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OPTIMISM AND PAIN INTERFERENCE IN AGING WOMEN

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OPTIMISM AND PAIN INTERFERENCE IN AGING WOMEN

THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in the
College of Arts and Sciences at the University of Kentucky

By

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2017

ABSTRACT OF THESIS

OPTIMISM AND PAIN INTERFERENCE IN AGING WOMEN

Pain interferes with people's daily lives and often limits the extent to which they can pursue goals and engage in activities that promote well-being. The present study tested how optimism affects and is affected by pain interference and activity among older women. Every three months for two years, middle- and older-age women (N = 199) completed daily diaries at home for a seven-day period, reporting their daily pain, pain interference, and activity. Optimism was measured at baseline and end-of-study. Multilevel models tested the between- and within-person relationships among pain, optimism, and pain interference or activity. Linear regression predicted change in optimism over two years from pain interference and activity. Pain best predicted pain interference, and optimism best predicted activity. There were subtle interactions between optimism and pain predicting interference and activity. Accumulated activity and pain interference across the study predicted longitudinal changes in optimism, with increased activity and decreased pain interference predicting increased optimism over two years. Optimism may play a protective role in disruptions caused by pain, leading to decreased pain interference and increased activity. In turn, less interference and more activity feed forward into increased optimism, resulting in a cycle that enhances optimism and well-being among older women.

KEYWORDS: optimism, pain, pain interference, active approach, aging

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05 December 2017

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Optimism and Pain Interference in Aging Women

Dispositional optimism, a generalized positive expectancy for the future, has been associated with better physical health, including maintenance of cardiac health, better post-surgical outcomes, faster healing, and longer life expectancy (Carver, Scheier, & Segerstrom, 2010). People who are more optimistic tend to approach rather than avoid problems and stressors (Solberg Nes & Segerstrom, 2008), which may account for their better psychological and physical health. Active approach is particularly important in the context of physical pain, as pain can worsen in the context of decreased activity (Crombez, Eccleston, Van Damme, Vlaeyen, & Karoly, 2012). Another potential benefit of active approach is that it supports an optimistic outlook by affording increased sense of control of one's circumstances and greater likelihood of goal attainment. The present study tested how optimism affects and is affected by active responses to pain among older women.

Optimism may play a protective factor in pain interference (Boselie, Vancleef, Smeets, & Peters, 2013), which is the degree to which pain prohibits an individual from engaging in physical or mental activities. Pain interference generally increases with increased pain. Women with fibromyalgia experienced greater pain interference on days with increased pain (Affleck et al., 2001). Similarly, among post-operative female breast cancer survivors, pain interference increased proportionally with mild, moderate, and severe pain, and interference subsequently abated as pain decreased (Langford et al., 2013). Although increased pain is associated with increased pain interference, different populations and age groups have stronger or weaker relationships between pain intensity and interference, suggesting that variables such as motivation, expectancies, and confidence moderate the correlation between pain and pain interference (Boggero, Geiger, Segerstrom, & Carlson, 2015; Fayers et al., 2011). For example, confidence in one's ability to manage and prevent migraines was more likely to affect the relationship between pain intensity and pain interference than other variables such as gender, negative affect, or pain intensity (Martel et al., 2015; Thomas et al., 2016). Confidence in one's ability to manage and prevent illness is similar to optimism in that both are rooted in expectancies of a positive future outcome. Thus, optimism may moderate the relationship between pain and pain interference.

Optimists' active approach to facing obstacles may be one reason they have less pain than those who are less optimistic. People who are more optimistic afford increased effort to tasks, vary their use of coping strategies to better adjust to stressors, seek out information to improve their condition, and focus less on negative aspects of an experience (Carver et al., 2010; Solberg Nes & Segerstrom, 2008). Indeed, there is some evidence that optimism plays a role in the relationship between pain and interference. More optimistic individuals with fibromyalgia were less likely than those who were less optimistic to reduce efforts to achieve their goals and more likely to pursue their goals in the face of increasing fatigue, which is a common correlate of chronic pain (Affleck et al., 2001). Similarly, those higher in optimism decreased pain intensity by engaging in activities aimed at reducing pain, such as faithfully taking medication, or activities that divert attention away from pain, such as household chores or projects (Bargiel-Matusiewicz & Krzyszkowska, 2008; Rosenstiel & Keefe, 1983). Individuals who showed greater acceptance of their pain (as opposed to those who attempted to avoid it) reported paying less attention to their pain and engaging more in daily activities (Viane, Crombez, Eccleston, Devulder, & De Corte, 2004). These active approaches to dealing with pain are indicative of the problem-oriented, approach-focused style of those who are optimistic (Solberg Nes & Segerstrom, 2006) and indicate the practical benefits of activity in the context of pain.

Optimism may change in response to changing life circumstances and resources (Segerstrom, 2007), so an individual's response to ongoing pain may in turn affect his or her level of optimism. Perimenopausal women who participated in a nine-week moderate-vigorous exercise regimen reported greater than 20 percent increase in dispositional optimism (Borges-Cosic et al., 2015). The optimism-increasing benefits of active approach may not require high levels of physical activity. Among patients with fibromyalgia, arthritis, and breast cancer, participation in an online patient support group led to increased acceptance of the illness, feeling more confident when meeting with physicians, and feeling better informed about the illness, which patients ultimately described as increased optimism about and control over their condition (van Uden-Kraan, Drossaert, Taal, Seydel & van de Laar, 2009). Thus, active approach, which includes not only physical activity but also seeking out helpful information, using approach-focused coping strategies, and increasing effort afforded to tasks, can increase optimism. Similarly, an avoidant approach may undermine optimism. When dealing with frequent pain, those who ruminate on their experience of pain, disengage from social and physical activity, and give up on seeking solutions will likely not experience the decreased pain, decreased pain interference, and sense of control over one's condition achieved by those who take active approach. Avoidance may set in motion a suboptimal chain of inactivity that leads to having less positive expectations for the future.

Aging women are an ideal population in which to study the relationship between the effects of optimism and responses to pain, as women have higher rates than men of chronic debilitating pain disorders such as autoimmune diseases, migraines, and arthritis (Bird & Rieker, 2008). Women are also more likely than men to employ higher levels of both active and passive coping when dealing with pain (Carroll, Mercado, Cassidy, & Cote, 2002). In light of the well-established health benefits of optimism (Carver et al., 2010) and given both an average longer lifespan and higher likelihood of chronic pain conditions, studying the effects of active approach and optimism on each other may provide new directions in which to explore non-pharmacologic pain response and management in aging women.

The present study tested two hypotheses about the relationship between optimism and pain responses among older women:

1. More optimistic women will report less pain interference and show greater levels of activity, particularly when daily pain is present.
2. Women who report less interference and more activity will maintain or increase their dispositional optimism over 2 years, whereas women who report more interference and less activity will decrease their dispositional optimism.

Methods

Participants

A sample of 199 community-dwelling women over the age of 50 was drawn from an ongoing longitudinal study of the effects of physical pain on well-being in middle-aged and older women. Women ranged in age from 50-75 years old (*M* = 62, *SD* = 6.42) and were well-educated (*M* = 17, *SD* = 2.27). The participants were 99% Caucasian, 1% African American and 99.5% non-Hispanic, 0.5% Hispanic.

Procedures

Participants were recruited from the Kentucky Women's Health Registry, a research registry of women of all ages. Because the effects of pain on well-being was a primary focus of the parent study, women who reported pain in the registry survey were oversampled. There were 109 women who reported zero pain sites in their most recent registry survey (54%), 53 women who reported one pain site (27%), and 37 women who reported more than one pain site (19%). Registry participants aged 50-75 and living in a seven-county area in Central Kentucky were sent an email invitation to participate in the parent study. Respondents were further screened for study exclusion criteria: BMI > 40; pacemaker; ongoing treatment for serious heart or other medical conditions; infectious or chronic inflammatory diseases; serious mental disorders; oral, inhaled, or injected corticosteroids in the three months prior to enrollment; severe hypertension (BP > 200/100mm Hg), tachycardia or bradycardia, or atrioventricular block; or any medical, neurological, or musculoskeletal condition that prevents treadmill exercise. After completing a single outpatient clinic assessment, women completed online daily diaries at home for a seven-day period. Seven-day diary completion was repeated once every three months for two years, for a total of nine waves. Interviewers administered additional questionnaires at the end of each seven-day period. Women received $50 for the clinic assessment, $25 for completion of each daily diary wave, and a $25 bonus at each wave for completing all 7 diaries between 8 pm and 2 am on each day. All procedures were approved by the Institutional Review Board at the University of Kentucky.

Of the 199 women included in this study, 156 completed all 9 waves, accounting for 1,598 of 1,800 expected waves. Of the 43 women who discontinued early, 8 discontinued because they were too busy (37 missing waves); 4 discontinued because they moved (17 missing waves); 7 discontinued because of serious illness in self or spouse (23 missing waves); 2 discontinued because the diary completion window interfered with their sleep schedule (9 missing waves); 21 discontinued for unspecified reasons or were lost to follow-up (112 missing waves); and 1 died (4 missing waves). Among the remaining 1,598 waves, there were 20 waves intermittently missing, yielding a total of 1,578 waves available for analysis. Overall, women completed a median of 7 days per wave (with a total of 431 individual days intermittently missing). Ninety-five percent of the diaries (n = 10,076) were completed within the target window.

Measures

Demographics. Participants provided information on their age, race, ethnicity, and education.

Dispositional optimism. Optimism was measured with the 10-item Life Orientation Test-Revised (LOT-R) (Scheier, Carver, and Bridges, 1994) at Wave 1 and Wave 9. The LOT-R is a measure of dispositional optimism that reflects positive and negative outcome expectancies. The LOT-R is comprised of 3 positive outcome expectancy items (i.e., “In uncertain times I usually expect the best”), 3 negative outcome expectancy items (i.e., “If something can go wrong for me it will”), and 4 filler items (i.e., “I enjoy my friends a lot”.) Items are scored on a scale of 0 to 4, where 0 = *strongly disagree* and 4 = *strongly agree*. Negative outcome expectancy items are reverse coded prior to scoring. Scores range from 0 to 24. In the validation samples (Scheier et al., 1994), the LOT-R demonstrated high internal consistency (Cronbach's α = .78) and test-retest reliability was .68 at 4 months, .60 at 12 months, .56 at 24 months, and .79 at 28 months. Small to medium positive correlations with measures of mastery and self-esteem, as well as small to medium negative correlations with measures of neuroticism demonstrated moderate convergent validity for the LOT-R. In the current sample, the LOT-R demonstrated good internal consistency at baseline (Cronbach's α = .82) and end-of-study (Cronbach's α = .71).

Pain intensity. Each daily diary included a one-item pain rating adapted from the short-form Global Health-10 Patient-Reported Outcomes Measurement Information System (PROMIS) (Stone, Broderick, Junghaenel, Schneider, & Schwartz, 2015). The original item reading "How would you rate your average pain?" was modified to read "Today, how would you rate your average pain?" because it was intended to capture daily pain. Participants rated their pain on a scale of 0 to 10, where 0 = *no pain* and 10 = *worst pain imaginable*.

Pain interference. Each daily diary included the Pain Interference short form from the PROMIS (PROMIS-PI) which includes six items that capture the degree to which people disengage from activity due to pain. Items include "How much did pain interfere with your day to day activities?" and "How often did pain keep you from socializing with others?" Items are rated on a scale of 1 to 5, where 1 = *not at all* and 5 = *very much*, with a minimum scale score of 6 and a maximum score of 30. The PROMIS-PI had excellent reliability across clinical samples (Cronbach's α = .96-.99) and strong convergent validity with similar pain interference scales (ρ = .84-.90) (Amtmann et al., 2010). In the current sample, the scale demonstrated excellent internal consistency (Cronbach's α = .93).

Activity. As a measure of activity, each daily diary included the Activation subscale of the Behavioral Activation for Depression Scale (Kanter, Mulick, Busch, Berlin, & Martel, 2007), which captures the degree to which activity was valued, goal-directed, and rewarding. Items include "I did something that was hard to do, but it was worth it" and "I made good decisions about what type of activities and/or situations I put myself in." Items are rated on a scale of 1 to 7, where 1 = *not at all* and 7 = *completely*. In the validation samples (Kanter et al., 2007), the subscale demonstrated strong internal consistency (Cronbach's α = .87). Small to medium negative correlations indicated moderate convergent validity with measures of depression, which is expected given the limited overlap between activity and the multifaceted domain of depression. In the current sample, the subscale demonstrated good internal consistency (Cronbach's α = .87).

Cardiorespiratory fitness: predicted maximal oxygen uptake (VO_2max) testing. Each participant performed a submaximal graded exercise test (GXT; 2-min progressive increase in speed and grade) on a treadmill using an indirect calorimetry testing system with integrated electrocardiogram (SensorMedics Vmax Encore, CareFusion Corporation, San Diego, CA). During the tests, continuous measurements of oxygen consumption were recorded and cardiovascular parameters were monitored. At the final 30 seconds of each stage, heart rate (HR), blood pressure, and ratings of perceived exertion were taken and recorded. The GXT was terminated at the end of a workload stage eliciting a heart rate response between 115-150 bpm. Following the GXT, the maximal oxygen uptake (VO_2max; ml/kg/min) was estimated relative to body weight using the following formulas: $b = (SM_2 – SM_1)/HR_2 – HR_1)$ where SM_1 and SM_2 = oxygen uptake, and HR_1 and HR_2 = the heart rate of the corresponding final two workload stages; and $VO_2max = SM_2 + b(HR_{max} – HR_2)$ where HR_{max} = predicted maximal heart rate.

Data Analysis

Multi-level models. For the first hypothesis, the data were analyzed using multi-level models with restricted maximum likelihood (REML) estimation (SAS 9.4 PROC MIXED). The data were structured with daily variation at level 1, wave-level variation at level 2, and between-person variation at level 3. Initially, null models were fitted at each wave to determine the best structure for the daily residuals. The best-fitting model had a random intercept to account for individual differences and a first-order autoregressive structure for the daily residuals. However, this model was not as good as an unstructured model by the likelihood ratio test. Therefore, the final models had a random intercept, unstructured covariance at the wave level, and first-order autoregressive structure at the day level. The final models also employed empirical standard errors to guard against estimation bias due to error covariance misspecification. Between-within degrees of freedom assigned degrees of freedom relative to the sample size to the between-subjects predictors and degrees of freedom relative to the number of observations to the within-subjects predictors.

At levels 1 (day) and 2 (wave), the data were centered within cluster so that the interaction of optimism and pain on pain interference could be distinguished at each level without correlation with the effect at the other levels (Brincks et al., 2016). Likelihood ratio tests in models with only pain predictors indicated that there were random effects of pain on both pain interference and activity at both the day and wave level. Therefore, these effects were included in the final models.

The model for the first hypothesis predicted pain interference (or activity) for day i during wave j for woman k from pain, optimism, and their interactions at the day and wave level:

<u>Level 1</u>

$PainInterference_{ijk} = \pi_{0jk} + \pi_{1jk}(Pain_{ijk}) + e_{ijk}$ — π_{1jk}, pain slope across days

<u>Level 2</u>

$\pi_{0jk} = \beta_{00k} + \beta_{01k}(Pain_{0jk}) + r_{0jk}$ — β_{01k}, pain slope across waves

$\pi_{1jk} = \beta_{10k} + r_{1jk}$ — r_{1jk}, random slope across days

<u>Level 3</u>

$\beta_{00k} = \gamma_{000} + \gamma_{001}(Pain_{00k}) + \gamma_{002}(Optimism) + \gamma_{003}(Pain_{00k}*Optimism) + u_{00k}$

γ_{003}, woman-level interaction

$\beta_{01k} = \gamma_{010} + \gamma_{011}(Optimism) + u_{01k}$ — γ_{011}, wave-level interaction; u_{01k}, random wave slope

$\beta_{10k} = \gamma_{100} + \gamma_{101}(Optimism)$ — γ_{101}, day-level interaction

By substitution, this model can be summarized:

$Y_{ijk} = \gamma_{000} + \gamma_{100}(Pain_{ijk}) + \gamma_{010}(Pain_{jk}) + \gamma_{001}(Pain_{k}) + \gamma_{002}(Optimism) + \gamma_{101}(Pain_{ijk}*Optimism) + \gamma_{011}(Pain_{jk}*Optimism) + \gamma_{003}(Pain_{k}*Optimism) + e_{ijk} + r_{0jk} + r_{1jk} + u_{00k} + u_{01k}$

A replication of the interaction between pain and age (Boggero et al., 2015) was conducted, and sensitivity analyses for effects of optimism and pain were conducted controlling for age effects. Additional sensitivity analyses tested model robustness by covarying education and physical fitness. Finally, the models were tested for robustness against models excluding diaries completed outside the target window. Gamma weights (analogous to unstandardized beta weights in regression) are reported with their standard errors.

Linear Regression. Data for the second hypothesis were analyzed using linear regression, with end-of-study optimism as the outcome. The data were tested for violations of the assumptions of regression. The dependent variable, optimism at the end of the study, was mildly skewed. As regression is robust to mild violations of the assumptions of regression, no remedial actions were necessary. The model for the second hypothesis was $Optimism_2 = \beta_0 + \beta_1(Optimism_1) + \beta_2(PainInterference_k) + e$, where pain interference (or activity) is the mean across all study assessments for each woman.

Results

Descriptive Statistics

Table 1 shows correlations among the study variables, with diary variables averaged across each woman. As expected, the highest positive correlations were between pain and pain interference ($r = .82$, $p < .0001$) and baseline optimism and follow-up optimism ($r = .75$, $p < .0001$.) Notably, the negative correlation between optimism and pain interference was higher at the end of the study ($r = -.42$, $p < .0001$) than at the beginning of the study ($r = -.23$, $p < .0001$.) Optimism had a moderate positive correlation with activity, and age was not highly correlated with any other variables. The variables used in the sensitivity analyses were not highly correlated with any of the substantive predictor variables.

Table 1
Descriptive Statistics and Variable Correlations (N =199)

	Mean (SD)	1	2	3	4	5	6	7	8	9
1. Age	62 (6.43)		.21	.17	-.08	-.14	.14	.14	-.04	-.29
2. $Optimism_1$	3.35 (.62)			.75	-.20	-.23	.46	.15	-.03	-.06
3. $Optimism_2$	3.40 (.54)				-.35	-.42	.51	.10	-.02	.01
4. Pain	1.46 (1.39)					.82	-.28	-.11	.03	-.20
5. Pain Interference	1.32 (.41)						-.34	-.12	.05	-.18
6. Activity	5.83 (.98)							-.02	-.05	.02
7. Education	17 (2.27)								.04	.01
8. $Diary_{CompletionTime}$	10:45 (2h 56min)									-.04
9. VO_2max (metric)	7.98 (2.11)									

Note. All correlations were significant at $p < .05$ except $r_{Optimism2VO2max}$; Education, Diary Completion Time, and VO_2max were used in sensitivity analyses.

Effects of Optimism and Pain on Pain Interference and Activity

Table 2 contains the results of multilevel models predicting pain interference. In the first model with only pain predictors, there were statistically significant main effects of pain at all three levels (person: $\gamma_{001} = .227$, SE = .022, $p < .0001$; wave: $\gamma_{010} = .267$, SE = .014, $p < .0001$; day: $\gamma_{100} = .246$, SE = .010, $p < .0001$). In the second model, which included interactions with optimism, more optimistic women tended to have less pain interference, but this main effect was not statistically significant ($\gamma_{002} = -.044$, SE = .026, $p = .09$). There was also a tendency for optimism to moderate daily pain such that the relationship between daily pain and pain interference was not as strong for optimistic women, but this interaction was not statistically significant ($\gamma_{101} = -.032$, SE = .018, $p = .07$; Figure 1).

Table 2

Parameter Estimates (Standard Errors) for Models Predicting Pain Interference

	Model 1	Model 2	Model 3	Model 4
Fixed Effects				
Intercept	1.322* (0.016)	1.319* (0.017)	1.322* (0.016)	1.319* (0.017)
Level 1				
$Pain_{Daily}$	0.246* (0.010)	0.246* (0.010)	0.246* (0.010)	0.246* (0.010)
$Pain_{Daily}$*Opt		-0.032† (0.018)		-0.026 (0.018)
$Pain_{Daily}$*Age			-0.003* (0.002)	-0.003† (0.002)
Level 2				
$Pain_{Wave}$	0.267† (0.014)	0.266* (0.014)	0.266* (0.014)	0.266* (0.014)
$Pain_{Wave}$*Opt		-0.022 (0.021)		-0.014 (0.021)
$Pain_{Wave}$*Age			-0.004 (0.002)	-0.004 (0.002)
Level 3				
$Pain_{Person}$	0.227* (0.022)	0.221* (0.023)	0.227* (0.022)	0.221* (0.023)
Opt		-0.044† (0.026)		-0.038 (0.026)
Age			-0.004 (0.002)	-0.003 (0.002)
$Pain_{Person}$*Opt		-0.021 (0.031)		-0.023 (0.030)
$Pain_{Person}$*Age			0.000 (0.003)	0.001 (0.003)
AR(1)	0.319* (0.011)	0.319* (0.011)	0.318* (0.011)	0.319* (0.011)
Random Effects and Fit Statistics				
Random intercept	0.045* (0.005)	0.044* (0.005)	0.044* (0.005)	0.044* (0.005)
Random pain slope,W	0.096* (0.004)	0.026* (0.003)	0.025* (0.003)	0.025* (0.003)
Random pain slope,D	0.094* (0.004)	0.016* (0.002)	0.016* (0.002)	0.016* (0.002)
-2 Log Likelihood	3743.6	3761.5	3781.0	3800.1
AIC	3855.6	3879.5	3899.0	3926.1

Note. AR(1) = first-order autoregressive term for covariance between days. W = Wave. D = Day. Opt = dispositional optimism. AIC = Aikake's Information Criterion. $^{*}p < .05$, $^{\dagger}p < .10$

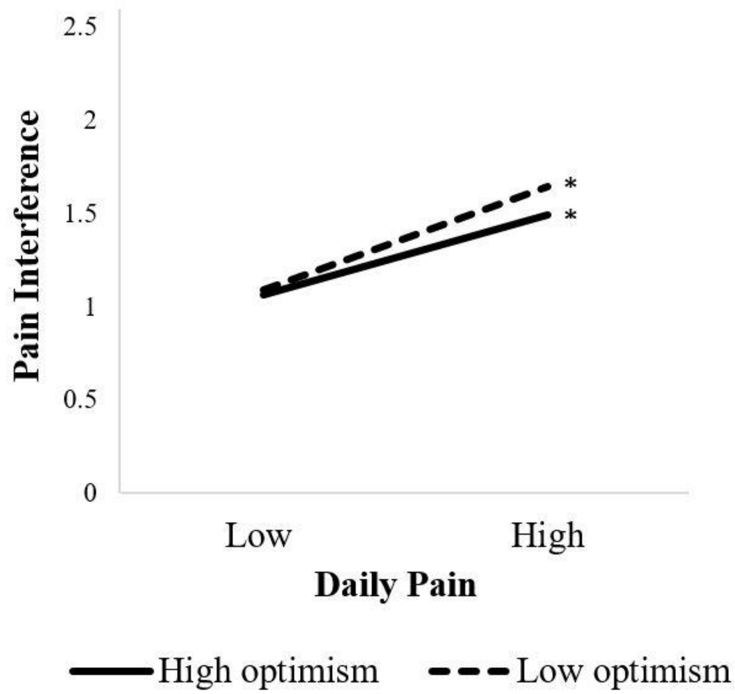

Figure 1. Interaction between pain and optimism at the day level. * Simple slope is statistically significant at $p < .05$

The third model included only pain, age, and their interaction, providing a replication of Boggero and colleagues (2015). There was a statistically significant interaction between age and daily pain (γ_{101} = -.003, SE = .002, *p* = .030), and an interaction between age and wave-level pain that was not statistically significant (γ_{011} = -.004, SE = .002, *p* = .09), suggesting that relationship between pain and pain interference was not as strong for older women. When age terms were included with optimism in the fourth model, the magnitude of the daily-pain-by-age interaction decreased by 15% and was no longer statistically significant. Finally, in sensitivity analyses, the inclusion of education or fitness in the model did not affect the main effect of pain. When fitness was included in the model, the magnitude of the main effect of optimism in the second model increased by 32% and was statistically significant (p = .026). The removal of diaries completed outside the target window did not affect the effects of pain or optimism.

Table 3 contains the results of multilevel models predicting activity. In the first model with only pain predictors, there was a statistically significant main effect of pain at the person level (γ_{001} = -.175, SE = .055, p = .002). In the second model, which included interactions with optimism, there was a statistically significant main effect of optimism (γ_{002} = .684, SE = .101, p < .0001) and a statically significant interaction between wave-level pain and optimism such that more optimistic women reported a slight decrease in activity as pain increased (γ_{011} = -.064, SE = .029, p < .025; Figure 2). The inclusion of age (in the third and fourth models) did not significantly impact the effects of pain and optimism or their interaction at the wave level predicting activity. Finally, in sensitivity analyses, the main effects of pain and optimism remained statistically significant after including education or physical fitness in the model. When education or fitness was added to the model, the magnitude of the wave-pain-by-optimism interaction decreased by 12% and 20%, respectively, and the interaction was no longer statistically significant in both cases. Similarly, when diaries completed outside the target window were removed, the main effects of pain and optimism did not change; however, the magnitude of the wave-pain-by-optimism interaction decreased by 16% and the interaction was no longer statistically significant.

Table 3

Parameter Estimates (Standard Errors) for Models Predicting Activity

	Model 1	Model 2	Model 3	Model 4
Fixed Effects				
Intercept	5.824* (0.067)	5.817* (0.063)	5.819* (0.067)	5.814* (0.062)
Level 1				
$Pain_{Daily}$	-0.003 (0.014)	-0.004 (0.014)	-0.004 (0.014)	-0.004 (0.014)
$Pain_{Daily}$*Opt		0.018 (0.024)		0.021 (0.024)
$Pain_{Daily}$*Age			-0.001 (0.002)	-0.001 (0.002)
Level 2				
$Pain_{Wave}$	-0.028 (0.019)	-0.030 (0.019)	-0.027 (0.020)	-0.029 (0.019)
$Pain_{Wave}$*Opt		-0.064* (0.029)		-0.071* (0.031)
$Pain_{Wave}$*Age			0.002 (0.003)	0.003 (0.003)
Level 3				
$Pain_{Person}$	-0.175* (0.055)	-0.130* (0.055)	-0.171* (0.055)	-0.128* (0.054)
Opt		0.684* (0.101)		0.678* (0.105)
Age			0.017 (0.011)	0.004 (0.010)
$Pain_{Person}$*Opt		-0.050 (0.073)		-0.029 (0.073)
$Pain_{Person}$*Age			-0.008 (0.009)	-0.010 (0.008)
AR(1)	0.203* (0.011)	0.204* (0.011)	0.203* (0.011)	0.204* (0.011)
Random Effects and Fit Statistics				
Random intercept	0.873* (0.091)	0.709* (0.075)	0.865* (0.091)	0.710* (0.076)
Random pain slope,W	0.015* (0.007)	0.014* (0.007)	0.016* (0.007)	0.015* (0.007)
Random pain slope,D	0.009* (0.003)	0.008* (0.003)	0.009* (0.003)	0.008* (0.003)
-2 Log Likelihood	30579.3	30550.0	30610.0	30582.2
AIC	30691.3	30668.0	30728.0	30708.2

Note. AR(1) = first-order autoregressive term for covariance between days. W = Wave. D = Day. Opt = dispositional optimism. AIC = Aikake's Information Criterion. $^{*}p < .05$

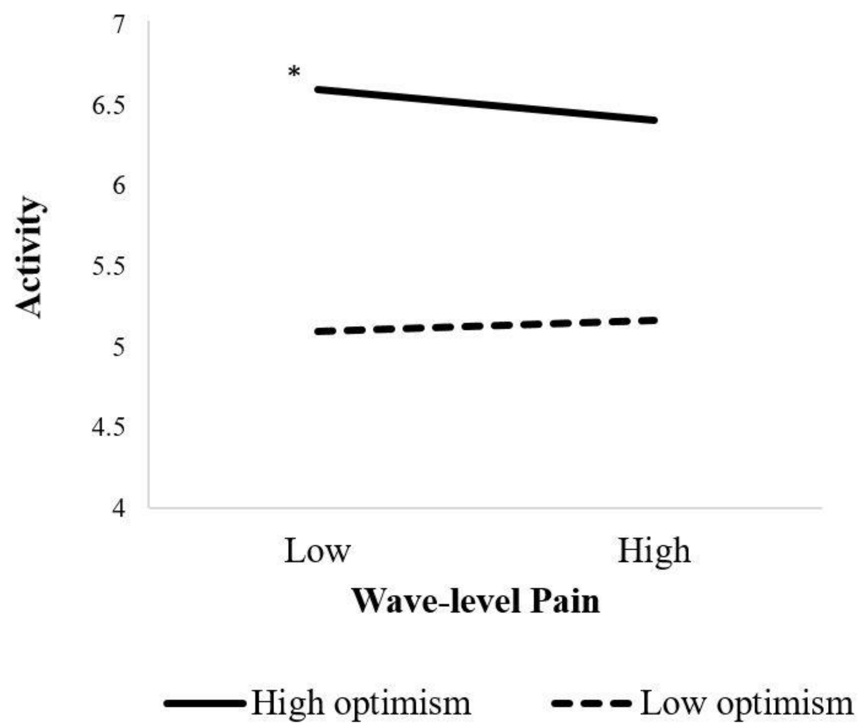

Figure 2. The main effect of optimism and the wave-level pain-by-optimism interaction.* Simple slope is statistically significant at $p < .05$

Effects of Pain Interference and Activity on Changes in Optimism

Table 4 contains the results for the regression models in which pain interference and activity predicted change in optimism. The overall model for pain interference predicting end-of-study optimism accounted for 62% of the variance ($R^2 = 0.620$, $F(2,154) = 126.17$, $p < .0001$). Baseline optimism predicted end-of-study optimism, accounting for 56% of the variance ($sr^2 = 0.560$, $p < .0001$). More pain interference during the study predicted lower end-of-study optimism above and beyond baseline optimism, accounting for 6% of the variance ($sr^2 = 0.064$, $p < .0001$).

The overall model for activity predicting end-of-study optimism accounted for 59% of the variance ($R^2 = 0.589$, $F(2,154) = 111.36$, $p < .0001$). Baseline optimism accounted for 56% of the variance (sr^2 = 0.560, $p < .0001$). Higher activity during the study predicted higher end-of-study optimism above and beyond baseline optimism, contributing 3% of the variance (sr^2 = 0.034, p = .000).

Finally, in the combined model with both pain interference and activity predicting end-of-study optimism, the overall model accounted for 63% of the variance (R^2 = 0.632, $F(3,154)$ = 89.18, $p < .0001$). Higher baseline optimism (sr^2 = 0.560, $p < .0001$), less pain interference (sr^2 = 0.064, $p < .0001$), and more activity (sr^2 = 0.015, p = .013) were associated with higher end-of-study optimism. In the combined model, the variance accounted for by activity decreased from 3% to 1 .5% but remained statistically significant.

Table 4

Slopes, Standard Errors, and Variances for Models Predicting End-of-Study Optimism

	Pain Interference			**Activity**			**Combined Model**		
Variable	B	SE	β	B	SE	β	B	SE	β
Intercept	3.398*	0.027		3.398*	0.028		3.398*	0.026	
BL Optimism	0.588*	0.044	0.686	0.561*	0.050	0.654	0.539*	0.047	0.630
Pain Interference	-0.388*	0.076	-0.261				-0.336*	0.078	-0.226
Activity				0.113*	0.031	0.208	0.078*	0.031	0.143
R^2		0.620			0.594			0.632	
F		126.17*			111.36*			89.18*	

Note. N = 155. BL = baseline. * $p < .05$

Discussion

Given the well-established link between optimism and health and the moderating role of psychological variables in pain outcomes, the present study examined the relationships among pain, pain interference, activity, and optimism in a longitudinal diary study of older women. Whereas pain emerged as the most robust predictor of pain interference, optimism emerged as the most robust predictor of activity. In addition, optimism moderated the effects of pain on pain interference at the day level ($p < .07$) and the effects of pain on activity at the wave level. Accumulated activity and pain interference across the study predicted longitudinal changes in optimism, with increased activity and decreased pain interference predicting increased optimism over two years.

Although the pain main effect was the strongest predictor of pain interference, in the context of daily pain, more optimistic women tended to experience less pain interference than less optimistic women (Figure 1). Because this effect was observed at the day level, but not the wave level, the effect of optimism on interference created by chronic pain remains unclear. There is evidence suggesting that more optimistic women are less likely to reduce effortful goal-pursuit (Affleck et al., 2001) and more likely to engage in activities that deemphasize pain (Viane et al., 2004) than less optimistic women. The day-level findings of the present study suggest that the interference-reducing effect of optimism may occur in daily pursuit of goals or daily engagement in behaviors targeting pain reduction. As the effect observed in this study was small and not statistically significant, future research should explore the extent to which daily engagement in goal-oriented activity impacts long-term reductions in pain interference.

Optimism was the strongest predictor of activity. However, women who were more optimistic (who had generally high levels of activity) had a slight but significant decrease in activity during waves when they experienced higher pain (Figure 2). These results dovetail with recent evidence from this sample indicating that at increasing levels of pain, women downregulate pursuit of valued activities to avoid fatigue (Segerstrom, Jones, Scott, & Crofford, 2016). Taken together, these findings suggest that during longer periods of increased pain (i.e., pain that lasts more than a day), more optimistic women may temporarily reduce their activity to protect themselves from fatigue and other deleterious effects of pain. Even with this reduction, however, more optimistic women maintained substantially higher activity than less optimistic women.

Controlling for cardiorespiratory fitness, pain remained a significant predictor of pain interference and activity. Inclusion of fitness in the model led to a larger effect of optimism on pain interference, which suggests that fitness and optimism each have a distinct effect on pain interference. Extracting the independent variance due to fitness allowed the effect of optimism to emerge; however, it reduced the tendency for more optimistic women to decrease their activity in response to higher wave-level pain. Controlling for education also reduced this effect. Attributing the variance to its proper variables likely removed overlapping variance that previously contributed to the optimism effect, making the already subtle effect no longer statistically significant.

Consistent with extant evidence that optimism changes in response to changing life circumstances (Segerstrom, 2007), the results for the second hypothesis indicated that both pain interference and activity predicted changes in optimism over two years. Activities specifically related to pain (such as exercise, engaging in support groups, etc.) can increase optimism (Borges-Cosic et al., 2015; van Uden-Kraan et al., 2009). Other predictors of increasing optimism over one to ten years included increases in social connection (Segerstrom, 2007) and lower role stress (Atienza, Stephens, & Townsend, 2004). The findings of this study suggest that goal-directed, rewarding activity can increase optimism, regardless of its direct relevance to pain or social connectedness. Increased social connection and lower role stress may fall under the umbrella of “goal-directed activity”, and goal-directed activity may facilitate social connectedness which in turn increases optimism. Other possible pathways between goal-directed activity and increased optimism include physical activity and behaviors aimed at improving health or reducing pain. Taken together, these results suggest a wide variety of goal-related activities (including those that target reduction of pain interference) can increase optimism. Thus, goal pursuit may be a mechanism by which optimism can increase. Future research should explore whether the outcomes of goal-directed activity mediate the effect of goal-pursuit on optimism.

This study advances health behavior research by utilizing the PROMIS PI scale in an intensive longitudinal design that distinguishes within- and between-person effects among behavioral and dispositional factors in the context of physical well-being. Using diary methodology to calculate reliability, the PI scale (as well as the activity scale) was found to have excellent internal consistency both between people and between days, within people. Furthermore, discriminant validity for pain interference was established insofar as results suggested that pain best predicts interference and optimism best predicts activity. Pain interference and activity, though not unrelated, are *not* two sides of the same coin. Additionally, separating day-, wave-, and person-level effects of pain distinguished the specific points at which effects on pain interference occurs, which provided a de facto demonstration of ecological validity for both the PROMIS pain scale and the PI scale used for daily assessment.

This study is not without limitations. The construct differences between pain interference and activity may have been partially due to the fact that the activity measure only captured goal-oriented activity and did not include physical activity or pain-specific activity. Additionally, racial and ethnic homogeneity of the sample limits the extent to which the findings inform the study of health outcomes in minority populations and younger pain populations. The overall sample was relatively low in pain, which made it difficult to specify the effects of optimism on pain interference and activity at higher levels of pain, and vice versa. Future research should compare optimism in higher-pain samples, as well as changes in interference and activity at short, medium, and long intervals.

Pain causes significant interference with peoples' daily lives and often limits the extent to which they can pursue goals and engage in activities that promote well-being; however, people vary in how much interference they experience at a given level of pain. The results of this study suggest that in addition to age and motivation, which are already associated with less pain interference, optimism may also play a protective role in disruptions caused by pain on a day-to-day basis, although further research is needed to confirm this effect. Additionally, combined with earlier research, the findings of this study suggest that those who are more optimistic are more active, and those who are more active experience less pain interference. Finally, the protective effect of optimism leads to decreased pain interference and increased activity, both of which feed forward into increased optimism, resulting in a virtuous cycle that continuously enhances optimism and well-being.

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