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The Relationship between Approach to Activity Engagement, Specific Aspects of Physical Function, and Pain Duration in Chronic Pain

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ABSTRACT

Objectives: **To examine: 1) the relationships between habitual approach to activity engagement and specific aspects of physical functioning in chronic pain, and 2) whether or not these relationships differ according to pain duration.**

Materials and Methods: **Outpatients (N=169) with generalised chronic pain completed a set of written questionnaires. Categories of 'approach to activity engagement' were created using the confronting and avoidance subscales of the Pain and Activity Relations Questionnaire (PARQ). An interaction term between 'approach to activity engagement' categories and pain duration was entered into analysis with age, gender, pain intensity, the categorical 'approach to activity engagement' variable, and pain duration, in nine ordinal regression models investigating functioning in a variety of daily activities.**

Results: **The 'approach to activity engagement' category predicted the personal care, lifting, sleeping, social life, and travelling aspects of physical functioning but, interestingly, not the performance skills used during these activities, i.e., walking, sitting and standing. The interaction term was significant in two models; however, the effect of pain duration on associations was the inverse of that theorised, with the relationship between variables becoming less pronounced with increasing duration of pain.**

Discussion: **The results of this study do not support the commonly held notion that avoidance and/or overactivity behaviour leads to deconditioning and reduced physical capacity over time. Findings do, however, suggest that a relationship exists between avoidance and/or overactivity behaviour and reduced participation in activities.**

Implications for the clinical management of chronic pain and directions for further research are discussed.

Key words: **Overactivity, avoidance, pain duration, physical capacity, activity pacing**

INTRODUCTION

Chronic pain represents a major burden for individuals and for society. The prevalence of chronic pain worldwide is estimated at 30%[1] and studies have shown that the prevalence in certain regions is increasing.[2] Numerous qualitative and quantitative investigations have shown that chronic pain has a profound effect on physical functioning with individuals with chronic pain reporting a reduction in their ability to maintain paid employment, complete household chores, and engage in leisure and social activities.[3-6] The economic cost of chronic pain is recognised to be greater than most other health conditions due to its impact on absenteeism rates, productivity levels, and early retirement.[7] Understanding the factors that contribute to functional decline is important for managing the economic/personal impact of chronic pain.[8]

It has been postulated that the habitual approach to activity engagement adopted by an individual with chronic pain impacts on function, with activity avoidance and overactivity behaviour thought to result in decreased physical functioning overtime.[9-11] Activity avoidance is frequently defined as a reduction in physical or other daily activities as a means to avoid pain escalation.[9, 12, 13] In contrast, overactivity is commonly referred to as persisting with activities despite pain (known as endurance behaviour)[14] to the point that pain is significantly exacerbated resulting in a period of inactivity.[9, 15, 16] Individuals who engage in overactivity are thought to resume daily tasks after inactive periods once their pain has subsided or frustration over inactivity stimulates new activity.[16, 17] This results in a "yo-yo" activity pattern sometimes referred to as overactivity-underactivity cycling.[13] All individuals who engage in overactivity display endurance behaviour but not all those who endure with activity in spite of pain do so to the extent that they severely aggravate their

pain and hence are *over*active. Clinicians have reported that a combination of high levels of overactivity and avoidance may simultaneously manifest in the same person with chronic pain.[9, 11] These observations suggest some individuals who initially engage in overactivity begin to avoid certain pain provoking activities (e.g. leisure activities) as pain exacerbations, secondary to overactivity, become more severe and prolonged over time. This has been supported empirically, with a subgroup of individuals with chronic pain reporting high levels of both overactivity and avoidance.[18, 19] Deconditioning (i.e. physiological loss of physical fitness secondary to inactivity)[20] and hypersensitisation of the nervous system are thought to be the mechanisms that contribute to a reduction in physical capacity in individuals who habitually avoid activity or are overactive.[9-11]

The notion that activity avoidance and/or overactivity lead to a decline in an individual's physical function is the rationale for the use of operant-based activity pacing as a treatment strategy.[10, 11, 21] While the definition of operant-based activity pacing varies, it is generally referred to as a strategy to divide one's daily activities into smaller, more manageable, portions.[13, 21, 22] This allows individuals to participate in activities in a way that should not exacerbate their pain, which then allows planned and calculated increases of activity.[13, 21] A key principal of operant-based activity pacing is that activity engagement becomes time-contingent or goal-contingent rather than pain-contingent, whereby individuals select a healthy level of activity (i.e. below tolerance levels) and gradually increase activity based on predetermined quotas as opposed to pain levels.[21] This is thought to gradually increase an individual's tolerance for activity, reverse deconditioning effects, and desensitise the nervous system.[10, 11] Activity pacing is widely considered an essential element of pain management programs;[23] however, evidence supporting pacing as a

standalone treatment is sparse[21, 24] and pacing, as a behavioural coping strategy, has been linked to high levels of pain and disability in cross-sectional examinations.[25] This has led prominent researchers to conclude that the value of pacing is questionable without clear evidence for the rationale behind the treatment strategy.[26]

The notion that activity avoidance and overactivity are associated with poorer physical functioning has received a certain amount of attention empirically. In a recent systematic review and meta-analysis, higher levels of self-reported use of either activity avoidance or overactivity were associated with higher levels of physical disability in cross-sectional chronic pain samples.[25] A number of studies have also examined differences in self-reported global disability across approach to activity engagement subgroups. Huijnen and colleagues[19] and McCracken and colleagues[18] found that subgroups of individuals who reported high levels of both avoidance and overactivity, or high levels of avoidance but low levels of overactivity, had higher levels of self-reported disability compared with a 'low avoidance, high overactivity' subgroup. In Huijnen and colleagues'[19] study, while the 'low avoidance, high overactivity' subgroup reported less disability than the 'high avoidance, low overactivity' and 'high avoidance, high overactivity' subgroups, all three subgroups reported more physical disability than a 'low overactivity, low avoidance' subgroup. These results suggest that higher levels of avoidance or overactivity are related to higher levels of disability; however, the association between avoidance and disability is stronger than that between overactivity and disability.

A few studies have investigated the association between physical functioning and avoidance and/or overactivity over time using longitudinal designs. Hasenbring and colleagues[27] found that subgroups of patients with subacute low back pain who reported a

combination of high levels of endurance and avoidance (labelled distress endurance response) had elevated physical disability at six months follow-up compared to a subgroup reporting lower levels of avoidance and endurance. Self-reported activity avoidance has also been found to predict changes in physical disability over a three month period in a heterogeneous chronic pain sample[28] and higher baseline levels of avoidance have been associated with greater physical disability after twelve months in patients with acute low back pain.[29]

Overall, cross-sectional and prospective examinations support the notion that overactivity and/or avoidance contribute to a decline in physical function, and this evidence provides the rationale for activity pacing. However, prospective studies have only examined associations over a maximum twelve-month period, providing little insight into the long-term effects of overactivity and avoidance behaviour. Furthermore, all existing studies have utilised global measures of physical disability; thus, little is known about how approach to activity impacts on specific daily activities. Developing a better understanding of the associations between specific aspects of physical functioning and avoidance and/or overactivity behaviour would provide insight into how avoidance and overactivity contribute to explaining disability which would lead to improvements in patient education and more targeted treatment strategies.

The aims of the present study were to build on previous findings by examining: 1) the relationship between habitual approach to activity engagement and specific aspects of physical functioning, and 2) whether or not these relationships differ according to pain duration. Based on the theoretical background of operant-based activity pacing, and previous findings as outlined above, it was hypothesised that subgroups reporting high

levels of overactivity and/or avoidance would report lower tolerances for activity and more restrictions to participation in daily tasks when compared to a low overactivity/low avoidance reference group. Based on the findings relating to 'approach to activity engagement' subgroups[18, 19, 27] it was hypothesised that a 'high overactivity, low avoidance' subgroup would have smaller mean differences in specific aspects of physical functioning (and hence less statistically significant differences) than both 'high avoidance, low overactivity' and 'high avoidance, high overactivity' subgroups when compared to the low overactivity and avoidance reference group. As activity avoidance and overactivity are thought to lead to a decline in functional capacity over time[9-11] it was hypothesised that associations would be more pronounced for individuals who had been experiencing pain for a longer period of time.

MATERIALS AND METHODS

Participants

Participants were recruited from a group of patients receiving either outpatient or inpatient treatment at a multidisciplinary pain center in a major metropolitan tertiary hospital in Australia. Inclusion criteria were: (a) persistent non-cancer pain for at least three months, (b) generalised pain distribution impacting on the participant's gross movement (i.e., gross movement patterns increase the participant's pain), (c) English literate, (d) 18 years and over, and (e) able to provide written informed consent. One hundred and seventy-nine consecutive patients were invited to participate in the study. Ten participants declined the invitation, resulting in a total of 169 (94%) participants.

Demographic details of the sample are presented in Tables 1 and 2. Participants were mostly married, and unemployed due to pain. Slightly more females participated (54%). An average of 4.76 pain sites was reported, with lower back pain the most common pain complaint (81.7%). The period of time participants had been experiencing pain ranged from 7 months to 52 years. Participants' age ranged from 22 to 81 years, and average age was 53 years.

Insert Tables 1 and 2 about here

Procedure

Patients were invited to participate in the study during either an outpatient appointment or a hospital admission. An information sheet was provided to patients and written informed consent was required prior to participation. Participation involved completing a set of written questionnaires investigating approach to activity engagement, disability, pain intensity, as well as demographic data. A researcher was available at all times to answer questions about the study or questionnaire, and participants were advised that a summary of the results from the study, along with any individual results, would be available on request. Participation was voluntary and no incentive was provided. Some of the participants were receiving treatment from the principal researcher as part of an inpatient pain management program at the time of their participation in the study. Patients who were approached to participate in the study were aware that the principal researcher was not the clinician responsible for their ongoing treatment following the program, and they were advised that their decision to participate would not effect their ongoing treatment at the multidisciplinary pain center. The Royal Brisbane and Women's

Hospital's Human Research Ethic Committee (Number: HREC/09/QRBW/365) and The University of Queensland's Behavioural and Social Sciences Ethical Review Committee (Number: 2010000501) approved the protocol for this study.

Measures

Demographic Questionnaire

Information on participants' age, gender, level of education, employment status, pain location and duration of pain was gathered. This information is presented in Tables 1 and 2.

Pain and Activity Relations Questionnaire

The self-report Pain and Activity Relations Questionnaire (PARQ)[18] is a 21-item measure that examines how individuals with persistent pain approach activity engagement. Participants are instructed to rate the frequency with which they engage in certain behaviors on a 6-point Likert scale (0 = never, to 5 = always). The measure has three sub-scales: avoidance (8 items), confronting (7 items), and pacing (6 items). The confronting subscale provides a measure of overactivity, while the avoidance subscale provides a measure of avoidance of activity. The pacing subscale was not used in the current study due to confusion in the literature about whether it measures quota-contingent pacing, which is reflective of operant-based activity pacing, or pain-contingent pacing which is considered maladaptive in accordance with operant-based activity pacing theoretical frameworks.[21, 25, 30] Validity and reliability of the questionnaire is adequate based on initial psychometric testing by its developers.[18] Sample items of the utilised scales include: 'I avoid activities that cause pain' (avoidance), and 'I spend too much time on some activities and

experience increased pain later' (confronting). Internal consistency ratings for these scales in the current study were 0.77 (confronting) and 0.83 (avoidance). The Pearson correlation coefficient between the confronting and avoidance subscales in the current study was 0.05.

The Oswestry Disability Index

The Oswestry Disability Index (ODI) version 2.0[31] represents a self-report measure for assessing an individual's physical functioning. The questionnaire consists of 10 items. Five items assess an individual's tolerance for five specific activities including travel, lifting, walking, sitting and standing. Restrictions to participation in personal care, sex life and social life are each measured by three items. One item examines restrictions to sleep and the final item provides a measure of pain intensity. Participants are asked to choose one of six statements corresponding to each item. Responses are scored on a 0–5 scale, with a score of 5 representing the highest level of pain intensity or physical disability for that item. For the purposes of this study, the walking distance items of 1 mile, ½ mile, and 100 yards were replaced by metric units (1 kilometre, ½ kilometre, and 100 metres). The ODI was developed for low back pain patients[32] and is a commonly used and validated outcome measure in this population (see Fairbank and Pynsent[33] for review). However, the items are not specific to back pain and the questionnaire has also been validated with people with heterogeneous pain,[34] and pelvic pain.[35] It has also been used with populations such as people with fibromyalgia[36, 37] and work-related chronic pain syndromes.[38] Numerous studies have shown that the ODI has a one-factor structure[39, 40] with an internal consistency coefficient ranging from 0.71-0.87.[33, 41] Using individual items in analyses is a method that has been employed in previous research (see review[33]). Mayo[42] outlined the reasoning for doing an item analysis of the ODI and why the procedure is valid, stating that as the scale

has been tested for internal consistency, the items should not be redundant or totally unrelated to other items. As such, when the scale is used it is of interest to look not only at the total score but the contribution of items to the total score. An issue that could be raised with examining each item independently is not that the estimate produced is biased but that the chances of a "false positive" association may increase due to multiple testing.[42] For the purposes of this study each item of the ODI was used as an outcome measure along with the total ODI score (excluding pain intensity). The total score was calculated as per the scoring criteria of the ODI.[33]

Statistical analysis

All statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS) GradPack version 18.0 for Windows. All data were initially assessed for missing data, linearity, constant variance, and outliers. No changes were made to the data set as a result of data screening. As there was no observable pattern to missing data, missing data resulted in exclusion of that case from analysis. The summary statistics and missing data count for each variable are presented in Tables 1, 2, and 3.

Insert Table 3 about here

As clinicians have reported that a combination of high levels of overactivity and avoidance may simultaneously manifest in the same person with chronic pain,[9, 11] and subgroups of individuals with chronic pain reporting high levels of both overactivity and avoidance have been identified in two studies,[18, 19] categories of 'approach to activity engagement' were created and used in analyses instead of continuous subscales in order to

consider combinations of avoidance and overactivity. Four categories were produced, as determined by the confronting and avoidance subscales of the PARQ: those high in overactivity and avoidance; those high in avoidance but low in overactivity; those high in overactivity but low in avoidance; and those low in both overactivity and avoidance. As the PARQ uses a six-point scale (0-5), an average score of three or higher indicated high avoidance (as measured by the avoidance subscale) or high overactivity (as measured by the confronting scale), whilst an average score below three indicated low levels of avoidance or overactivity. This cut-off point was chosen as there is no normative data available for the PARQ and the middle of the scale will allow replication and comparisons across studies as opposed to using a median split to determine group classification. The summary statistics for the 'approach to activity engagement' categories are presented in Table 4.

Insert Table 4 about here

In accordance with the study aims, in order to examine the association between 'approach to activity engagement' categories and specific aspects of physical functioning, each item of the ODI (excluding pain intensity) was used as an outcome measure in nine ordinal regression models. Five different link functions are available in the ordinal regression procedure in SPSS. Link functions transform the cumulative probabilities of the ordinal dependent variable that result in a linear model in the parameters.[43] In order to select an appropriate link function for each model, the distribution for each ordinal outcome variable was first examined using bar charts. The logit link function was chosen in models where personal care, walking, sitting, sleeping, and travelling were entered as dependent variables as these ODI items had relatively evenly distributed categories. As lifting and sex life were negatively skewed, the complementary log-log link function was chosen in these models. As both standing and social life had relatively normal distributions, the probit link function was chosen. The association between 'approach to activity engagement' categories and the total ODI score (excluding pain intensity) was examined using a general linear model as the ODI total score is considered to be a dimensional scale.[33]

The *probit link function* treats predicted probabilities as cumulative probabilities from the standard normal distribution and coverts them to z-scores.[44] A probit index for each independent variable is produced which gives the change in the z-score for a one unit change in the predictor.[44] The *logit link function* is based on the proportional odds model which is an extension of binary logistic regression.[45] The proportional odds model transforms the ordinal outcome scale into a number of binary cut-off points and determines how each predictor variable uniquely affects the probability of observing a particular score or less compared to higher scores (i.e., probability of a score of 0 vs 1, 2, 3, 4, 5, probability of a score of 0 or 1 vs 2, 3, 4, 5, and so on).[46] An odds ratio for a predictor variable is then produced which can be interpreted as a summary of the odds ratios obtained from separate binary logistic regressions using all possible cut-off points of the ordinal outcome.[46] The *complementary log-log link function* is based on the continuation ratio model and like the proportional odds model, transforms the ordinal outcome scale into a number of cut-off points; however, the dichotomization of the data differs.[45] The continuation ratio model determines how each predictor variable uniquely affects the probability of observing a particular score compared to the probability of observing all higher scores with scores at a given level discarded after being compared to higher levels (i.e., probability of a score of 0 vs 1, 2, 3, 4, 5, probability of a score of 1 vs 2, 3, 4, 5, and so on).[46] Thus, the focus of a continuation ratio model is to understand the factors that

distinguish between those persons who have reached a particular response level but do not move on, from those persons who do advance to a higher level. A summary hazard ratio is produced for each independent variable as opposed to an odds ratio. The key assumption of all models is that the effects of any explanatory variables are consistent or proportional across all separate regressions using different cut-off points.[46] This means that the estimates from the separate regression models can be pooled to provide one set of coefficients.

The four-category variable ‘approach to activity engagement’ was entered as an independent variable alongside age, gender, pain intensity, and pain duration in all models. As a ‘low avoidance, low overactivity’ approach is considered to have a more positive effect on physical functioning compared to the other three ‘approach to activity engagement’ categories, this category was selected as the reference category and coded accordingly. To examine whether or not the relationship between the ‘approach to activity engagement’ categories and physical functioning differs according to pain duration, an interaction term between the ‘approach to activity engagement’ categories and pain duration was created and used in all models. If the interaction effect was not significant it was removed from models to allow for the interpretation of the main effects.[47] In order to interpret significant interaction effects in ordinal regression models, predicted values for each ‘approach to activity engagement’ category by different levels of pain duration were calculated and plotted graphically using Excel. Odds or hazard ratios that compare each ‘approach to activity engagement’ category with the ‘low avoidance, low overactivity’ reference group at different levels of pain duration were then obtained. This was done by transforming pain duration and re-running ordinal regression analyses as described by Jaccard.[47] The test of parallel lines was produced with each model which tests the assumption that the effects of any explanatory variables are proportional across all separate regressions using different cut-off points.

Simulation research by Taylor and colleagues[48] has indicated that larger sample sizes are needed when a coarsely categorised dependent variable is modelled in place of a continuous one in regression analysis. Based on their analyses, the loss of power and required sample size to regain power is greatest when the coarsely categorised outcome variable has a skewed distribution or has few categories (i.e., 2 or 3). An a priori sample size calculation of a minimum of 91 participants would be needed for an 80% chance to detect medium effect sizes for the independent variables in our models given the outcome variable is continuous. Based on figures by Taylor and colleagues[48] a minimum sample size 1.8 times this figure, i.e., a minimum sample of 164, was estimated for ordinal models to account for loss of power secondary to skewness in outcome variables and missing data. A significance level of 0.05 was set for statistical tests. As recommended by Streiner and Norman[49] a correction was not used to account for multiple analyses due to the exploratory nature of this study.

RESULTS

Summary statistics for ordinal regression models are presented in Table 5. All models, except for the model examining predictors of sex life, had a statistically significant chi-square statistic for model fit indicating that the final models significantly improved the fit of the data over baseline intercept-only models. Chi-square Goodness-of-Fit values were also not significant in all models suggesting that the observed data are consistent with the

fitted model. All models fulfilled the assumption that effects of explanatory variables are proportional across all separate regressions using different cut-off points, since the test of parallel lines was not significant for all models. The effect of independent variables on each dependent variable is presented in Table 6 and is summarised below.

Insert Tables 5 and 6 about here

Personal Care

There was a significant association between the categorical 'approach to activity engagement' and participation in personal care tasks. Individuals reporting high levels of avoidance and low levels of overactivity were 3.23 times more likely to report more restrictions to their ability to engage in personal care tasks compared to the odds for individuals reporting low levels of both avoidance and overactivity (*p* =.03, *95% CI* =.13 – 2.22). The interaction between pain duration and the categorical 'approach to activity engagement' was not significant, indicating that odds ratios for approach to activity categories were not altered by the length of time an individual has been experiencing chronic pain. Pain intensity was the only significant covariate in the model, with the odds of reporting more restrictions to engagement in personal care tasks increasing by 1.66 for each unit increase in pain intensity (*p* =.001, *95% CI* =.19 – .82).

Lifting

There was a significant interaction between the categorical 'approach to activity engagement' and pain duration in this model, indicating that the relationship between approach to activity and lifting tolerance was affected by how long an individual has been

experiencing pain. Predicted regression coefficients (log of the hazards ratio) for each approach to activity category at different levels of pain duration are illustrated in Supplementary Figure 1, Supplemental Digital Content 1, http://links.lww.com/CJP/A163 In addition, Supplementary Table 1, Supplemental Digital Content 2, http://links.lww.com/CJP/A164 displays the hazards ratios comparing each approach to activity category to the 'low avoidance, low overactivity' reference group at different levels of pain duration. As illustrated in Supplementary Figure 1, Supplemental Digital Content 1, http://links.lww.com/CJP/A163 the hazards of all groups reporting lower lifting tolerances in relation to the 'low avoidance, low overactivity' reference group, decreased per unit increase in pain duration. For individuals who had been experiencing pain for one year, those reporting a combination of high overactivity and high avoidance were 2.52 times more likely to report a lower lifting tolerance compared to individuals reporting low levels of overactivity and avoidance (*p* =.04, *95% CI* =.05 – 1.80), but the difference in hazards between the two groups was not significant for individuals who had been experiencing pain for 10 years or more. Individuals reporting high levels of overactivity and low levels of avoidance, who had been experiencing pain for one year, were also more likely to report difficulties compared to 'low avoidance, low overactivity' subgroup (*HR* =2.42, *p* =.05, *95% CI* =.001 – 1.77), but no significant differences were observed for individuals who had been experiencing pain for 10 years or more. Similarly, individuals reporting high levels of avoidance and low levels of overactivity, who had been experiencing pain for one year or who had been experiencing pain for 10 years, were significantly more likely to report more difficulties compared to the reference group (*HR* =4.61, *p* =.002, *95% CI* =.58 – 2.47 and *HR* =2.55, *p* =.006, *95% CI* =.27 – 1.60 respectively),

but no significant differences were found for those who had been experiencing pain for 20 years or more. Pain intensity was the only significant covariate in the model with the hazards of reporting a lower tolerance for lifting increasing by 1.23 for each unit increase in pain intensity (*p* =.03, *95% CI* =.02 – .40).

Walking

The ‘approach to activity engagement’ categorical variable was not significantly associated with walking tolerance, and the interaction between the categorical ‘approach to activity engagement’ and pain duration was not significant in this model. Covariates age and pain intensity were both significant predictors of walking tolerance. Older individuals and individuals reporting higher levels of pain were both more likely to report lower walking tolerances (*OR*= 1.03, *p* =.03, *95% CI* =.003 – .06; *OR* = 1.82, *p* =<.001, *95% CI* = .28 - .91).

Sitting

The association between the ‘approach to activity engagement’ categorical variable and sitting tolerance, and the interaction term, were not significant in this model. Only pain intensity made a significant contribution to the prediction of sitting tolerance with individuals reporting more intense pain more likely to report a lower sitting tolerance (*OR*= 1.90 *p* =<.001, *95% CI* =.32 – .96).

Standing

The four category ‘approach to activity engagement’ variable was not significantly associated with standing tolerance, with pain intensity being the only significant predictor

in this model. Individuals reporting more intense pain were more likely to report a lower standing tolerance (*PI*=.45 *p* =<.001, *95% CI* =.27 – .64).

Sleeping

The interaction between the 'approach to activity engagement' categorical variable and pain duration was significant in this model indicating that the relationship between approach to activity engagement and sleep is affected by how long an individual has been experiencing pain. The predicted regression coefficients (log of the odds ratio) for each approach to activity category at different levels of pain duration are illustrated in Supplementary Figure 2, Supplemental Digital Content 3, http://links.lww.com/CJP/A165 , and the odds comparing each approach to activity category to the 'low avoidance, low overactivity' reference group at different levels of pain duration are presented in Supplementary Table 2, Supplemental Digital Content 4, http://links.lww.com/CJP/A166 . For those who had been experiencing pain for one year, the 'high overactivity, low avoidance' and 'high avoidance, high overactivity' subgroups were more likely to report poorer sleep secondary to pain compared to the 'low avoidance, low overactivity' reference group. The largest effect was observed in the 'high overactivity, low avoidance' group, with these individuals 9.23 times more likely to report poorer sleep compared to individuals reporting low levels of overactivity and low avoidance (*p* =.004, *95% CI* =.70 – 3.75). Individuals with a combination of high levels of avoidance and overactivity were 4.77 times more likely to report poorer sleep compared to the reference group (*p* =.04 *95% CI* =.06 – 3.06). However, the difference in odds between the reference group and all categories attenuates per unit increase in pain duration from one year up to 20 – 30 years, and the association between approach to activity engagement and sleep is no longer significant for

individuals who had been experiencing pain for 20 years or longer. Pain intensity was the only significant covariate in the model with the odds of reporting poorer sleep increasing by 1.80 for each unit increase in pain intensity (*p* =.001, *95% CI* =.26 – .91).

Sex Life

The categorical 'approach to activity engagement' was not significantly associated with restrictions to sex life and the interaction between 'approach to activity engagement' and pain duration was not significant in this model. In addition, none of the covariates made a significant contribution to this model.

Social Life

There was a significant association between the 'approach to activity engagement' categorical variable and participation in social activities. Individuals reporting high levels of both avoidance and overactivity were more likely to report more restrictions to their social life compared to the 'low avoidance, low overactivity' reference group (*PI* = .59 *p* =.04, *95% CI* =.02 – 1.16). Individuals reporting high levels of avoidance but low levels of overactivity were also more likely to report restrictions compared to the reference group (*PI* = .77, *p* =.02, *95% CI* =.14 – 1.40). The interaction between pain duration and 'approach to activity engagement' was not significant, indicating that the associations are not altered by the length of time an individual has been experiencing chronic pain. Pain intensity was also significantly associated with engagement in social activities, with individuals reporting more intense pain more likely to report difficulties engaging in these activities (*PI* = .37, *p* =<.001, *95% CI* =.18 – .56).

Travel

There was a significant association between the categorical 'approach to activity engagement' and travel tolerance. All approach to activity engagement categories were more likely to report a lower tolerance for travel compared to the 'low avoidance, low overactivity' reference group. The 'high avoidance, low overactivity' subgroup were the group most likely to report difficulties (*OR*= 5.10, *p* =.003, *95% CI* =.56 – 2.70), followed by the 'high avoidance, high overactivity' subgroup (*OR*= 3.70, *p* =.009, *95% CI* =.33 – 2.3), then the 'high overactivity, low avoidance' subgroup (*OR*= 2.99, *p* =.03, *95% CI* =.08 – 2.11). The interaction between pain duration and the categorical 'approach to activity engagement' was not significant, indicating that odds ratios for approach to activity categories are not altered by the length of time an individual has been experiencing chronic pain. Pain intensity was the only significant covariate in the model with the odds of reporting more difficulties travelling increasing by 1.93 for each unit increase in pain intensity (*p* =<.003, *95% CI* =.31 – .95).

Global Disability (ODI Total Score)

The interaction between the categorical 'approach to activity engagement' variable and pain duration was not significant and was removed from the model. The association between the categorical 'approach to activity engagement' variable and the total ODI score was significant (*F* (3,146) =4.79, *p* =.003). Parameter estimates revealed that individuals reporting high levels of both avoidance and overactivity were more likely to report more global disability compared to the 'low avoidance, low overactivity' reference group (*B*=10.95, *p*=.003, *95% CI* =3.81 – 18.10). Similarly, the mean total disability score for the 'high avoidance, low overactivity' group was higher than the reference group (*B*=13.30, *p*=.001, *95% CI* =5.40 – 21.21). Individuals reporting high levels of overactivity but low

levels of avoidance did have a higher mean total disability score compared to the reference group; however, this was not statistically significantly (*B*=5.84, *p*=.13, *95% CI* =-1.75 – 13.43). None of the covariates made a significant contribution to this model. The Levene's test was not significant and the residuals resembled a normal distribution in accordance with model assumptions.

DISCUSSION

The aim of this study was to extend prior research examining associations between an individual's approach to activity engagement and global measures of physical functioning by investigating: 1) the relationship between habitual approach to activity engagement and specific aspects of physical functioning, and 2) whether or not the relationship between approach to activity and aspects of physical functioning differs according to pain duration.

An individual's habitual approach to activity engagement was associated with only certain aspects of physical functioning. There was a significant association between approach to activity and restrictions to the ability to travel, personal care and social life, irrespective of pain duration. A significant interaction effect between pain duration and 'approach to activity' categories was found in two models, suggesting that an individual's approach to activity was associated with sleep quality and lifting tolerance; however, this was dependent on how long an individual had been experiencing pain. No relationship was found between approach to activity and four variables: restrictions to sex life, walking, standing, and sitting tolerances.

In accordance with the World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF),[50] disability covers a spectrum of various levels of functioning at body level (body functions and structures), person level (activity limitations) and societal level (participation restrictions). Research linking ODI items to ICF categories has suggested that: 1) the sleep item is a measure of body functions, 2) personal care, lifting, walking, sitting and standing items measure activity limitations, and 3) social life and travel items relate to participation restrictions.[51, 52] In addition, Jette and colleagues[53] have demonstrated that two different domains exist within activity limitations: 'mobility activity' (difficulties performing physical actions) and 'daily activities' (difficulties with basic and instrumental activities of daily life). Based on this conceptualisation, walking, standing, and sitting items of the ODI are measures of mobility activity, while personal care and lifting relate to daily activities.

The three ODI items that relate to the mobility activity domain i.e. standing, walking and sitting, were the only items (besides the sex life item) that were not associated with an individual's approach to activity engagement. These three items differ from the other items of the ODI in that they are performance skills (i.e., the smallest observable elements of goal-directed action) that facilitate engagement in a range of daily activities.[54] These items are also worded differently from the other activity limitation items of the ODI. The sitting, standing and walking items require participants to rate their ability based on specific distances and times, while the response options for the lifting and personal care items are more ambiguous e.g. 'I can lift very light weights'. Thus, participant responses for the sitting, standing and walking items may be more reflective of the participant's actual physical capacity. As such, the results of the current study may indicate that an

individual's approach to activity engagement is associated more with that individual's perceived capacity to participate in daily activities, and perhaps the emotional and psychosocial aspects of activity engagement, as opposed to their actual physical ability to engage in these tasks.

The majority of significant associations between the four category 'approach to activity engagement' variable and physical functioning variables were in the hypothesised direction. Compared to individuals with low levels of avoidance and overactivity, participants reporting high levels of avoidance but low levels of overactivity reported more restrictions to their social life, more difficulties engaging in self care tasks, a lower lifting tolerance and lower tolerance for travelling and had a significantly higher mean total disability score (i.e. reported more global disability). Individuals with high levels of overactivity and low levels of avoidance were more likely to report a poorer tolerance for travel and lifting. These individuals did have a higher mean global disability score compared to the 'low overactivity and avoidance' reference group however this was not statistically significantly. Those reporting a combination of high levels of avoidance and overactivity had significantly higher levels of global disability and were more likely to report more restrictions to their social life, a lower tolerance for lifting, and a lower travel tolerance.

These relationships compliment associations found in previous studies. Cane and colleagues[15] found that high levels of avoidance were a stronger predictor of higher levels of global physical disability than was overactivity. In addition, research examining categories of approach to activity engagement has indicated that the 'high overactivity, low avoidance' subgroup reports less disability than both 'high avoidance, low overactivity'

and 'high avoidance, high overactivity' subgroups,[18, 19] but more physical disability than the 'low overactivity, low avoidance' subgroup.[19] The associations observed in this study could be explained in terms of the potential impact of avoidance and overactivity behaviour on perceived capacity to participate in daily activities. Two possible reasons that individuals reporting higher levels of avoidance may perceive that they have more difficulties engaging in activities included: 1) guarding behaviour associated with fear avoidance may restrict the movements involved in these activities or 2) individuals may have reduced their participation in the actual activity secondary to fear of pain. For these individuals, a perceived or actual reduction in participation may not be related to their actual physical ability to engage in these activities. Individuals with high levels of overactivity are thought to have activity and pain levels that fluctuate whereby periods of prolonged activity engagement are followed by significant pain increases and prolonged periods of rest. It may be that this impacts on their perceptions relating to their ability to participate in activities (e.g. "I can travel on some days but not others so therefore I have difficulty with this activity") but not their perceived physical capacity per se (e.g. "On my good days I can sit for two hours").

People in the approach to activity engagement subgroups who reported high levels of overactivity were more likely to report poorer sleep secondary to pain compared to the 'low avoidance, low overactivity' reference group. The largest effect was observed in the 'high overactivity, low avoidance' group, for individuals who had been experiencing pain for one year, with these individuals 9.23 times more likely to report poorer sleep compared to individuals reporting low levels of overactivity and avoidance. The present paper is the first study to establish that, for those who have been experiencing pain for 10 years or less,

individuals reporting a combination of high levels of overactivity and low levels of avoidance are more likely to report poorer sleep quality than any other subgroup. This compliments research linking indicators of overactivity (objective measures of high levels of activity and high fluctuations in activity) to subsequent poorer sleep quality in a different patient sample.[55] Taken together, these results suggest that activity modulation may be a key treatment strategy to address sleep complaints for those in chronic pain. A comprehensive multicentre study has revealed that individuals with chronic pain consider improved sleep as one of the most important outcomes of treatment.[56] However, currently there are not many sleep programs designed for people with chronic pain with non-pharmacological treatments limited to sleep hygiene education and interventions aimed at addressing negative thoughts, mood, and stress.[11, 57, 58] Introducing treatment strategies such as pacing education, activity scheduling, and guided exercise sessions (based on graded activity principals)[10] into sleep programs for chronic pain that target individuals who are habitually overactive may be of value.[55]

Based on the premise that avoidance and overactivity led to functional decline, it was theorised that the hypothesised relationships would be more pronounced in individuals who had been experiencing pain for a longer period of time. The interaction between pain duration and approach to activity engagement was significant in two models. However, the effect of pain duration on the relationship between approach to activity and these aspects of physical functioning was the inverse of that theorised, with the difference in odds/hazards between groups attenuating per unit increase in pain duration.

There are a number of possible explanations for these results. A subgroup of older chronic pain patients who have a 'stoic profile' has been identified empirically; this group

was associated with longer pain durations and less perceived disability.[59] Theoretically, this stoicism may explain pain duration-related disparities in disability questionnaire responses and alter effect sizes. In addition, pain duration may be associated with changes in behaviour that are not detected on current measures of approach to activity engagement. While little is known about how an individual changes the way they approach activities over time, a positive association has been found between duration of an illness and adaption to that illness in chronic disease research.[60] It may be that when an individual has been experiencing pain for an extended period of time their reports of avoidance and overactivity on self-report measures relate to more adaptive behaviour (e.g., avoidance of lifting extreme weights versus avoidance of spinal flexion) which may not be captured on current measures. Thirdly, the amount of functional improvement that results from changing ones approach to activity may also be dependent on pain duration. A study by Buchner and colleagues[61] found that a group of patients with low back pain who had been experiencing pain for a longer period of time had less improvement in their physical functioning after multidisciplinary treatment despite having similar physical function to other groups at baseline. If the effect of changing ones approach to activity has less of an impact on physical functioning the longer an individual has been experiencing pain, it would be expected that individuals who report low levels of avoidance and overactivity, after changing their approach to activity at higher levels of pain duration, would still report lower levels of physical functioning. Thus, there is a need for research to investigating the nature of changes to an individual's approach to activity, the effect this has on an individual's daily function, and the influence of pain duration on these processes.

The notion that overactivity and/or avoidance behaviour leads to a reduction in physical capacity due to deconditioning and hypersensitisation of the nervous system is outlined in pain education material and taught in pain management programs worldwide.[10, 11] Chronic pain models, including the mood-as-input model[62] and avoidance-endurance model,[14] also propose that overactivity and avoidance led to increased physical disability overtime through overuse (i.e. damage to body structures and tissue damage) and disuse (i.e. a reduction in activity resulting deconditioning) respectively. While the results of this study do support an association between activity participation and avoidance and/or overactivity behaviour, results do not support the idea that avoidance and/or overactivity is associated with a reduction in physical capacity overtime. These findings highlight the need for research investigating links between an individual's approach to activity engagement and objective functional capacity over time. There is also a need to look at the effect of an individual's approach to activity engagement on deconditioning[20] and hypersensitisation[63] changes, which have not been previously considered, in order to support current educational practices. In this study, an association between overactivity and poor sleep quality was found. Hypothalamic-pituitary-adrenal axis (HPA-axis) dysfunction is thought to initiate and perpetuate sensitisation of the nervous system[64] with numerous studies suggesting a relationship between chronic widespread pain and HPA-axis dysfunction exists.[64-66] As sleep disturbance has been shown to impact HPA-axis dysfunction,[67] sleep quality may be one of the mechanisms that contributes to hypersensitisation of the nervous system in individuals with chronic pain who habitually engage in overactivity behaviour which is currently not considered in patient education.

While the results of this study do not provide support for the theorised mechanisms of functional decline in individuals who engage in avoidance and/or overactivity behaviour the association between activity participation and avoidance and/or overactivity behaviour does, nevertheless, provide a rational for operant-based activity pacing as a chronic pain treatment strategy. Results may, however, indicate that pacing and graded activity education could be more effective when applied to an individual's daily activities (e.g. working on a computer or ironing) and overall daily routine as opposed to performance skills (e.g. sitting or standing tolerance). In addition, activity participation may be a more important outcome variable as opposed to physical capacity in clinical trials investigating the effectiveness of operant-based activity pacing as a treatment strategy.

The results of this study should be interpreted cautiously. The cross-sectional nature of the study limits conclusions regarding causality. Variables were measured using self-report instruments; thus, results reflect patients' perceptions. Social desirability responding was possible due to the self-report nature of measures and the inclusion of the principal researcher as a member of the multidisciplinary treatment team. In addition, the categorisation of approach to activity engagement was based on arbitrarily chosen cut-off points. Those who participated in the study all reported generalised pain impacting on gross movement and were sourced from a tertiary pain clinic; thus, limiting the ability to generalise findings to other chronic pain populations. The number of statistical tests conducted in the current study also increases the chance of making a type I error and, as such, the results require replication. Despite these limitations, the results of this study build upon existing evidence linking an individual's approach to activity engagement to global measures of physical functioning, and raise a number of additional questions leading to new avenues of research which will continue to increase our understanding of a topic that is considered important in the management of chronic pain.

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SUPPLEMENTARY FIGURE 1. **Predicted Regression Coefficients (Log of the Hazards Ratio) for each Approach to Activity Category at Different Levels of Pain Duration for Lifting**

SUPPLEMENTARY FIGURE 2. **Predicted Regression Coefficients (Log of the Odds ratio) for each Approach to Activity Category at Different Levels of Pain Duration for Sleeping**

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TABLE 1. Descriptive Data of Categorical Demographic Variables, N=169

Variable	Value	*n*	%
Gender	Female	92	54.4
	Male	77	45.6
Relationship status	Single	23	13.6
	Defacto or in a stable relationship	15	8.9
	Married	81	47.9
	Separated	14	8.3
	Divorced	30	17.8
	Widowed	6	3.6
Education level	Primary School	16	9.5
	Junior High School Certificate	52	30.8
	Senior High School Certificate	34	20.1
	Tertiary University	44	26.0
	Tertiary Non-University	23	13.6
Employment	Employed full-time	12	7.1
	Employed part-time	12	7.1
	Home duties	13	7.7
	Retired	43	25.4
	Unemployed due to pain	83	49.1
	Unemployed due to other reasons	6	3.6
Pain location	Head and face	30	17.8
	Shoulder/upper limb	83	49.1
	Lower Back	138	81.7
	Abdomen/groin	35	20.7
	Thigh	59	34.9
	Calve/ankle/feet	83	49.1
	Neck	67	39.6
	Upper Back	51	30.2
	Chest	24	14.2
	Buttocks	51	30.2
	Knees	55	32.5
	Total Body Pain	7	4.1

TABLE 2. Descriptive Data for Continuous Demographic and Experimental Variables, N=169

Variable	*n*	Mean	SD	Range
Pain Duration (years)	166	12.29	11.49	.58-52
Age (years)	169	53.74	11.72	22-81
Number of Pain Sites	169	4.76	3.25	1-15
PARQ Avoidance	162	24.86	7.47	5-40
PARQ Confrontation	162	22.97	6.16	5-40

PARQ = Pain and Activity Relations Questionnaire

TABLE 3. Descriptive Data for Oswestry Disability Index Items, N=169

Variable	*n*	Median	Interquartile range	Range
Pain Intensity	169	2	2-3	0-5
Personal Care	169	1	1-2	0-5
Lifting	168	2	2-4	0-4
Walking	167	2	1-3	0-4
Sitting	169	2	2-3	0-5
Standing	166	3	2-4	0-4
Sleeping	168	2	1-3	0-5
Sex Life	132	4	2-5	0-5
Social Life	168	3	3-3	0-5
Travelling	168	2	1.25-3	0-5

TABLE 4. Descriptive Data of 'Approach to Activity Engagement' Categories

Statistics	High avoidance and overactivity	High overactivity, low avoidance	High avoidance, low overactivity	Low avoidance and overactivity
*n**	61	40	34	20
%	36.1	23.7	20.1	11.8
Avoidance subscale range	3-5	.63-2.88	3-4.88	.63-2.88
Avoidance subscale mean	3.73	2.25	3.66	2.08
Avoidance subscale SD	.56	.57	.58	.66
Confronting subscale range	3-5	3-4.71	.71-2.86	.86-2.86
Confronting subscale mean	3.72	3.84	2.38	2.17
Confronting subscale SD	.53	.47	.48	.63

* Missing data = 14 (8.3%)

TABLE 5. Summary Statistics for Ordinal Logistic Regression Models

Model	Link function	Model Fit	Goodness of Fit	Nagelkerke R2	Test of Parallel Lines
Personal Care	Logit	24.97**	633.43	.158	12.94
Lifting	Complementary Log-log	25.70**	736.24	.163	47.44
Walking	Logit	25.87**	575.76	.165	20.84
Sitting	Logit	15.75*	637.28	.104	29.12
Standing	Probit	29.98**	764.95	.189	33.77
Sleeping	Logit	26.37**	559.64	.169	19.32
Sex Life	Complementary Log-log	12.39	593.88	.100	31.65
Social Life	Probit	32.20**	670.47	.205	37.91
Travelling	Logit	28.48**	762.57	.178	31.52

* Significant at the 0.05 level

** Significant at the 0.01 level

TABLE 6. Probit Indexes, Odds and Hazard Ratios for Independent Variables in Ordinal Regression Models Predicting Aspects of Physical Functioning

Independent Variables		Dependent Variable																	
Variable	Value	Personal Care		Lifting		Walking		Sitting		Standing		Sleeping		Sex Life		Social Life		Travelling	
		OR	*p*	HR	*p*	OR	*p*	OR	*p*	PI	*p*	OR	*p*	HR	*p*	PI	*p*	OR	*p*
Age		1.00	.73	1.13	.14	1.03	.03	1.01	.42	.004	.58	1.00	.75	1.01	.25	-.01	.35	1.01	.28
Pain Intensity		1.66	.002	1.23	.03	1.82	<.001	1.90	<.001	.45	<.001	1.80	<.001	1.23	.08	.37	<.001	1.93	<.001
Pain Duration		1.00	.79	1.03	.17	0.99	.57	1.01	.75	.01	.57	1.08	.07	1.00	.66	-.01	.11	0.99	.57
Gender	Female	1.00	R	1.00	R	1.00	R	1.00	R	1.00	R	1.00	R	1.00	R	1.00	R	1.00	R
	Male	.87	.65	0.73	.09	.77	.40	1.38	.30	-.25	.15	1.03	.93	.72	.15	.17	.36	.97	.93
Approach to	LB	1.00	R	1.00	R	1.00	R	1.00	R	1.00	R	1.00	R	1.00	R	1.00	R	1.00	R
activity	HB	2.24	.10	2.63	.04	1.21	.69	.89	.81	-.14	.61	5.03	.05	1.62	.17	.59	.04	3.70	.009
engagement	HO	1.13	.81	2.56	.05	1.04	.93	1.06	.91	.04	.89	10.19	.004	1.02	.95	.44	.14	2.99	.03
	HA	3.23	.03	4.92	.002	2.21	.14	.68	.48	.17	.57	4.69	.07	1.72	.15	.77	.02	5.10	.003
		MF	*p*	MF	*p*	MF	*p*	MF	*p*	MF	*p*	MF	*p*	MF	*p*	MF	*p*	MF	*p*
LB*Pain Duration		-	-	1.00	R	-	-	-	-	-	-	1.00	R	-	-	-	-	-	-
HB*Pain Duration		-	-	.96	.14	-	-	-	-	-	-	0.95	.30	-	-	-	-	-	-
HO*Pain Duration		-	-	.95	.05	-	-	-	-	-	-	0.90	.04	-	-	-	-	-	-
HA*Pain Duration		-	-	.94	.02	-	-	-	-	-	-	0.93	.14	-	-	-	-	-	-

OR = Odds ratio, HR = Hazards ratio, PI = Probit index, MF = Multiplication factor by which odds/hazards ratio changes given a 1-unit increase in pain duration, R = Reference category, LB = Low overactivity and avoidance, HB = High overactivity and avoidance, HO = High overactivity, low avoidance, HA = High avoidance, low overactivity

Supplementary Figure 1
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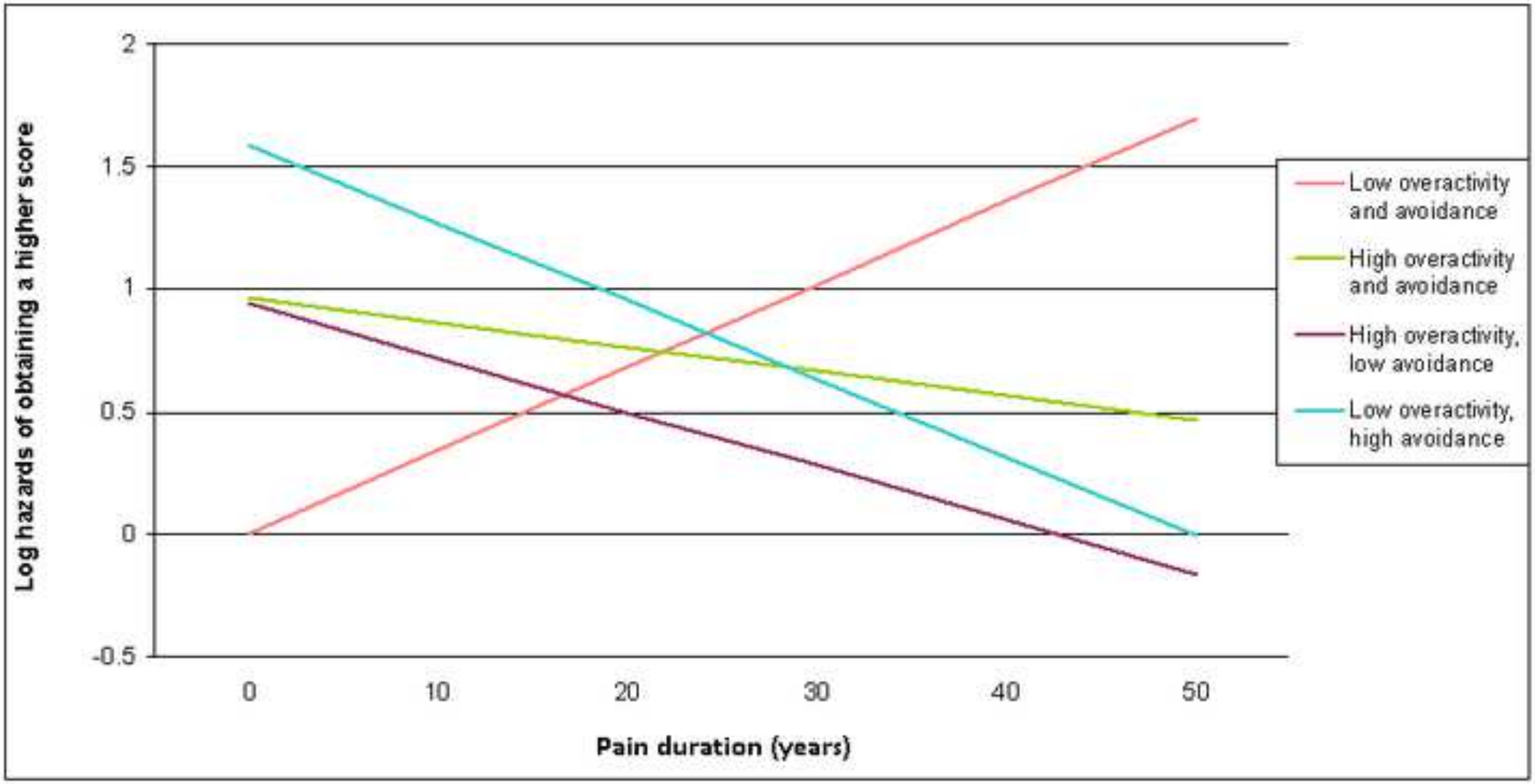

Supplementary Figure 2

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