Psychological pain responses in athletes and non-athletes with low back pain

Avoidance and endurance matter

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Published in:
European Journal of Pain

DOI:
10.1002/ejp.1442

Publication date:
2019

Document version:
Accepted manuscript

Citation for published version (APA):

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Download date: 15. Sep. 2023
Psychological pain responses in athletes and non-athletes with low back pain: avoidance and endurance matter

Running head: Psychological pain responses in athletes with LBP

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Original Manuscript for: European Journal of Pain

Funding: The present study was initiated and funded by the German Federal Institute of Sport Science (IIA1–080102B/11–14).

Conflict of interest: The authors declare that they have no conflict of interest.

Significance: Athletes train to endure pain in the course of athletic socialization, at least in the context of exercise. However, there is sparsity of knowledge about psychological pain responses in athletes with low back pain and whether they differ from those in non-athletes. The results of this comparative
study suggest that endurance responses are more frequent than avoidance responses among athletes and non-athletes. However, both types of responses seem relevant to clinical pain management in athletes as well as non-athletes.
Abstract

Background: Dysfunctional psychological pain responses, namely fear-avoidance (FAR), including catastrophizing and helplessness, as well as endurance-related responses (ER), including thought suppression and overactivity have been shown to be risk factors for persistent low back pain (LBP). Literature suggests that athletes may differ from non-athletes regarding psychological responses to pain.

Objectives: This study set out to compare FAR and ER between athletes and non-athletes with LBP. It was hypothesized that athletes would report less frequent FAR and more frequent ER, and that both FAR and ER are associated with LBP intensity and disability.

Methods: 173 athletes and 93 non-athletes cross-sectionally reported how frequently they employ FAR and ER on the Avoidance-Endurance Questionnaire (AEQ), as well as LBP intensity and disability on the Chronic Pain Grad Questionnaire (CPGS). MANOVA was applied to compare FAR and ER between athletes and non-athletes. Hierarchical multiple linear regression models were used to determine the unique associations between FAR and ER with LBP intensity and disability.

Results: Athletes reported lower frequencies of behavioural avoidance than non-athletes, but no other FAR variables differed between the groups. Frequencies of ER did not differ between athletes and non-athletes. Regression analysis indicated substantial associations of FAR with LBP intensity, as well as of FAR and ER with disability in athletes and non-athletes.

Conclusions: The results of the present study suggest that athletes and non-athletes with LBP differ regarding behavioural avoidance, but overall, differences regarding pain responses are marginal. FAR and ER are both reported in athletes and non-athletes and contribute to disability in both groups.

Keywords: low back pain, spine, pain coping, kinesophobia, overactivity, sport, exercise, pain management.
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1. Introduction

In addition to biomechanical approaches, the study of psychosocial risk factors has helped to understand the development and maintenance of persistent LBP (Pincus & McCracken, 2013) and augmented its treatment (Kamper et al., 2015). With a point prevalence of 22-23 %, LBP in athletes is roughly as prevalent as in non-athletes (Trompeter, Fett, Brüggemann, & Platen, 2018). However, LBP in athletes was traditionally viewed as a biomechanical problem (Bahr et al., 2004; Heidari, Mierswa, Kleinert et al., 2016; Puentedura & Louw, 2012) and a need for psychological interventions for athletes with persistent pain has only been recognized in recent times (Hainline, Derman et al., 2017; O'Sullivan, O'Sullivan, Gabbett, & O'Keeffe, 2019). Thus, little is known about psychosocial

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Risk factors involved in athletes’ LBP (Hainline, Turner, Caneiro, Stewart, & Moseley, 2017; Puente & Louw, 2012), and whether these differ from those in the general population.

Psychosocial risk factors in the general population comprise depressive symptoms, emotional distress, and dysfunctional responses to pain (Pincus & McCracken, 2013; Pinheiro et al., 2016). Regarding the latter, the Avoidance-endurance model (Hasenbring & Verbunt, 2010) describes fear-avoidance and endurance-related responses as risk factors for persistent pain, particularly if highly rigid and inflexible.

Fear-avoidance responses (FAR) comprise cognitions of catastrophizing and helplessness, emotional responses of pain-related fear, as well as behavioural avoidance of pain-eliciting situations (Vlaeyen & Linton, 2012), Fig. 1). FAR are associated with higher LBP intensity and disability cross-sectionally (Zale, Lange, Fields, & Ditre, 2013), and predict disability in longitudinal studies (Wertli, Rasmussen-Barr, Weiser, Bachmann, & Brunner, 2014).

More recent research has shown that not only behavioural avoidance, but also behavioural endurance may lead to unfavourable outcomes in LBP (Andrews, Strong, & Meredith, 2012; Hasenbring & Verbunt, 2010). To this end, pain-related thought suppression may serve to enable pain persistence, also known as overactivity, eventually resulting in over-use (Andrews et al., 2012; Hasenbring & Verbunt, 2010) and depressive mood (Hülsebusch, Hasenbring, & Rusu, 2016; Konietzny et al., 2018) (Fig. 2). Thus, endurance-related responses (ER) are, like FAR, associated with disability (Andrews et al., 2012; Hasenbring, Hallner, Klasen et al., 2012; Held et al., 2013; Pegram, Lumley, Jasinski, & Burns, 2017; Scholich, Hallner, Wittenberg, Hasenbring, & Rusu, 2012), and pain intensity (Hasenbring, Marienfeld, Kuhlendahl, & Soyka, 1994; Held et al., 2013; Pegram et al., 2017; Scholich et al., 2012), (see Fig. 2).

In athletes, mental toughness specifically relates to sports ethic and athletic identity and has been suggested to be detrimental in the context of rehabilitation (Levy, Polman, Clough, Marchant, & Earle, 2006). One aspect of this trait is the ability to exercise or play in the presence of pain (Deroche, Woodman, Stephan, Brewer, & Le Scanff, 2011; Diehl, Mayer, Thiel, Zipfel, & Schneider, 2018; Jones, 2002). This demonstrates an overlap with ER, and may furthermore be reflected in higher pain tolerances in athletes (Tesarz, Schuster, Hartmann, Gerhardt, & Eich, 2012). Thus, ER may be more common in athletes than in non-athletes. Indeed, one study indicates that athletes tend to ignore pain more than non-athletes (Ghazaie, Tajikzadeh, Sadeghi, & Saatchi, 2015), while another study did not.
show such differences (Azevedo & Samulski, 2003). However, just like in the general population, ER in athletes may be dysfunctional in the context of LBP.

Also FAR have been observed in athletic populations (Deroche et al., 2011; Dover & Amar, 2015; Hsu, Meierbachtol, George, & Chmielewski, 2017; Jones & Parker, 2018). There is some evidence for the notion that pain-free athletes report less catastrophizing (Ghazaie et al., 2015; Sullivan, Tripp, Rodgers, & Stanish, 2000) and avoidance behaviour than non-athletes (Sharma, Sandhu, & Shenoy, 2011), while another study did not show such differences (Azevedo & Samulski, 2003). To our knowledge, this is the first study to address these differences in populations with LBP. Quantifying FAR or ER within this comparative approach is important, because LBP treatments should consider group-specific peculiarities if there is convincing evidence for specific differences in pain responses between athletes and non-athletes.

Therefore, the primary aim of this study was to quantify and differentiate the respective frequencies of FAR and ER in athletes and non-athletes with LBP. Secondly, we aimed to determine the associations of FAR and ER with LBP intensity and disability, i.e. their functionality regarding LBP. We hypothesized that, firstly, athletes report higher frequencies of ER than non-athletes and lower frequencies of FAR than non-athletes, and secondly, that both FAR and ER are dysfunctional, i.e. associated with higher LBP intensity and disability in athletes and non-athletes.

2. Methods

2.1 Participants

Within a research project of broader scope, 279 LBP patients took part in the study. Individuals of the general population were recruited from rehabilitation and health establishments as well as fitness centers in North Rhine-Westphalia, Germany. Athletes were recruited via physiotherapists of various German Olympic Training Centers. In addition to the paper-pencil versions, a link to the online survey was provided on different websites of German sports federations for the athletes. Non-specific LBP as the main inclusion criterion was defined as low back pain which cannot be ascribed to a recognized pathology or red flags, such as infection, tumour, osteoporosis, fracture, herniated discs and other known specific disorders of the spine (Balagué, Mannion, Pellisé, & Cedraschi, 2012). Exclusion criterion was the absence of pain symptoms on the applied self-report measures, which led to the exclusion of 12 participants.

From the remaining sample, 173 subjects were classified as athletes on the basis of their performance level in the respective sports category. This procedure for classification of athletes was based on the recommendations by Haskell et al (Haskell et al., 2007) and De Pauw et al (De Pauw et al., 2013). Participants who indicated to be active in competitive sports at a high (i.e. international, national) or medium (i.e. regional) levels were defined as athletes. These participants engaged in various disciplines, with the highest percentages being active in volleyball (16 %), hockey (13 %), archery (11 %), and track and field sports (10 %). The remaining 94 participants indicated to not be actively
competing or to be competing on a local competition level, and thus were classified as non-athletes. In order to validate the group assignment, all participants were asked to indicate how many hours per week they currently spend on physical exercise, notated as training frequency.

The study was approved by the Medical Ethic Committee of the Ruhr-University Bochum.

2.2 Back pain and pain-related disability

Back pain intensity and pain-related disability were assessed using the German version of the Chronic Pain Grade Scale (CPGS, (Klasen, Hallner, Schaub, Willburger, & Hasenbring, 2004; Korff, Ormel, Keefe, & Dworkin, 1992)). The CPGS is a self-report measure with three items which quantify the worst and the average back pain intensity in the last three months, as well as the acute back pain intensity using a rating scale from 0 – 10, with 0 indicating no pain and 10 indicating as bad as could be. A pain intensity score is calculated, by averaging the three items and multiplying by 10, resulting in a range of 0–100.

Four further items assess pain-related disability, as the grade to which pain interfered with each occupational, social and leisure time activities in the last 3 months on a rating scale from 0 – 10, as well as the number of days this occurred. A value of 0 indicates no interference, while a value of 10 indicates that the respective domain of activity is completely altered due to pain. An overall disability score was calculated from these items by averaging the three items and multiplying by 10, resulting in a range of 0–100.

The CPGS has been shown to be sensitive to changes of chronic pain severity over time (Elliott, Smith, Smith, & Chambers, 2000). For the German version, moderate to high associations with other instruments assessing pain and disability have been shown, as well as the frequency of use of pain medication (Klasen et al., 2004). Cronbach’s alpha is .86 for pain intensity and .82 for disability, showing good reliability for both scales (Heidari, Mierswa, Hasenbring et al., 2016).

2.3 Measurement of fear-avoidance- and endurance responses to pain

The German version of the Avoidance-Endurance Questionnaire (AEQ, Hasenbring, Hallner, & Rusu, 2009) is an instrument to measure pain responses in the cognitive, emotional and behavioural domains, which can be related to FAR or ER. Hereby, participants are asked to indicate which feelings and thoughts they experienced in response to any pain during the last 14 days on a scale ranging from 0 – 6. The pain to which the psychological response was referred in this scale, was not specified, e.g. specific for training or back pain. Reliabilities of the AEQ-subscales have been shown to be acceptable (Cronbach’s alpha between .76 and .91 (Hasenbring, Hallner, & Rusu, 2009).

Emotional responses are measured with the scales Anxiety/Depression Scale (ADS, ‘I felt anxious, tense.’, ‘I felt depressed/gloomy.’) as well as Positive Mood Scale (PMS, e.g. ‘I felt happy anyway.’). Cognitive responses include the Help- and Hopelessness Scale (HHS, e.g. ‘It feels this pain...
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will never ease up.’), the Catastrophizing Scale (CTS, e.g. ‘It isn’t a serious illness, is it?’) and the Thought Suppression Scale (TSS, e.g. ‘Pull yourself together!’). Further, participants are asked to indicate which behavioural coping responses they applied in the last 14 days when experiencing severe pain, also on a 0–6 rating scale. These include the Avoidance of Social Activities Scale (ASAS, e.g. ‘I cancel private appointments.’), the Avoidance of Physical Activities Scale (APAS, e.g. ‘I stop doing physically demanding activities.’), the Humour and Distraction Scale (HDS, e.g. ‘I take it with a laugh.’) and the Pain Persistence Scale (PPS, e.g. ‘I carry on doing what I’m doing no matter what.’).

Hereby, CTS, HHS, ADS, ASAS and APAS are classified as FAR, whereas PMS, TSS, HDS and PPS are classified as ER.

2.4 Measurement of depressive symptoms

The Beck Depression Inventory for primary care (BDI-PC, (Beck, Guth, Steer, & Ball, 1997)) was used to assess pain-unspecific depressive symptoms. It assesses cognitive and affective symptoms of depression with seven items by self-report. The sum score ranges from 0 to 21 with scores above 4 indicating severe depressive symptoms. The BDI-PC was developed for the use in medical, non-psychiatric settings and has been shown to be associated with the diagnosis of a mood disorder in a sample recruited in these settings. The internal consistency of the BDI-PC is good (Cronbach’s alpha = .88).

2.5 Statistical Analyses

In advance of analyses, data were explored regarding plausibility and potential outliers. With regard to plausibility, it was checked whether the range of each study variable matched to the corresponding range of response. Outliers were identified in the respective multivariate analyses using Cook’s distance (Kannan & Manoj, 2015), with exclusion of cases with Cook’s distance >1. Multivariate normality was inspected visually using histograms of standardized residuals in the respective analyses.

Potentially confounding influences of the demographic variables age and gender on the FAR and ER variables, as well as on the outcome variables pain and disability were examined with correlation analyses and t-tests for independent samples, respectively.

Differences in gender and mean age, as well as differences in number of days in pain and BDI-PCs scores between athletes and non-athletes were tested with χ²-test and Mann-Whitney-U-tests, respectively.

First, the self-reported occurrence frequency of FAR and ER pain responses was compared within the cognitive, emotional and behavioural domain for the whole group. Three repeated measures ANOVAs (rm-ANOVAs) were separately computed for each cognitive, emotional and behavioural pain response scale assessed by the AEQ, with the respective within-subjects factor cognitions (helplessness vs. hopelessness vs. catastrophizing vs. thought suppression), emotions (positive mood despite pain vs. anxiety/depression), and behaviours (avoidance of social activities vs. avoidance of physical activi-

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ties vs. humour/distraction vs. pain persistence). Greenhouse-Geisser corrections were applied in the case of violation of sphericity. Main effects were scrutinized with Bonferroni-corrected post hoc tests in case of multiple comparisons (i.e. cognitions: \( \alpha = .017 \) (\( \alpha = .050/3 \)); emotions: \( \alpha = .025 \) (\( \alpha = .050/2 \)); behaviours: \( \alpha = .013 \) (\( \alpha = .050/4 \)).

In order to compare the self-reported occurrence frequency between athletes and non-athletes, MANOVAs were computed separately for FAR and ER with group (athletes vs non-athletes), and gender as fixed factors. In advance of the MANOVAs, the inter-correlations of AEQ variables that are related to either FAR or ER were inspected in order to test the assumption of moderately correlated dependent variables in MANOVA (Table 2). For FAR, these were the inter-correlations between CTS, HHS, ADS, APAS and ASAS, and for ER, those between TSS, PMS, HDS and PPS. Equalities of error variances and covariance matrices between groups were tested using Levene’s test and Box’s test, respectively (Stevens, 2012). Partial eta squared (\( \eta^2_p \)) served to estimate effect sizes of group effects. Here, effect sizes were considered small when \( \eta^2_p \leq .06 \), medium when \( \eta^2_p \leq .14 \), and large when \( \eta^2_p \geq .14 \) (Richardson, 2011). For post-hoc analysis of group effects, discriminant function analysis was applied.

Bivariate correlations of age, gender, the BDI-PC and FAR and ER of the AEQ-scales with LBP intensity and disability were analysed with Spearman correlation coefficients because of non-normal distribution. The bivariate correlations were first calculated for the whole sample. Bonferroni-correction was applied in order to adjust for multiple testing, with a resulting \( \alpha = .010 \) (\( \alpha = .050/5 \)) for FAR and \( \alpha = .0125 \) for ER (\( \alpha = .050/4 \)). Next, correlations were computed for athletes and non-athletes, separately. Differences in the magnitude of correlations between non-athletes and athletes were tested using a browser-based service (Diedenhofen & Musch, 2015) which uses Fisher’s z-test. Bonferroni-correction was applied in order to adjust for multiple testing, with a resulting \( \alpha = .003 \) (\( \alpha = .050/18 \)).

In a next step, two stepwise multiple linear regression analyses were run for the outcome disability and back pain intensity, respectively. Gender and age were entered with forced entry in the first step, and BDI-PC-Score in the second step. In the third step, AEQ-variables that overall correlated significantly with the respective outcome were entered using stepwise method. Homoscedasticity was inspected visually using scatterplots of standardized predicted values against standardized residuals, respectively. Variance inflation factors were checked regarding multicollinearity. All statistical analyses except for tests of significant group differences in magnitude of correlations were conducted using SPSS 25 (IBM Corp, Armonk, NY).

3. Results
3.1 Sample description

Table 1 displays means and standard deviations of demographic variables, training frequency, pain outcome variables, as well as psychological variables. The groups significantly differed in age with athletes being younger than non-athletes (\( p < .001 \), \( d = 1.19 \)), whereas the gender propor-

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Differences between the groups did not differ significantly, \(p = .072, r = 0.10\). Athletes reported higher training frequency \((p < .001, d = -1.10)\), and less disability than non-athletes \((p = .017, d = .30)\), while reporting equal back pain intensity \((p = .827, d = -.11)\), BDI-PC scores \((p = .673, d = .07)\) and number of days in pain \((p = .983, d = .00)\). The differences in disability between athletes and non-athletes are discussed elsewhere in detail (Heidari, Mierswa, Hasenbring et al., 2016).

Age did not correlate with disability \((\rho = .095, p = .114)\), nor LBP intensity \((\rho = -.11, p = .080)\). Females reported significantly higher disability \((\text{female} = 25.67(19.45), \text{male} = 21.36(19.15), p = .029, d = -1.22)\) and mean LBP intensity than men \((\text{female} = 46.82(17.32), \text{male} = 41.84(16.91), p = .017, d = -.29)\).

3.2 Frequency of self-reported FAR and ER

3.2.1 Comparison within cognitive, emotional and behavioural domain. Regarding cognitive pain-responses (catastrophizing (CTS) vs. help-hopelessness (HHS) vs. pain-related thought suppression (TSS)), there was a main effect in the rmANOVA, \(F(1.83, 481.82) = 284.53, p < .001, \eta^2_p = .52\). Pairwise comparisons indicated that individuals reported more PTS than HHS \((p < .001)\) and CTS \((p < .001)\); and more HHS than CTS \((p < .001, \text{Fig. 1})\).

RmANOVA for two emotional pain responses (positive mood despite pain (PMS) vs. anxiety/depression (ADS)) revealed a main effect of emotions, \(F(1, 266) = 104.40, p < .001, \eta^2_p = .29\), indicating that individuals reported significantly more PMS than ADS.

With respect to behavioural responses (avoidance of social activities (ASAS) vs. avoidance of physical activities (APAS) vs. humour/distraction (HDS) vs. pain persistence (PPS)), there was a main effect in the rmANOVA, \(F(1.89, 466.99) = 111.08, p < .001, \eta^2_p = .31\). Pairwise comparisons indicated that individuals reported higher frequencies in APAS and PPS compared to ASAS \((p < .001, \text{and } p < .001, \text{respectively})\), and HDS \((p = .001, \text{and } p = .001, \text{respectively})\). APAS and PPS did not differ.

3.2.2 Frequency of self-reported FAR and ER in comparison between athletes and non-athletes. The mean values of FAR varied between very low occurrence frequency for CTS and moderate frequency for APAS \((\text{Fig. 3})\). The meaningful pattern of inter-correlation within FAR variables \((\rho = .02 - .62)\) suggested that MANOVA was appropriate \((\text{Table 2})\).

Regarding FAR, MANOVA indicated that there was a significant difference with a small effect size between non-athletes and athletes using Pillai’s trace, \(F(5, 250) = 4.01, p = .001, \eta^2_p = .07\). There were neither significant differences in FAR between males and females, \(F(5, 250) = 1.76, p = .

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Levene’s tests were non-significant for all dependent variables, indicating equal error variances between groups (p = .092 - .601) and a non-significant Box’s test indicated equal covariance matrices between groups (p = .850). Normal distribution of residuals was not given for HHS, CTS and ASAS.

Subsequent discriminant function analysis revealed one discriminant function, which significantly differentiated athletes from non-athletes \( \lambda = .94, \chi^2(4) = 13.67, p = .018 \). The correlations between outcomes and the discriminant function revealed high to moderate loads of APAS (r = .92) and ASAS (r = .60), respectively. This indicates that the variance in these variables distinguished the groups with higher values in non-athletes (Fig. 3), whereas the remaining FAR variables, CTS (r = .06), HHS (r = .12) and ADS (r = .04), did not.

ER variables showed a consistent moderate occurrence frequency (Fig. 4), with inter-correlations varying between rho = -.02 - .52 (Table 2), suggesting that MANOVA was appropriate. The results of MANOVA indicated that there was no significant difference between non-athletes and athletes using Pillai’s trace, \( F(4,249) = .38, p = .823 \), partial eta\(^2\) = .01. There were neither significant differences in ER between males and females, \( F(4,249) = .46, p = .762 \), eta\(^2\) = .01, nor significant interactions of gender and group, \( F(4,249) = .38, p = .825 \), eta\(^2\) = .01. Levene’s tests was non-significant for all dependent variables, indicating equal error variances between groups (p = .085 - .492) and a non-significant Box’s test indicated equal covariance matrices between groups (p = .213). Normal distribution of residuals was given for all dependent variables.

Correlations of FAR and ER-pain responses with outcome variables

The variables age, AEQ-help- and hopelessness, AEQ-catastrophizing, AEQ-avoidance of social activities, as well as disability deviated from the normal distribution with positive skews. Therefore, Spearman correlations were computed to evaluate the association of these variables with the respective outcomes.

Correlation coefficients for the whole group, as well as for each group with respective tests of differences in the magnitude of correlations between non-athletes and athletes, are displayed in Table 3. Regarding disability, there were moderate positive correlations with FAR variables, such as HHS, ADS and ASAS, and a small correlation with APAS. Smaller correlations comprised ER variables, such as a positive correlation with TSS and a negative correlation with PMS. Regarding pain intensity, there was a moderate positive correlation with HHS, and a small correlation with ADS, as

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well as TSS. None of the significance tests for group differences in the correlation coefficients between athletes and non-athletes reached significance after Bonferroni-correction.

3.5 Hierarchical multiple linear regression

Disability. In the first step, introduction of gender and age significantly improved model fit $F(2,243) = 4.67, p = .010$. In the second step, BDI-PC further improved model fit $F(2,242) = 11.21, p < .001$. In the third step, ADS, HHS, CTS, ASAS, APAS, as well as PMS, TSS, were introduced to the model. In the final model (Table 4A), HHS, ASAS and TSS remained as significant predictors of disability, with the highest regression coefficient of HHS, and a significant increase in model fit $F(5,225) = 12.00, p < .001$. BDI-PC was no longer significant after introducing HHS to the model.

LPB intensity. Introduction of gender and age significantly improved model fit in the first step, $F(2,257) = 3.15, p = .045$. In the second step, BDI-PC further improved model fit $F(2,256) = 5.09, p = .002$. In the third step, ADS, HHS, as well as TSS were added to the model. In the final model, HHS remained as a unique predictor of back pain intensity with a significant increase in model fit $F(3,253) = 9.09, p < .001$; Table 4B), while BDI-PC again was no longer significant.

In each model predicting disability and LPB intensity, residuals were acceptably independent as indicated by the Durbin-Watson-Test (1.93 and 1.96, respectively). Normal distribution of residuals was given in both regression models, as indicated by histograms and P-P-plots of standardized residuals. Further visual examination of the scatterplots of standardized predicted values against standardized residuals indicated that homoscedasticity was marginally given in the models predicting disability, but still acceptable, and fully given in the model predicting back pain intensity. Despite moderate inter-correlations among the predictors, multicollinearity was acceptable in both models, as indicated by variance inflation factors (see Table 4a and b).

4. Discussion

This is the first study to systematically compare the occurrence frequency of fear-avoidance-(FAR) and endurance responses (ER) between athletes and non-athletes, and their associations with outcomes in low back pain (LBP). Regarding FAR, athletes reported less frequent avoidance behaviour, while regarding ER, athletes and non-athletes did not differ in any of the measures. Furthermore, non-athletes and athletes did not differ in the functionality of pain responses. For both groups, helplessness was observed to be strongly associated with both LBP intensity and disability. Avoidance of social activities, and pain-related thought suppression were furthermore associated with disability.
4.1 Fear-avoidance responses in athletes and non-athletes

Athletes reported lower occurrence frequencies regarding avoidance behaviour in the social
and physical domain compared to the non-athletes. This is in line with the findings of Sharma et al.
(2011), who reported less avoidance in 90 national/state level professional male athletes compared
with 30 non-athletes. Therefore, the present study adds evidence to the notion that avoidance beha-
vour is less frequent in athletes than in non-athletes when both populations suffer from LBP. The ob-
served relationship between avoidance behaviour and disability corroborates the predictions of the
Fear-avoidance model of chronic pain (Vlaeyen & Linton, 2012) and the fear-avoidance pathway of
the Avoidance-endurance model (AEM, Hasenbring, Chehadi, Titze, & Kreddig, 2014). Notably, ath-
letes reported less disability than non-athletes. As avoidance behaviour was significantly associated
with higher disability for both, athletes and non-athletes. This may have driven lower disability in
athletes. It is of note, however, that avoidance behavior seems to play a role in athletes’ LBP nonethe-
less, which is in accordance with previous research (Dover & Amar, 2015).

In contrast to help-/hopelessness, the occurrence frequency of catastrophizing as measured
by the AEQ-CTS scale was low. Furthermore, AEQ-CTS was not uniquely associated with LBP inten-
sity or disability. This is in contrast to considerable evidence for a link between catastrophizing and
chronic pain in non-athletes (Martinez-Calderon, Jensen, Morales-Asencio, & Luque-Suarez, 2019)
and athletes (Ghazzie et al., 2015). However, it is of note that catastrophizing is conventionally as-
sessed using the Pain Catastrophizing Scale (Sullivan, Bishop, & Pivik, 1995) which summarizes the
subscales magnification, helplessness and rumination (Adachi et al., 2018). The magnification sub-
scale corresponds to the AEQ-CTS, assessing the tendency to over-estimate possible threat of painful
sensations (Hasenbring et al., 2009; Sullivan et al., 1995). Therefore, the present results question the
importance of CTS/magnification in athletes’ and non-athletes’ LBP and emphasize helplessness. It
has been pointed out before that magnification und helplessness affect different stages in the ap-
praisal process within the Lazarusian coping approach (Lazarus & Folkman, 1987): while magnifica-
tion influences the primary appraisal, helplessness reflects the secondary appraisal of one’s inability
to cope with a painful stimulus (Quartana, Campbell, & Edwards, 2009; Sullivan et al., 2001). How-
ever, the present results prompt a strong association between help-/hopelessness and disability in non-
athletes as well as in athletes, which may be a result of repeated unsuccessful attempts to cope with
pain. A number of studies supports this link in persistent pain (Flor & Turk, 1988; Samwel, Evers,
Crul, & Kraaimaat, 2006), and it seems to accentuate in the course of chronic pain (Adachi et al.,
2018; Craner, Gilliam, & Sperry, 2016; Vienneau, Clark, Lynch, & Sullivan, 1999).

Furthermore, help-/hopelessness was associated with LBP intensity in the present study. This is
in line with observational evidence for a link between HHS and chronic pain (Adachi et al., 2018;
Craner et al., 2016; Flor, Behle, & Birbaumer, 1993; Samwel et al., 2006; Sullivan et al., 2001). It has
been suggested that a helpless orientation may compromise an individual’s effort to engage in pain-
reducing coping strategies (Crisson & Keefe, 1988). Moreover, experimental research in pain-free
participants suggests that a helpless orientation towards pain results in lower pain tolerance (Bandura, 1987; Sullivan, Rouse, Bishop, & Johnston, 1997) and disruptions of opioid-dependent endogenous pain inhibitory circuits (Campbell & Edwards, 2009; Goodin et al., 2009). In sum, the present results stress the importance of help-/hopelessness in LBP. It may be that clinicians are informed by an over-estimation of the impact of magnification on LBP in psychological pain research which could lead to a focus on minimizing patient’s pain experiences. Instead, the detrimental role of help-/hopelessness should be addressed more strongly. Suitable targets of intervention may be the fostering of acceptance (Veehof, Trompetter, Bohlmeijer, & Schreurs, 2016), as well as self-efficacy (Damush et al., 2016), and a flexible use of coping strategies (Hasenbring et al., 2014; Scott & McCracken, 2015).

It is of further note that in the regression models for both disability and LBP intensity, the BDI-PC score was no longer significant after introducing HHS. This indicates that BDI-PC and help-/hopelessness shared a substantial amount of variance, but that help-/hopelessness explained more variance in these outcomes. Learned helplessness reflects a central aspect of depressive symptoms and has been a prominent model in the etiology of depression (Seligman, 1972). In the AEQ-HHS scale, the content of helpless thoughts is pain-specific. Therefore, it seems plausible to assume that pain-related help-/hopelessness is a cognitive reaction to pain that is closely tied to depressive symptoms, or even represents a pain-specific depressive symptom itself.

4.2 Endurance-related responses in athletes and non-athletes

The occurrence frequencies of ER were equal in athletes and non-athletes. This is unexpected and contrasts the widely acknowledged notion of the athletic inclination to play through pain (Deroche et al., 2011; Diehl et al., 2018; Jones, 2002; Nixon, 1993; Wegner & Zanakos, 1994; Weinberg, Vernau, & Horn, 2013). To date, the rare studies comparing pain responses between athletes and non-athletes yielded equivocal evidence (Azevedo & Samulski, 2003; Ghazaie et al., 2015). This discrepancy may be due to differences in whether the study participants were experiencing persistent pain. The present study surveyed athletes and non-athletes with persistent LBP. Azevedo and Samulski (2003) also studied participants with persistent pain. In contrast, the presence of pain was not specified in the study of Ghazaie et al. (2015) who reported higher ER in athletes than in non-athletes. Therefore, it may be speculated that persistent pain reduces the occurrence frequency of ER, or that athletes over-estimate the extent to which they would engage ER in the absence of persistent pain.

Regarding the functionality of ER in LBP, pain-related thought suppression (PTS) was associated with higher disability, which is in accordance to previous studies in (sub)acute (Hasenbring, Hallner, Klasen et al., 2012; Held et al., 2013) and chronic LBP (Pegram et al., 2017; Scholich et al., 2012). Experimental research suggests that pain-related thought suppression results in thought intrusions and increases of the very painful sensations that were sought to be suppressed (Cioffi & Hollaway, 1993; Sullivan et al., 1997). Therefore, frequent pain-related thought suppression may lead to re-

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occurring experiences of uncontrollability and with it, increases in disability (Arnstein, Caudill, Mandle, Norris, & Beasley, 1999). More research is needed to investigate the causal relationship between PTS and disability and the possible mediating role of uncontrollability.

In contrast to our hypothesis, behavioural endurance was not associated with LBP intensity and disability. This leaves the present study contributing to considerable discrepancy of evidence on the relationship between endurance behaviour and pain outcomes (Andrews et al., 2012; Hasenbring et al., 2009). It may be worthwhile for future studies to differentiate excessive endurance, i.e. endurance behaviour lasting until pain exacerbation, from other forms of endurance (Kindermans et al., 2011).

4.3 Limitations

There are some limitations that need to be addressed in the present study. First, there was a significant age difference between the groups, with the non-athletes being significantly older than the athletes. We did refrain from analysis of covariance because of these age differences between groups (Miller & Chapman, 2001). However, as age was correlated with avoidance behaviour, the group difference in avoidance behaviour should be considered cautiously. There is evidence that athletes with LBP are usually younger than non-athletes with LBP (Schmidt et al., 2014). Thus, subsequent studies should address this issue already in the stage of recruitment. Furthermore, the procedure used to recruit the non-athletes targeted rehabilitation and health establishments as well as fitness centers and resulted in a relatively physically active sample of non-athletes with LBP. Therefore, the generalizability of the present findings to more sedentary individuals with LBP is restricted.

It could further be argued that the instrument used in this study to assess pain responses is only valid in the general population, i.e. in non-athletes, and not in athletes. Dover and Amar (2015) stated that current instruments assessing FAR are inappropriate in athletes, as athletes have specific contents of fear and avoidance, such as return to play, or their team role. This might lead to an underestimation of FAR in athletes. However, using different instruments for two groups under comparison will crucially complicate the interpretation of findings.

Finally, the cross-sectional design of this study is not adequate to infer causal relationships between the studied pain responses and pain outcomes. However, causal directions between PTS and disability, as well as HHS and disability and pain intensity have been suggested in the discussion based on existing evidence incorporating longitudinal designs (Hasenbring et al., 1994; Hasenbring, Hallner, Klasen et al., 2012). This evidence should be extended in the future, using experimental designs to answer whether these claims made previous sections stand to test.

4.4 Conclusions

Although athletes with LBP reported less avoidance behaviour than non-athletes, the differences in psychological pain responses in the present study were more marginal than expected. Furthermore, the results of this study suggest that non-athletes and athletes do not differ with respect to

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the functionality of pain responses in LBP. Therefore, athletes might similarly benefit from psychological interventions in LBP, as it has been strongly supported in the general population.

As both FAR and ER were related to disability, the present results are in line with the predictions of the Avoidance-endurance model of chronic pain, proposing that both FAR and ER contribute to the chronification and maintenance of LBP (Hasenbring & Verbunt, 2010). Concurrently, the study results stress the importance of HHS for both pain intensity and disability in LBP.

Acknowledgements
The research was realized within MiSpEx—The National Research Network for Medicine in Spine Exercise.

Author contributions
Hannah Gajsar conducted analysis and interpretation of the data and drafted the article. Christina Titze, Adina C. Rusu, Christina Levenig, Jahan Heidari and Monika I. Hasenbring critically revised the article and provided important intellectual content. Michael Kellmann, Jens Kleinert, Christina Levenig and Monika I. Hasenbring provided substantial contribution to conception and design of the study, as well as acquisition of data. All authors discussed the interpretation of the results and commented on the manuscript. Monika I. Hasenbring finally approved the version to be published.

5. References


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https://doi.org/10.1097/01.BRS.000096176.92881.37


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**Figure legends**

Figure 1: Dysfunctional fear-avoidance responses in persistent pain according to the Avoidance-endurance model (Hasenbring, Hallner, & Rusu, 2012)

Figure 2: Dysfunctional distress-endurance responses in persistent pain according to the Avoidance-endurance model (Hasenbring, Hallner, & Rusu, 2012)

Figure 3: Means and standard deviations of fear-avoidance responses (FAR) as assessed by the AEQ for non-athletes and athletes. Asterisks indicate significant group differences with p < .05

Figure 4: Means and standard deviations of endurance responses (ER) as assessed by the AEQ for non-athletes and athletes.

**Table legends**

Table 1

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Psychological pain responses in athletes with LBP

Means with standard deviations or frequencies for sociodemographic, pain outcome variable, as well as psychological variables for the whole sample, non-athletes and athletes. Significance tests for group differences are reported in the last column.

Table 2
Intercorrelations among BDI-Score (Beck Depression Inventory), FAR and ER in the whole sample.

Table 3
Correlations of disability and LBP intensity with BDI, FAR and ER for the whole sample, non-athletes and athletes, and respective tests of difference in the magnitude of correlations between non-athletes and athletes.

Table 4
Hierarchical multiple linear regression models: A for disability and B for LBP intensity, with standardized beta coefficients ($\beta$) and respective p-value, and variance inflation factors (VIF), as well as change in $R^2$ and respective p-value for each step.
Table 1
Means with standard deviations or frequencies for sociodemographic, pain outcome variable, as well as psychological variables for the whole sample, non-athletes and athletes. Significance tests for group differences are reported in the last column.

<table>
<thead>
<tr>
<th></th>
<th>Whole sample</th>
<th>Non-athletes</th>
<th>Athletes</th>
<th>Sig. group difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (% female)</td>
<td>43.32</td>
<td>50.01</td>
<td>39.93</td>
<td>n.s.</td>
</tr>
<tr>
<td>Age</td>
<td>33.17 (13.06)</td>
<td>41.63 (14.37)</td>
<td>28.67 (9.69)</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Competition level (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td>29.21</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td></td>
<td>35.58</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
<td>10.11</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
<td>25.09</td>
<td></td>
</tr>
<tr>
<td>Disability</td>
<td>23.25 (19.32)</td>
<td>27.02 (20.66)</td>
<td>21.18 (18.28)</td>
<td>p &lt; .05</td>
</tr>
<tr>
<td>LBP intensity</td>
<td>44.35 (17.18)</td>
<td>44.04 (18.89)</td>
<td>44.53 (16.23)</td>
<td>n.s.</td>
</tr>
<tr>
<td>Number of days in pain</td>
<td>900.10 (1588.11)</td>
<td>897.68 (1628.27)</td>
<td>902.80 (1570.49)</td>
<td>n.s.</td>
</tr>
<tr>
<td>Training hours per week</td>
<td>7.10 (5.49)</td>
<td>3.63 (2.95)</td>
<td>8.99 (5.63)</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>BDI-PC</td>
<td>2.20 (2.70)</td>
<td>2.33 (2.79)</td>
<td>2.13 (2.66)</td>
<td>n.s.</td>
</tr>
<tr>
<td>FAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AEQ-ADS</td>
<td>2.14 (1.16)</td>
<td>2.10 (1.25)</td>
<td>2.15 (1.11)</td>
<td>n.s.</td>
</tr>
<tr>
<td>AEQ-HHS</td>
<td>1.64 (1.19)</td>
<td>1.72 (1.30)</td>
<td>1.63 (1.16)</td>
<td>n.s.</td>
</tr>
<tr>
<td>AEQ-CTS</td>
<td>.57 (.96)</td>
<td>.62 (.97)</td>
<td>.56 (.96)</td>
<td>n.s.</td>
</tr>
<tr>
<td>AEQ-ASAS</td>
<td>1.51 (1.27)</td>
<td>1.83 (1.36)</td>
<td>1.39 (1.24)</td>
<td>p &lt; .05</td>
</tr>
<tr>
<td>AEQ-APAS</td>
<td>3.21 (1.27)</td>
<td>3.63 (1.29)</td>
<td>3.02 (1.22)</td>
<td>p &lt; .05</td>
</tr>
<tr>
<td>ER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AEQ-PMS</td>
<td>3.47 (1.22)</td>
<td>3.38 (1.31)</td>
<td>3.51 (1.18)</td>
<td>n.s.</td>
</tr>
<tr>
<td>AEQ-TSS</td>
<td>2.85 (1.52)</td>
<td>2.84 (1.62)</td>
<td>2.92 (1.47)</td>
<td>n.s.</td>
</tr>
<tr>
<td>AEQ-HDS</td>
<td>2.82 (1.04)</td>
<td>2.81 (.97)</td>
<td>2.81 (1.10)</td>
<td>n.s.</td>
</tr>
<tr>
<td>AEQ-PPS</td>
<td>3.17 (1.10)</td>
<td>3.07 (1.17)</td>
<td>3.23 (1.08)</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

BDI-PC (Beck Depression Inventory for Primary Care), AEQ (Avoidance-Endurance Questionnaire).

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FAR: (Fear-avoidance responses), ADS (anxiety/depression), HHS (help/hopelessness), CTS (catastrophizing), ASAS (avoidance of social activities), APAS (avoidance of physical activities); ER (Endurance responses): PMS (positive mood despite pain), TSS (thought suppression), HDS (humor/distraction), PPS (pain persistence)
## Table 2

Intercorrelations among BDI-Score (Beck Depression Inventory), FAR and ER in the whole sample.

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<thead>
<tr>
<th></th>
<th>BDI-PC</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
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<td>FAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 AEQ-ADS</td>
<td>.55*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 AEQ-HHS</td>
<td>.50*</td>
<td>.64*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 AEQ-CTS</td>
<td>.28*</td>
<td>.33*</td>
<td>.30*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 AEQ-ASAS</td>
<td>.36*</td>
<td>.39*</td>
<td>.40*</td>
<td>.32*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 AEQ-APAS</td>
<td>.13</td>
<td>.23*</td>
<td>.16</td>
<td>.01</td>
<td>.56*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 AEQ-PMS</td>
<td>-.40*</td>
<td>-.60*</td>
<td>-.43*</td>
<td>-.28*</td>
<td>-.35*</td>
<td>-.17</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>7 AEQ-TSS</td>
<td>.15</td>
<td>.28*</td>
<td>.24*</td>
<td>.14</td>
<td>.18</td>
<td>.11</td>
<td>.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 AEQ-HDS</td>
<td>-.16</td>
<td>-.18</td>
<td>-.26*</td>
<td>-.06</td>
<td>-.30*</td>
<td>-.29*</td>
<td>.32*</td>
<td>.16</td>
<td></td>
</tr>
<tr>
<td>9 AEQ-PPS</td>
<td>-.02</td>
<td>-.00</td>
<td>-.04</td>
<td>-.06</td>
<td>-.23</td>
<td>-.29*</td>
<td>.20</td>
<td>.52*</td>
<td>.20*</td>
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</tbody>
</table>

Note: Correlation coefficients are Spearman’s rho with asterisks indicating $p < .05$
Table 3

Correlations of disability and LBP intensity with BDI, FAR and ER for the whole sample, non-athletes and athletes, and respective tests of difference in the magnitude of correlations between non-athletes and athletes.

<table>
<thead>
<tr>
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<th>LBP intensity</th>
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<td></td>
<td>Whole</td>
<td>Non-athletes</td>
<td>Athletes</td>
<td>Whole</td>
</tr>
<tr>
<td></td>
<td>sample</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rho</td>
<td>sig.</td>
<td>rho</td>
<td>sig.</td>
</tr>
<tr>
<td>BDI-PC</td>
<td>.37*</td>
<td>n.s.</td>
<td>.20*</td>
<td>n.s.</td>
</tr>
<tr>
<td>FAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AEQ-ADS</td>
<td>.41*</td>
<td>n.s.</td>
<td>.28*</td>
<td>n.s.</td>
</tr>
<tr>
<td>AEQ-HHS</td>
<td>.53*</td>
<td>n.s.</td>
<td>.41*</td>
<td>n.s.</td>
</tr>
<tr>
<td>AEQ-CTS</td>
<td>.17*</td>
<td>n.s.</td>
<td>.08</td>
<td>.11</td>
</tr>
<tr>
<td>AEQ-ASAS</td>
<td>.37*</td>
<td>n.s.</td>
<td>.04</td>
<td>.05</td>
</tr>
<tr>
<td>AEQ-APAS</td>
<td>.22*</td>
<td>n.s.</td>
<td>.02</td>
<td>.07</td>
</tr>
<tr>
<td>ER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AEQ-TSS</td>
<td>.26*</td>
<td>n.s.</td>
<td>.18*</td>
<td>n.s.</td>
</tr>
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<td>AEQ-PMS</td>
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<td>n.s.</td>
<td>-.07</td>
<td>n.s.</td>
</tr>
<tr>
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<td>-.02</td>
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<td>AEQ-PPS</td>
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<td>.03</td>
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</table>

Note: Correlation coefficients are Spearman’s rho with asterisks indicating p < .05
Table 4

Hierarchical multiple linear regression models: A for disability and B for LBP intensity, with beta coefficients (b), variance inflation factors (VIF), as well as change in $R^2$ for each step.

### A: Disability

<table>
<thead>
<tr>
<th>Step</th>
<th>Variables</th>
<th>$\beta$</th>
<th>sig.</th>
<th>VIF</th>
<th>$R^2$-change</th>
<th>Sig.</th>
</tr>
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<td></td>
<td>Gender</td>
<td>-.07</td>
<td>.116</td>
<td>1.06</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Age</td>
<td>.13</td>
<td>.021</td>
<td>1.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Depressive symptoms</td>
<td>.09</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>BDI-PC</td>
<td>.07</td>
<td>.253</td>
<td>1.43</td>
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<tr>
<td>3</td>
<td>Psychological pain responses</td>
<td>.21</td>
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<td>FAR</td>
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<td>.024</td>
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Note. $R^2=.04$ for Step 1, $R^2=.12$ for step 2, $R^2=.33$ for step 2, all $R^2$ adjusted.

### B: Pain intensity

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Note. $R^2=.02$ for Step 1, $R^2=.05$ for Step 2, $R^2=.17$ for step 3., all $R^2$ adjusted.

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