sample. Activities of daily life, however, remained largely unchanged, even diminished in the chronic group. With respect to FABs, at the final assessment patients in both groups were less prone to attribute their present condition to the burden of physical activity. The belief that pain was due to past physical activity did change only in the acute sub group.

Results reported in the literature appear inconclusive, but tend to support our findings. Elfving et al. (2007) found an association between fear-avoidance beliefs and self-reported physical activity in a cross-sectional study. Physical activity was rated on a six-level scale for summer and winter activities, which seems less differentiated in comparison to the FQPA and to the computation of MET units. Elfving and colleagues dichotomized the physical activity score and analysed the associations by logistic regressions. Moreover, what the authors measured may have been closer to the construct of disability. In fact, the effect of pain-related fear on disability was frequently reported in the past (e.g. Basler et al., 2006; Fritz et al., 2001; Grotle et al., 2004). The results of other authors, however, corroborate our findings. In addition to those studies reported in the introduction section, Verbunt et al. (2003) also did not detect an association between fear-avoidance beliefs and aerobic-fitness (VO_2max) in patients with subacute non-specific LBP. Although Smeets et al. (2006) found differences in aerobic fitness levels between CLBP patients and healthy controls, fear-avoidance beliefs were not associated with lower aerobic fitness. Leeuw et al. (2007), in summarizing the empirical evidence, concluded that neither lower physical activity levels nor the physical consequences of long-term avoidance behaviour in CLBP patients have been confirmed to date.

In the present study, a decrease of basic activity was only found in the chronic sample, whereas both groups increased their sportive and leisure time activities. Contrary to our findings, Bousema et al. (2007) did not see a change in physical activity in a sample of sub-acute LBP patients over one year. Accelerometer measurements as well as subjective reports did not allow the assumption of a general decline of deconditioning; only a subgroup of individuals appeared to be affected. The authors concluded that CLBP patients in general seem to be able to cope with their pain in such a way that they maintain their daily activities.
With regard to the unexpected result that the chronic subgroup has a higher amount of total physical activity at baseline and follow-up we still have to keep in mind the possibility that a subgroup of patients could cope with their pain using endurance strategies and overload their muscles (Hasenbring et al., 2006).
Our findings rather support the assumption that repeated measurements contributes to an increase of physical activity with the exception of activities of daily living in the chronic sample. One explanation might be that patients in the process of chronicity tend to avoid certain types of activities that appear especially harmful. Indeed, there is growing evidence for the assumption that fear of movement is not a phobic state generalized to reduced activity and deconditioning, but more likely a dysfunctional cognitive scheme for specific movements only. Kronshage (2001) studied anxiety

regarding certain movements with the startle paradigm. She and her colleagues hold the opinion that the FABQ (Waddell et al., 1993) is indicative rather of cognitive components of activity related fear than of behaviour itself. Avoidance behaviour in terms of *specific* activities and not in terms of the total amount of physical activity probably reflects individual beliefs and attitudes concerning back stressing movements (Kronshage et al., 2001). This could also be an explanation for our findings: Patients only avoid movements which they assume to be dangerous, but do not reduce their general level of activity.

This argument will be strengthened by findings from Vlaeyen et al. (2002) who could show that individually tailored exposure in vivo treatment was superior to graded activity treatment in decreasing levels of fear of movement/ (re)-injury.

Limitations

One limitation of the study is reliance on self-report instruments. Bias from failure of memory or social desirability cannot be excluded. Objective measurements like triaxial accelerometers will have to be included in future studies. But even with the use of technological equipment, the control of performance bias remains difficult. It is well known that measurement itself produces higher activity scores (van Sluijs et al., 2006). We can also not exclude that repeated measurements contributed to a self-reported increase in physical activity.

On the other hand, the “Freiburger Questionnaire on Physical Activity” (FQPA) is a well-documented, validated questionnaire with allows a differentiated measurement of the modality, the intensity, and the duration of the activity. Moreover, apart from complex observation tools and physical examinations self-reports appear to be an effective way to determine the kind of activity an individual performs. Given the assumption that avoidance behaviour only reflects certain types of activities, questionnaires and observational methods are prone to play an important role in future research. They may be supplemented by the assessment of specific signs for deconditioning like neuromuscular changes or fibre changes of deep lumbar muscles (Smeets and Wittink, 2007). As Verbunt et al. (2003) underscored, several physical domains can be affected by disuse, not only activity in daily life (Verbunt et al., 2003). Nevertheless, from a methodological perspective the conclusion seems to be justified that our findings further support the assumption that there is no causal pathway neither from FABs to PAL nor from PAL to FABs.

Another limitation is a potential selection bias. In fact, we have pointed out in prior analyses (Leonhardt et al., 2007b) that an increased motivation for physical activity might have influenced the decision to participate. Moreover, in the present study individuals with incomplete data sets had to be excluded for methodological reasons. Although included and excluded patients did not differ in the magnitude of fear avoidance beliefs and in the magnitude of changes in physical activity over one year, a statistical analysis showed that excluded individuals were older and less physically active both at the beginning and at the end of the study. This may explain why in comparison with a survey on the general German population (Rütten and Abu-Omar, 2004) the level of physical activity in the present sample was unexpectedly high. Consequently, the assumption seems to be justified that the excluded patients might have been more disabled and less motivated to take any additional effort in addition to participating in the treatment options. In fact, the phenomenon that more disabled patients are less prone to collaborate meticulously in scientific studies has been observed before (Cutler et al., 2001; Storheim et al., 2003). Based on theses findings, the generalization of the present results might be restricted to the sample of younger and more active individuals among patients with low back pain.

We did not stratify for gender. Indeed, there are findings that aerobic fitness levels are often less affected in female than in male pain patients (Nielens and Plaghki, 2001, Wittink et al., 2000). However, we could not find physical activity to be influenced by gender in prior analyses (Leonhardt et al., 2007a), and, therefore, abstained from gender analyses.

Conclusions

In the present study we did not find sufficient evidence to maintain the assumption of a general lack of physical activity in LBP patients and, therefore, of a need to have them “reconditioned”. Although we cannot rule out selection bias in our study, we will have to think about other reasons that explain the positive outcome of exercise therapies (Hayden et al., 2005) apart from solely an increase of physical fitness. Possibly, the change of cognitions like self-efficacy or perceived advantages of activity play a more important role in the adoption and maintenance of physical activity than fear avoidance beliefs themselves. Consequently, the psychology of motivation in LBP patients does not appear to be so different from healthy individuals. George et al. (2003) demonstrated that a focus on fear avoidance in the treatment can also produce adverse effects. A fear-avoidance based physical therapy only showed beneficial effects in patients who scored high on a FAB-scale at the beginning (see also Klaber Moffett et al., 2004). Smeets et al. (2006) argued that we have to widen our perspective and have to admit the interplay between many different factors in the framework of a bio-psycho-social model that will have to be specified in future studies. Beta-Endorphin levels or other mediators and moderators have to be studied for apparent physical-activity-induced effects in pain patients (Hurwitz et al., 2005).

Future research will have to address the identification of specific activities avoided by the patients. This includes the elaboration of more specific assessment instruments with respect to both subjective self-report and objective measurements of movements and activities. Moreover, the underlying mechanisms of the beneficial effects of functional restoration and reconditioning will have to be studied in more detail. The incorporation of fear avoidance beliefs may only be an option for those individuals with very high scores on respective scales.

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Table I: Selected Baseline Characteristics

	Classification of pain at baseline	
	Acute **(<=*90 days of pain per year*)**	**Chronic** **(>*90 days of pain per year)***
Age (Mean, SD)	45.4 (12.3)	50.4 (13.2)
Gender (N, %)		
Men	225 (49.9)	121 (35.8)
Women	224 (50.1)	217 (64.2)
Marital status (N, %)		
Single	81 (18.2)	42 (12.5)
Married	317 (71.4)	232 (69.0)
Widowed	13 (2.9)	19 (5.7)
Divorced	33 (7.4)	43 (12.8)
Living with partner (N, %) (Yes)	360 (82.8)	261 (79.6)
Level and years of education (N, %)		
13/12 years	141 (31.8)	76 (22.6)
10 years	160 (35.9	103 (30.7)
9 years	137 (30.8)	150 (44.6)
other graduation	5 (1.1)	7 (2.1)
No qualification	2 (0.4)	0 (0.0)
Employment status (N, %)		
Working full or part-time	337 (75.8)	202 (59.9)
Housewife	37 (8.3)	32 (9.5)
Retired	51 (11.5)	81 (24.0)
Unemployed	14 (3.1)	15 (4.5)
Other	6 (1.3)	7 (2.1)
Applied for a pension (N, %)	16 (3.7)	42 (13.1)
BMI (Mean, SD)	26.5 (4.77)	26.6 (4.6)
Job satisfaction (NRS 0-10) (Mean, SD)#	6.3 (2.3)	5.9 (2.5)
Depression (CES-D) (Mean, SD)	13.9 (9.0)	15.5 (9.0)

only employed patients (N=342/ 209)

Table II: Selected descriptive characteristics at baseline and after one year

	Acute LBP (<= 90 days/ year) N=449		**Chronic LBP (> 90 days/ year) N= 338**	
Mean (SD)	Baseline	> 12 months	Baseline	> 12 months
Total Physical Activity Level (MET-hours/ week)	34.7 (29.7)	45.3 (34.1) [a] **	41.1 (34.3)	48.6 (42.3) [a] **
Median	27.0	37.9	31.9	36.2
Daily activities	16.8 (17,5)	16.2 (14,9)	20.7 (22,2)	16.9 (18,0) [a] **
Sportive activities	7.8 (12,4)	13.9 (18,5) [a] **	8.9 (13,9)	15.5 (20,4) [a] **
Leisure time activities	9.6 (11,4)	14.1 (16,5) [a] **	10.0 (11,1)	13.5 (16,8) [a] **
FABQphys (physical activity)	17.0 (6.7)	15.2 (7.6) [b]**	18.4 (6.4)	17.8 (6.9)

[a] **Wilcoxon-matched-pair-test: significant periodic change with $p < .01$
[b] **t-test: significant periodic change with $p < .01$

Table III: Correlations (Spearman-Rho) between fear-avoidance beliefs and physical activity at T1 (baseline) and T2 (1 year later)

	FABphys T1	FABphys T2	PAL T1
Whole sample (N=787)			
FABphys T1			
FABphys T2	.432**		
PAL T1	-.088*	-.010	
PAL T2	-.019	-.099**	.416**
Acute LBP patients (n= 449)			
FABphys T1			
FABphys T2	.412**		
PAL T1	-0.93*	-.011	
PAL T2	-0.46	-.098	.428**
Chronic LBP patients (n=338)			
FABphys T1			
FABphys T2	.432**		
PAL T1	-.095	-.040	
PAL T2	.013	-.098	.411**

FABphys: fear-avoidance beliefs concerning physical activity (FABQ, scale 1)
PAL: physical activity level in MET-hours/week (Freiburger Questionnaire on Physical Activity)
* significant p< .05
** significant p< .01

Table IV: Fit indices of tested models

Model tested	df	X^2	p	CFI	RMSEA	SRMR	R^2 PAL >12 months	R^2 FABphys >12 months
Whole sample (N=787)	5	25.96	<.001	.974	.0209	.021	.17	.43
Acute LBP patients (n= 449)	5	13.63	=.018	.980	.062	.0197	.18	.38
Chronic LBP Patients (n=338)	5	12.27	=.031	.978	.066	.0252	.17	.49

χ^2: Chi-Square goodness of fit test
CFI: Comparative fit index
SRMR: Standardized root mean squared residuals
RMSEA: Root mean square error of approximation
PAL: Physical Activity Level (energy expenditure in MET-hours/week)
FABphys: Fear-avoidance beliefs concerning physical activity

Baseline 12months-Follow-up

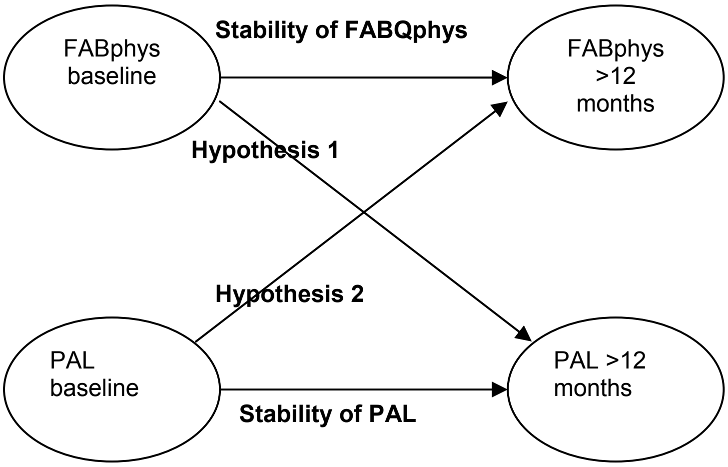

Figure 1: Reciprocal causation model
FABphys: fear-avoidance beliefs concerning physical activity (FABQ, scale 1)
PAL: physical activity level in MET-hours/week (Freiburger Questionnaire on Physical Activity)

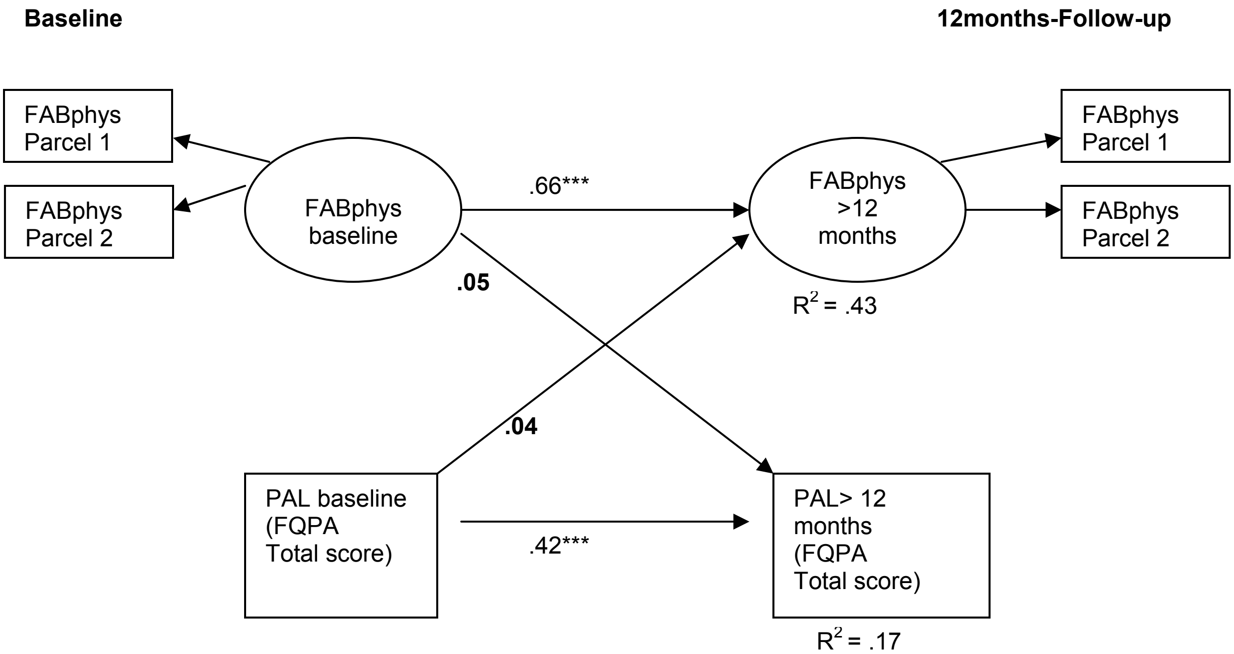

Figure 2: Structural equation model with a reciprocal causation design for the whole sample (N= 787)

***p<0.001

FABphys: fear-avoidance beliefs concerning physical activity (FABQ, scale 1)

PAL: physical activity level in MET-hours/week (Freiburger Questionnaire on Physical Activity)

FQPA: Freiburger Questionnaire on Physical Activity