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How variability in pain and pain coping relates to pain interference during multi-stage ultramarathons

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Abstract

An important and substantial body of literature has established that maladaptive and adaptive coping strategies significantly impact pain-related outcomes. This literature, however, is based primarily on populations with painful injuries and illnesses. Little is known about coping in individuals who experience pain in other contexts and whether coping impacts outcomes in the same way. In an effort to better understand pain coping in such contexts, the present study evaluated pain coping in ultramarathon runners, a population known to experience moderate levels of pain with minimal perceived negative effects. This study reports on pain coping in 204 entrants in 2016 RacingThePlanet© multi-stage ultramarathon events. Participants provided data over five consecutive days on pain severity, pain interference, exertion, and coping. Results demonstrated that the study participants were more likely to employ adaptive than maladaptive coping responses. However, maladaptive coping, but not adaptive coping, was positively associated with percent time spent thinking about pain and pain-related interference. Taken together, the study supports the idea that this high functioning group of individuals experiencing pain emphasizes the use of adaptive coping strategies over maladaptive strategies, reinforcing the perspective that such a pattern may be the most effective way to cope with pain. Within the group, however, results supported traditional patterns, such that greater use of maladaptive strategies was associated with greater pain-related interference, suggesting that optimizing pain coping may be critical to reducing factors that may interfere with ultramarathon performance.

Keywords: Pain, coping, ultramarathon, sports medicine

It is now well-understood that pain beliefs, coping, and attitudes are associated with meaningful pain-related outcomes, such as pain interference. Maladaptive coping approaches are well-substantiated, and a growing body of research describes adaptive coping approaches.[9; 15; 18; 28] Research generally supports that maladaptive approaches are "unhelpful" and adaptive approaches are "helpful" in relation to function.[10; 28] However, these findings are primarily from patients suffering negative consequences of painful injuries or illnesses. Little is known about coping employed by individuals who function at high levels despite their pain, leaving the assumption that those who thrive in the face of pain cope inversely to those who suffer from pain.

Ultramarathon runners are a unique population well-versed in the experience of pain. Up to 85% of these endurance athletes seek medical care during multi-stage races, with the vast majority needing care for skin injuries that were bothersome but not a reason to drop out from racing.[23] Interestingly, few of these individuals drop out of events despite pain and perceived need of medical care.[12; 23] Ultramarathon pain research has focused primarily on pain thresholds and tolerance,[13] and explored the possibility that, relative to the general population, these athletes may be able to exert themselves further before pain prohibits their continuation. While informative, this research incompletely describes the pain experience in athletes and does not describe how they persist in the face of pain.

Among non-athlete samples it has been noted that *how* someone copes with pain is more impactful than individual pain thresholds.[2] Such research in athletes is scant. One lab-based study found that marathon runners were positively impacted by both higher pain tolerance and higher levels of pain-specific self-efficacy relative to non-runners, but the two groups did not differ in their coping strategy use.[20] There is little understanding of the strategies ultramarathon runners use to cope with pain, and how their use relates to pain-related outcomes.

This study sought to define the experience and impact of pain in ultramarathon runners during a multi-stage event. First, we sought to understand how ultramarathon runners experience pain by examining how they rate its intensity and their approach to coping with pain during a race. We hypothesized that over the course of an ultramarathon athletes would generally rate their pain in the moderate range, and the profile of pain coping strategies would emphasize a greater use of adaptive relative to maladaptive coping strategies. Second, we investigated how stage-to-stage fluctuations in coping related to the amount of time a runner spent thinking about

it, and the amount of pain-related interference they experienced. We expected that traditional patterns would emerge, such that when (i.e. during a given race stage) an individual used more maladaptive coping strategies and less adaptive strategies than usual for them, they would spend more thinking about pain and report higher pain interference, above and beyond the effects of exertion and worst pain intensity. In line with prior research in non-athlete populations, we anticipated stronger findings would emerge for maladaptive coping than for adaptive coping.

METHODS

Recruitment and Procedures

Participants were recruited at the 2016 RacingThePlanet© 155 mile (250 km) six-stage ultramarathon races in the Atacama Desert of Chile, the Gobi Desert in China, and Namibian Desert. The races had similar distances of 25 miles (40 km) for each of the first 4 stages, a 50 mile (80 km) stage 5, and a short 5 mile (8 km) sixth stage. These races are self-supported with participants responsible for carrying their own clothing, water, and food for the duration of the event, with the race organizers providing only replenishment water and tents for sleeping. As all races were operated with similar logistical demands, the races were combined into a single cohort for analysis (as has been done in prior research [22; 24]).

All race entrants were offered the opportunity to participate in the study at the time of mandatory check-in, which occurred the day before the first stage. Interested participants who met the inclusion/exclusion criteria (age 18 or older, able to read/write in English so as to be able to answer study questionnaires), signed informed consent and subsequently completed a demographics questionnaire. They then completed a daily questionnaire of the primary study variables after completion of each day's stage for the subsequent five stages (given the brevity of the sixth stage, data were not collected after that stage). Participation was voluntary and no compensation was provided. Study approval was provided by the University of Washington's Human Subjects Division.

Measures

Demographics questionnaire

At enrollment, participants completed a questionnaire assessing basic demographic information (age, sex), as well as information on their running experience (number of marathons entered and completed, number of ultramarathons entered and completed).

Daily questionnaire

The daily questionnaire items were selected to balance the competing demands of providing a thorough assessment of the study variables, while respecting the situational necessity for brevity. Thus, we opted to use a series of single-item questions to assess key study domains, as prior work suggested value in one- and two-item scales of longer measures.[16] All study questions were answered in reference to "today's stage" of the ultramarathon immediately after stage completion.

Pain severity. Participants were asked to rate their average pain and worst pain using the 0-10 Numerical Rating Scale (NRS).[17] The 0-10 NRS is the most commonly used self-report measure to describe pain intensity or severity in both research studies and clinical settings.

Time spent thinking about pain. For the purposes of this study, a variable was developed that asked participants to estimate the percentage of time (0-100%) in the stage they spent thinking about their pain.

Pain interference. Participants rated their perception of the extent to which their pain interfered with their performance with a 0-10 rating in response to a single item derived from the Brief Pain Inventory (BPI; i.e., "How much did pain interfere with your performance?").[6] The BPI is a commonly used measure of pain interference in studies of chronic pain populations and carries sound psychometrics.[7]

Exertion. A rating of perceived exertion (RPE) was provided using the Borg scale, which is frequently used in studies that include exercise or physical exertion.[5; 25] Participants rated their perception of how hard they felt they were working from 6 (no exertion at all) to 20

(maximal exertion). Prior research has shown a strong correlation between the RPE and heart rate (HR), such that HR = 10 x RPE.[25]

Coping. Three categories of coping were assessed: experiential awareness, adaptive pain-related coping, and maladaptive pain related coping. To assess experiential awareness, participants indicated on a 0 (never) – 6 (always) scale the extent to which they: (1) felt optimistic, (2) felt an urge to keep going, (3) maintained a sense of mindful observation, and (4) maintained a sense of automaticity using single items derived from Jensen et al.[19] and the Five Facet Mindfulness Questionnaire – Short Form (FFMQ-SF).[4] To assess adaptive pain-related coping they were asked to rate on a 0 (never) – 6 (always) scale the extent to which they: (1) ignored their pain, (2) saw pain as a challenge, and (3) tried to not let pain bother them. To assess maladaptive pain-related coping, they were asked to rate on this same 0 – 6 scale the extent to which they: (1) felt they could not stand their pain anymore, (2) felt defeated by their pain, (3) felt frightened by their pain, and (4) felt an urge to stop because of the pain, using items derived from the Coping Strategies Questionnaire – 2 item scales[16] and Jensen et al.[19] For each of the aforementioned domains (experiential awareness, adaptive pain-related coping, maladaptive pain-related coping), the items were averaged to generate a composite score. A principal component analyses of the 11 coping items indicated three components (scree plot bend at three points) that accounted for 74.6% of the variance. Each of the three components accounted for over 10% of the variance and Varimax rotated component loadings showed three clear dimensions, with all items loading on scales as expected. All component loadings were ≥.753 with no evidence of cross loading (all cross-loadings ≤|.356|; the one exception was the sense of automaticity item, which had a loading = .528 on the experiential awareness component and evidence of cross-loading on the adaptive pain coping subscale (.426). We examined the effect of removing the item from the experiential awareness subscale. Because its removal did not improve internal consistency of the subscale, did not change findings for the scale in main analyses of the scale, and was considered a conceptually important facet of general coping, it was retained. For all three scales, the possible range was 0-6; and in all three cases the scales demonstrated good internal consistency (Cronbach's alpha for experiential awareness = 0.83; adaptive pain coping = 0.78; and maladaptive pain coping = 0.89).

Statistical Analysis

Descriptive statistics for all outcome and predictor variables were calculated and analyzed for normality. Study hypotheses were examined using multilevel modeling (MLM) due to the hierarchical structure of the data with pain and coping ratings nested within each stage of racing and nested within each runner. MLM, using the SAS PROC MIXED procedure, simultaneously models between- and within-person variance accounting for the auto-correlation of observations in nested data such as this. This analytical approach also includes all available repeated data points and retains cases with missing within-person data. Prior to performing the MLMs, variables were centered based on current guidelines.[8] Deviation scores for coping measures, worst pain, and exertion (Borg) were created by person-centering each of the scores such that the centered value indicated the stage-specific change from each person's race average. These deviation scores essentially index stage-to-stage changes relative to an individual's average coping (adaptive general, adaptive pain, maladaptive pain), worst pain, and exertion levels. We constructed two separate MLMs, one for each pain outcome – percent time thinking of pain and pain interference – that simultaneously modeled the association between the outcome and the three coping composite scores. Covariates –time-invariant sex, age, and average levels of coping composite scores, and time-varying perceived exertion and worst pain ratings for the concurrent stage - were chosen *a priori* based on theoretical considerations and/or past empirical findings. Inclusion of person means for repeated measures as covariates is recommended as a way to remove between-person variable from analyses of within-person variables and prevent predictors from correlating with individual intercepts[11]. Statistical tests were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

RESULTS

Demographic and descriptive statistics

The race series was comprised of 427 individuals, 385 (90%) of whom completed their race. A total of 204 runners enrolled in this study (47.8% of race series entrants) and provided data for at least one stage of the race. The vast majority of the study participants (N = 176, 86% of study participants) completed their race. The samples were not statistically significantly different in dropout rate ($p = ns$).

Within the study sample, one hundred sixty (78%) study participants had no missing data, and overall 87.2% of the data were complete [889 of a possible 1020 data points (5 stages X 204 participants)].

Descriptive statistics are shown in Table 1. Participants were majority men (n=148, 72.5%) with average age 41.35y±10.30. Runners spent, on average, nearly 1/3 of their time during the race thinking about pain. Average pain, worst pain, and pain interference, were all in the moderate intensity range. The runners reported lower levels of maladaptive pain coping relative to experiential awareness and adaptive pain coping.

Insert Table 1 about here

Between and within-athlete relationship of pain coping with time spent thinking about pain

Results of MLMs (Table 2; random effects output in top rows, with fixed effects results below) showed that during stages when a runner reported higher than usual maladaptive pain coping strategies (relative to their personal average), they reported a higher percent time thinking about pain (est. = 5.56, p <.0001). These effects were found above and beyond the effects of average levels of the three types of coping, current-stage ratings of perceived exertion (which was not significantly related to percent time thinking of pain), and worst pain (which was positively related to the outcome). Changes in experiential awareness and adaptive pain coping were not significantly related to percent time thinking about pain. In terms of aggregated coping variables, only between-person levels of maladaptive pain coping were significantly related to percent time thinking of pain, such that people who reported more maladaptive pain coping reported more time thinking of pain. Both types of adaptive coping – general and pain-specific were not related to time spent thinking of pain at either the between- or within-person level.

Insert Table 2 about here

Between and within-athlete relationship of pain coping with pain interference

Results of MLMs with pain interference as the criterion (Table 3; random effects output in top row, with fixed effects results below) showed that when a runner reported higher than usual maladaptive pain coping, they reported an increase in pain interference (est = .70, *p* <.0001); in contrast, higher than usual experiential awareness was related to a decrease in pain interference (est = -.22, *p* .013). The findings were present even after accounting for the effects of average levels of the three types of coping and current-stage ratings of perceived exertion and worst pain; both of which were significantly positively related to pain interference. Between-person levels of the three types of coping were all significantly related to pain interference in the expected directions for experiential awareness, which was negatively related to pain interference, and for maladaptive coping, which was positively related to pain interference. However, those who reported higher levels of adaptive pain coping reported higher pain interference compared to those with lower levels of adaptive pain coping, even when controlling for worst pain ratings.

Insert Table 3 about here

DISCUSSION

This study provides unique insight on pain, pain coping, and their relationship to meaningful pain-related variables in an athletic population that is known to thrive despite persistent and moderate levels of pain. Consistent with our hypotheses, as a group, these ultramarathon runners reported a prioritization of adaptive coping strategies and infrequent use of maladaptive strategies. Regardless of this apparent difference from chronic pain populations,[18] between-person and within-person analyses were consistent with the findings from pain coping research in chronic pain populations, such that the more an individual utilized maladaptive strategies relative to their norm, the more negative pain-related outcomes were reported.

The study participants reported moderate levels of average and worst pain, consistent with prior research indicating that experiencing moderate pain is common in this type of endurance event.[12; 23] However, despite this pain, the runners reported a higher use of

adaptive coping strategies relative to maladaptive coping strategies. It is important to place these findings into context when compared to other populations, particularly as it relates to duration and context of the pain. The vast majority of pain coping research has been conducted using chronic pain populations, while the pain experienced by athletes in competition is mostly acute. Thus it is not surprising that our findings parallel acute pain studies, suggesting that acceptance and distraction have a positive impact on pain tolerance and pain intensity.[21] Participants in these races are well-aware of the inevitability of pain and discomfort when entering the event, and that their pain is finite that will most likely end with race completion. The pain is expected, and expected pain is known to be associated with less distress, compared to pain that is unexpected or pain associated with uncertainty.[3; 14] Similarly, expected pain is also believed to be less likely to induce fear responses and is experienced as less unpleasant than unexpected pain.[32] Thus, the "healthy" coping profile that we found likely reflects characteristics central to the study participants (i.e., a person may be more likely to be an ultramarathon runner if they are able to cope effectively with pain and discomfort) combined with factors associated with the task (i.e., pain is known to occur during a multi-stage ultramarathon and therefore it is not surprising when it is experienced).

Although the study population demonstrated a propensity towards adaptive pain coping as a whole, within the population the pattern of findings were consistent with those found in chronic pain samples, such that greater use of maladaptive coping strategies was associated with worse pain-related outcomes, even when controlling for pain severity.[1; 27; 30; 31] Also, the influence of maladaptive pain coping on outcomes was much greater than that of adaptive pain coping, similar to prior non-athlete research that suggests a greater relative strength for maladaptive coping strategies.[28] This effect was evident both between participants and when examined as within-participant change over the course of the race (i.e., if a person used more maladaptive coping strategies than usual for them, they reported worse pain-related outcomes). Thus, this ultramarathon athlete population demonstrated that pain coping represented an influential factor in the relationship of pain to function. Future research should address the fact that it is not known if modifying pain coping approaches or training runners to reduce their maladaptive responses improves perceived and objective performance.

Beyond pain coping variables, we also observed an interesting finding related to the experiential awareness variables, such that these variables that are traditionally considered "enhancing" in the sports world (e.g.,[26]) were associated with worse pain-related functioning in this population. This was an unanticipated finding, although in hindsight may be a direct reflection of the variables that were used. Specifically, these variables were selected based on their association with constructs viewed as instrumental to high performance, particularly to the extent that they represent mindfulness and flow state. Individual items included runners' ratings of optimism, urge to keep going, awareness of physical sensations, and sense they were running on automatic. Under average, non-pain circumstances, high awareness of physical sensations could represent the extent to which a person is feeling the breeze on their face, the pavement on their feet, or a sense of floating through the air, all wonderful, performance enhancing experiences. In contrast, under pain circumstances, an individual with high awareness of physical sensations could be rating the extent to which they are noticing just how much this hurts. In this case, we would expect this to be associated with a decline in performance, as we observed in this study. We encourage further exploration around this finding, both in terms of identifying flow state or mindfulness questions that do not change so substantially under changing context, as well as in terms of how to best leverage these targets of performance psychology to function as a performance enhancer when pain is present.

This study has several limitations. As all study measures were self-reported, it is possible that shared method variance might have contributed to an over-estimation of the associations between variables. To make this study logistically feasible, we used brief measures of the study variables in order to reduce the participant time burden and potentially minimize study attrition. While there is research supporting the use of such measures,[16] we recognize limitations including the potential for lower reliability (which can limit the strength of associations found) and limited content validity. It would be useful to examine the associations between versions of the belief and coping measures that have more items and outcomes in future studies. Furthermore, the use of brief measures resulted in our selection of a limited number of variables. Data on types and location of pain, nor the nature or severity of injuries were not collected. Although our findings suggest that there may be unique characteristics of ultramarathon runners (i.e., a greater endorsement of adaptive coping, relative to studies of chronic pain populations), it is outside the scope of this study to determine if these athletes acquire a more frequent use of

adaptive responses due to their running experience, if people who already use more adaptive coping gravitate towards these activities, or a combination of both.[29] Longitudinal research examining how pain beliefs and coping changes over time would be needed in order to determine the relative role that experience plays in this relationship.

This study extends prior pain research by demonstrating that accepted and well-understood associations hold even with a population that appears relatively unimpeded by pain. Specifically, our observations support the idea that a group of endurance athletes frequently use adaptive responses, both generally, and in response to pain. While both adaptive and maladaptive responses play a role in function in this specific athletic population, the presence and use of maladaptive responses appears to play a more instrumental role than adaptive responses. The study's results provide an impetus for future research exploring whether optimizing pain coping would be impactful in minimizing barriers to ultramarathon performance.

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Conflicts of interest: The authors declare no conflicts of interest.

References Cited

[1] Alschuler KN, Hoodin F, Murphy SL, Geisser ME. Ambulatory monitoring as a measure of disability in chronic low back pain populations. Clin J Pain 2011;27(8):707-715.
[2] Alschuler KN, Hoodin F, Murphy SL, Rice J, Geisser ME. Factors contributing to physical activity in a chronic low back pain clinical sample: A comprehensive analysis using continuous ambulatory monitoring. Pain 2011.
[3] Arendsen LJ, Hugh-Jones S, Lloyd DM. Transcranial Alternating Current Stimulation at Alpha Frequency Reduces Pain When the Intensity of Pain is Uncertain. J Pain 2018.
[4] Bohlmeijer E, ten Klooster PM, Fledderus M, Veehof M, Baer R. Psychometric properties of the five facet mindfulness questionnaire in depressed adults and development of a short form. Assessment 2011;18(3):308-320.
[5] Borg GA. Perceived exertion: a note on "history" and methods. Med Sci Sports 1973;5(2):90-93.
[6] Cleeland CS, Ryan KM. Pain Assessment: Global Use of the Brief Pain Inventory. Annals of the Academy of Medicine 1994;23(2):129-138.
[7] Cleeland CS, Ryan KM. Pain assessment: global use of the Brief Pain Inventory. Ann Acad Med Singapore 1994;23(2):129-138.

[8] Enders CK, Tofighi D. Centering predictor variables in cross-sectional multilevel models: a new look at an old issue. Psychol Methods 2007;12(2):121-138.
[9] Finan PH, Burns JW, Jensen MP, Nielson WR, Kerns RD. Pain coping but not readiness to change is associated with pretreatment pain-related functioning. The Clinical journal of pain 2012;28(8):687-692.
[10] Geisser ME, Robinson ME, Riley JL. Pain beliefs, coping, and adjustment to chronic pain - Let's focus more on the negative. Pain Forum 1999;8(4):161-168.
[11] Hoffman L, Stawski RS. Persons as Contexts: Evaluating Between-Person and Within-Person Effects in Longitudinal Analysis. Res Hum Dev 2009;6(2-3):97-120.
[12] Hoffman MD, Krishnan E. Health and exercise-related medical issues among 1,212 ultramarathon runners: baseline findings from the Ultrarunners Longitudinal TRAcking (ULTRA) Study. PLoS One 2014;9(1):e83867.
[13] Hoffman MD, Lee J, Zhao H, Tsodikov A. Pain perception after running a 100-mile ultramarathon. Arch Phys Med Rehabil 2007;88(8):1042-1048.
[14] Holten-Rossing S, Slimani H, Ptito M, Danti S, Kupers R. Uncertainty about the intensity of impending pain increases ensuing pain responses in congenital blindness. Behav Brain Res 2018;346:41-46.
[15] Jensen MP. Psychosocial approaches to pain management: an organizational framework. Pain 2011;152(4):717-725.
[16] Jensen MP, Keefe FJ, Lefebvre JC, Romano JM, Turner JA. One- and two-item measures of pain beliefs and coping strategies. Pain 2003;104(3):453-469.
[17] Jensen MP, Turner JA, Romano JM, Fisher LD. Comparative reliability and validity of chronic pain intensity measures. Pain 1999;83(2):157-162.
[18] Jensen MP, Turner JA, Romano JM, Karoly P. Coping with chronic pain: a critical review of the literature. Pain 1991;47(3):249-283.
[19] Jensen MP, Ward LC, Thorn BE, Ehde DM, Day MA. Measuring the Cognitions, Emotions, and Motivation Associated With Avoidance Behaviors in the Context of Pain: Preliminary Development of the Negative Responsivity to Pain Scales. Clin J Pain 2017;33(4):325-334.
[20] Johnson MH, Stewart J, Humphries SA, Chamove AS. Marathon runners' reaction to potassium iontophoretic experimental pain: pain tolerance, pain threshold, coping and self-efficacy. Eur J Pain 2012;16(5):767-774.
[21] Kohl A, Rief W, Glombiewski JA. Acceptance, cognitive restructuring, and distraction as coping strategies for acute pain. J Pain 2013;14(3):305-315.
[22] Krabak BJ, Lipman GS, Waite BL, Rundell SD. Exercise-Associated Hyponatremia, Hypernatremia, and Hydration Status in Multistage Ultramarathons. Wilderness Environ Med 2017;28(4):291-298.
[23] Krabak BJ, Waite B, Schiff MA. Study of injury and illness rates in multiday ultramarathon runners. Med Sci Sports Exerc 2011;43(12):2314-2320.
[24] Lipman GS, Shea K, Christensen M, Phillips C, Burns P, Higbee R, Koskenoja V, Eifling K, Krabak BJ. Ibuprofen versus placebo effect on acute kidney injury in ultramarathons: a randomised controlled trial. Emerg Med J 2017;34(10):637-642.
[25] Robertson RJ, Goss FL, Metz KF. Perception of physical exertion during dynamic exercise: a tribute to Professor Gunnar A. V. Borg. Percept Mot Skills 1998;86(1):183-191.

[26] Scott-Hamilton J, Schutte NS, Brown RF. Effects of a Mindfulness Intervention on Sports-Anxiety, Pessimism, and Flow in Competitive Cyclists. Appl Psychol Health Well Being 2016;8(1):85-103.
[27] Sullivan MJL, Bishop SR, Pivik J. The Pain Catastrophizing Scale: Development and validation. Psychological Assessment 1995;7(4):524-532.
[28] Tan G, Teo I, Anderson KO, Jensen MP. Adaptive versus maladaptive coping and beliefs and their relation to chronic pain adjustment. Clin J Pain 2011;27(9):769-774.
[29] Thornton C, Sheffield D, Baird A. A longitudinal exploration of pain tolerance and participation in contact sports. Scand J Pain 2017;16:36-44.
[30] Vlaeyen J, KoleSnijders A, Rotteveel A, Ruesink R, Heuts P. The role of fear of movement (re)injury in pain disability. Journal of Occupational Rehabilitation 1995;5(4):235-252.
[31] Vlaeyen JW, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. Pain 2000;85(3):317-332.
[32] Zaman J, Wiech K, Claes N, Van Oudenhove L, Van Diest I, Vlaeyen JWS. The influence of pain-related expectations on intensity perception of non-painful somatosensory stimuli. Psychosom Med 2018.

Table 1

Sample descriptives (N=204)

Variable (possible range)	**M±SD**	**range**
Age	M=41.35y±10.30	20-66
Percent time thinking of pain (0-100)	M=30.90±20.79	0-85
Average pain (0-10)	M=3.92±1.96	0-8.33
Worst pain (0-10)	M=5.24±2.33	0-10
Pain Interference(0-10)	M=4.14±2.31	0-10
Adaptive General Coping (0-6)	M=3.70±1.18	0-5.83
Adaptive Pain Coping (0-6)	M=3.04±1.25	0-6
Maladaptive Pain Coping (0-6)	M=1.31±1.09	0-4.33

Table 2

Multilevel model results predicting **percent time thinking about pain** from changes in adaptive general coping, adaptive pain coping, and maladaptive pain coping (controlling for perceived exertion and worst pain, and average levels of the three types of coping).

Covariance Parameter Estimates				
	Estimate	SE	Z	p
UN(1,1)	116.66	21.94	5.32	<.0001
AR(1)	0.1218	0.06	2.09	0.037
Residual	272.19	18.13	15.01	<.0001
Fixed Effects				
Variable	**Beta**	**SE**	**t**	**p-value**
Between-Person (df = 196)				
Intercept	9.02	4.73	1.91	0.058
Sex	-0.97	2.35	-0.41	0.679
Age	-0.15	0.10	-1.50	0.136
Adaptive General Coping (mean)	-1.07	0.90	-1.20	0.234
Adaptive Pain Coping (mean)	-0.43	0.94	-0.45	0.651
Maladaptive Pain Coping (mean)	6.11	1.25	4.90	<.0001
Within-Person (df = 644)				
Rating of Perceived Exertion	0.27	0.23	1.19	0.233
Worst Pain	4.52	0.57	7.99	<.0001
Δ Adaptive General Coping	-0.54	0.99	-0.55	0.583

Δ Adaptive Pain Coping	0.28	0.64	0.44	0.657
Δ Maladaptive Pain Coping	5.56	1.08	5.13	<.0001
Note Δ = person-centered change score; Sex: 0=female, 1=male				

Table 3

Multilevel model results predicting **pain interference** from changes in adaptive general coping, adaptive pain coping, and maladaptive pain coping (controlling for perceived exertion and worst pain, and average levels of the three types of coping).

Covariance Parameter Estimates				
	Estimate	SE	Z	p
UN(1,1)	0.58	0.13	4.39	<.0001
AR(1)	0.07	0.06	1.30	0.194
Residual	2.09	0.13	15.81	<.0001
Fixed Effects				
Variable	**Beta**	**SE**	**t**	**p-value**
Between-Person (df = 197)				
Intercept	0.04	0.38	0.12	0.907
Sex	0.36	0.18	1.99	0.048
Age	-0.01	0.01	-1.66	0.099
Adaptive General Coping (mean)	-0.25	0.09	-2.82	0.005
Adaptive Pain Coping (mean)	0.16	0.08	2.06	0.041
Maladaptive Pain Coping (mean)	0.59	0.10	6.02	<.0001
Within-Person (df = 649)				
Rating of Perceived Exertion	0.08	0.03	2.73	0.007
Worst Pain	0.57	0.05	11.15	<.0001
Δ Adaptive General Coping	-0.22	0.09	-2.51	0.013

Δ Adaptive Pain Coping	-0.07	0.06	-1.11	0.269
Δ Maladaptive Pain Coping	0.70	0.08	8.36	<.0001
Note. Δ = person-centered change score; Sex: 0=female, 1=male				