Title

When it hurts, a positive attitude may help: association of positive affect with daily walking in knee osteoarthritis. Results from a multicenter longitudinal cohort study

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When it hurts, a positive attitude may help: The association of positive affect with daily walking in knee OA: the MOST Study

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Abstract

OBJECTIVE—While depressive symptoms and knee pain are independently known to impede daily walking in older adults, it is unknown whether positive affect promotes daily walking. This study investigated this association among adults with knee osteoarthritis (OA) and examined whether knee pain modified this association.

DESIGN—Cross-sectional analysis of the Multicenter Osteoarthritis Study. We included 1018 participants (mean age 63.1 ± 7.8 years, 60% female) who had radiographic knee OA and had worn a StepWatch monitor to record steps/day. High- and low- positive affect, and depressive symptoms were based on the Center for Epidemiologic Studies-Depression Scale. Knee pain was categorized as present in respondents who reported pain on most days at both a clinic visit and a telephone screen.

RESULTS—Compared to respondents with low positive affect (27% of respondents), those with high positive affect (63%) walked similar steps/day while those with depressive symptoms (10%) walked less (adjusted beta coefficients = −32.6 [−458.9, 393.8] and −579.1 [−1274.9, 116.7], respectively). There was a statistically significant interaction of positive affect by knee pain (p= 0.0045). Among respondents with knee pain (39%), those with high positive affect walked significantly more steps/day (711.0 [55.1, 1366.9]) than those with low positive affect.

CONCLUSION—High positive affect was associated with more daily walking among adults with painful knee OA. Positive affect may be an important psychological factor to consider to promote physical activity among people with painful knee OA.

Keywords

Physical Activity; Positive Affect; Depressive Symptoms; Knee Pain; Walking

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INTRODUCTION

Walking is the most common means by which older adults stay physically active(1) and can reduce the risk of cardiovascular disease and other adverse health outcomes.(2) Daily walking, or the number of steps one takes per day, can be difficult for older adults with knee osteoarthritis (OA), given that knee OA is the leading cause of functional limitation.(3) While knee pain is considered the primary reason for limited walking among older adults with knee OA,(4) psychological factors, notably depressive symptoms, are also associated with decreased physical activity in this population.(5)

Among older adults, depressed persons have more limitations with physical functioning(6) and lower levels of physical activity(7) than non-depressed persons. However, the absence of depressive symptoms may not be sufficient to promote daily walking. Rather, high positive affect, i.e. the absence of depressive symptoms coupled with a sense of emotional well-being or a positive attitude, may be a determining factor. Positive affect is associated with faster walking speed,(8-10) and with lower rates of frailty and mortality in older adults. (11) Nevertheless, the relationship between positive affect and daily walking is not known. Understanding this association is important. People with knee OA commonly have insufficient levels of physical activity(2) and the identification of factors that may promote daily walking and physical activity in general is needed.

The association of positive affect with daily walking in adults with knee OA may also differ depending on the presence of knee pain. Knee pain is common, prevalent in 20 to 25% of Americans over the age of 60.(12) The amount of daily walking varies among people with the same amount of knee pain, with some walking more than others.(13) Positive affect may be one reason for this variation. In particular, persons with knee pain may need to draw on psychological resources, such as high positive affect, to continue daily walking habits. In contrast, positive affect may be less important for maintaining daily walking habits among OA patients without knee pain. For these individuals, obstacles to daily walking may be more related to lifestyle preferences, scheduling, environmental and policy influences found to be associated with physical activity in the general population.(14, 15)

The current study investigated the association of positive affect with daily walking in a large, multi-site sample of people with knee OA. We hypothesized that respondents with high positive affect would walk more per day than those with low positive affect. Moreover, we hypothesized the association between positive affect and daily walking would be stronger among respondents with knee pain compared with those without knee pain.

METHOD

Sample

The study sample consisted of participants in the Multicenter Osteoarthritis (MOST) Study, a large multi-site longitudinal cohort study of community-dwelling adults, aged 50-79 years, who have or are at high risk of knee OA.(16) The MOST sample was recruited from two communities, Birmingham, Alabama and Iowa City, Iowa, through mass letter mailings, study brochures, and media and community outreach programs. Inclusion criteria included the presence of known risk factors for knee OA, including being over age 50, female gender, previous knee injury or operation, and body weight higher than the median weight for each age- and sex-specific group, based on data from the Framingham OA Study.(17)

Daily Walking Subsample

The present cross-sectional study utilized data from 60-month follow-up exam, conducted between May 2009 and January 2011, since objective data on daily walking was only collected at this visit. The sample for these analyses was restricted to participants with knee OA based on radiographic findings in either Tibiofemoral (TF) or Patellofemoral (PF) joints. For the TF joint, this was a Kellgren and Lawrence grade 2, and for the PF joint, an osteophyte score 2, or any joint space narrowing score 2 with any osteophyte, sclerosis, or cyst score of 1 on a lateral plain view film.(18, 19) Furthermore, we restricted our sample to those participants who wore a StepWatch monitor with a minimum of 3 days of valid walking data since previous studies have found this to be the minimum number of days needed for a reliable estimate of physical activity.(20, 21)

The MOST study protocol was approved by the institutional review boards at the University of Iowa in Iowa City, University of California in San Francisco, University of Alabama in Birmingham, and Boston University Medical Center.

Independent Variables

Positive Affect—Positive affect was based on the Center for Epidemiologic Studies Depression Scale (CESD) (22) following previously published methodology.(10, 23) In brief, the 20-item CES-D scale includes a positive affect factor, comprised of four positively worded items: "I felt that I was just as good as other people," "I felt hopeful about the future," "I was happy," and "I enjoyed life". Participants were grouped into three mutually-exclusive categories: 'depressive symptoms,' 'low positive affect,' or 'high positive affect'. Depressive symptoms were defined as an overall CES-D score of 16 or more irrespective of the number of positive items participants reported, which is the traditional cutpoint for depressive symptoms. Respondents with overall CES-D scores less than 16 were categorized as 'low positive affect' if they reported experiencing no more than 2 of the positive affect items 'most of the time in the previous week'. We classified respondents with 'high positive affect' if they reported experiencing 3 or 4 of items 'most of the time in the previous week'. Thus, no one categorized with high or low positive affect could have depressive symptoms (CES-D 16).

Outcome

Daily Walking—We measured daily walking with a StepWatch monitor, which is a small ($70 \times 50 \times 20$ mm; 38 g), waterproof, self-contained device that is worn on the ankle and records the number of steps taken every minute, while providing no feedback to the user. The StepWatch has high concurrent validity in comparison with several standard measures of step frequency in older adults and high convergent validity when compared with SF-36 scores among participants with OA.(24)

Following collection of data at the clinic visit where positive affect and other study variables were collected, each study participant was fitted with the StepWatch and provided written and verbal instructions for attaching the monitor each morning and removing it at bedtime for 7 consecutive days (plus part of the day that the participant received the device and the day it was returned). To determine whether participants wore the monitor long enough to be counted as a full day, we adopted a published method for processing accelerometry data(25) and defined ten hours of monitoring as the minimum amount of time needed for a full monitored day. The ten hour requirement represents more than 66% of waking hours and has been utilized as a threshold in studies of physical activity in the general adult population(26) and people with knee OA.(25) Time worn was counted from the first step recorded in the morning to the last step recorded in the evening. To exclude times participants may have taken the StepWatch off during the day, we omitted times where the monitor registered no

steps for 180 consecutive minutes during the day.(25, 27) Finally, we restricted our sample to those participants who had a minimum of 3 days of valid data since previous studies have found this to be the minimum number of days needed for a reliable estimate of physical activity.(20, 21)

We quantified walking as the average number of steps/day. We calculated steps/day by totaling the number of steps taken each valid day of monitoring divided by the number of valid days.

Knee Pain

Subjects were asked about knee pain at a telephone screen and again at the clinic visit.(28) In particular, subjects were asked "During the past 30 days, have you had pain, aching, or stiffness in your knee on most days?" These two timepoints were seprated by a median of 33 days. Subjects who responded "yes" to this question at both visits were defined as having knee pain.

Other covariables—The following factors were treated as potential confounders based on their association with function in previous studies(29-31): age, sex, race (White, other), living situation (alone or with someone), education (<some college, college), Body Mass Index (BMI) computed from standardized weight and height assessments classified into World Health Organization categories(32), severity of knee pain measured from a visual analogue scale with 0 and 100 as endpoints, knee strength determined from the mean of four isokinetic knee extensor torque repetitions at 60 deg/sec (Cybex Inc. Medway, MA) categorized by strength of the stronger knee into sex-specific and weight adjusted quartiles, self-reported comorbidities based on the modified Charlson comorbidity index(33) (none/ 1), and widespread pain (absent/present), defined by the American College of Rheumatology as pain above and below the waist, pain on the right and left sides of the body, and back pain using subject marked pain patterns on a figure of the human body.(34)

Analysis

We compared characteristics of participants with different levels of positive affect by performing t-tests for continuous covariables and chi-square tests for categorical covariables. Next, we examined levels of daily walking by using descriptive statistics. To examine the association of positive affect with daily walking, we calculated the mean number of steps for those with high positive affect, low positive affect, and depressive symptoms, and their 95% confidence intervals (CI) using multivariable linear regression adjusting for potential confounders which is equivalent to an analysis of covariance. We designated low positive affect as a reference to examine the association of low and high positive affect, i.e. those without depressive symptoms, with daily walking. To examine if this association differed by knee pain, we examined the interaction of positive affect and knee pain with daily walking. We then repeated analyses stratified by knee pain and adjusted for potential confounders. We confirmed that was normally distributed from visual inspection of steps per day in the sample. We assessed whether each covariable was a potential confounder by determining whether its addition to the regression model, containing only the positive affect variable, changed the association between positive affect with daily walking by 10% or more.(35) The following variables were evaluated as potential confounders: race, education, strength, comorbidity, and widespread pain. All of these covariables met criteria for a confounder and were included along with age, sex, BMI, site (Alabama/Iowa), and knee pain severity in multivariable linear models.

RESULTS

Of the 2330 participants who completed the 60-month clinic visit, 1345 had radiographic knee OA and were eligible for the study. Of these participants, 83% (1116) received a StepWatch and 93% wore it for at least 3 days (1018) and were included in analyses. Of the 229 who did not receive a StepWatch, 72% refused, 16% had medical or physical impairments preventing use, 7% there was no device available, and 5% for other reasons. The majority participants included in the study were women (60%) and white (89%) (Table 1). Their mean age was 63.1 (sd=7.8) years, and mean BMI was 31.7 (6.3) kg/m^2. Generally, participants who were not included were more likely to have worse health indicators (higher BMI, less strength, widespread pain, more knee pain, and higher CES-D scores) compared to participants included in analyses.(Table 1) The average (sd) number of steps taken per day was 8394.5 (3469.0) with an interquartile range of 5888 to 10359.

Association of positive affect with daily walking

Respondents with high positive affect walked the greatest number of steps per day (mean= 8560.3, sd = 3317.5), followed by respondents with low positive affect (mean = 8401.8, sd= 3864.2) and those with depressive symptoms (mean= 7305.9, sd= 3083.9). In unadjusted analyses, respondents with high positive affect walked an average of 158.5 more steps per day compared with those with low positive affect, though this was not statistically significant. Those with depressive symptoms walked 1059.9 fewer steps per day, on average, which was statistically significant. After adjusting for confounders, high positive affect was not associated with walking more steps per day and depressive symptoms were associated with walking about 579 fewer steps per day, compared with those with low positive affect, though this difference was not statistically significant. (Table 2)

Association of positive affect with daily walking stratified by knee pain

The interaction of positive affect by knee pain was statistically significant, p= 0.0045. Approximately 39% of respondents reported knee pain. Among these respondents, those with high positive affect walked 1157.7 more steps per day, which was statistically significant, and those with depressive symptoms walked 59.5 fewer steps per day, which was not statistically significant compared with respondents with low positive affect. After adjusting for confounders including knee pain severity, high positive affect remained significantly associated with walking over 700 steps per day more than respondents with low positive affect.

Among respondents without knee pain, high positive affect was not associated with daily walking in adjusted analyses. Participants with depressive symptoms walked 1197 fewer steps per day compared with those with low positive affect, which was statistically significant after adjustment for confounders. (Table 3)

DISCUSSION

We found that positive affect was not associated with more daily walking among adults with knee OA overall. However in the presence of knee pain, respondents with high positive affect walked 711 more steps per day compared with those with low positive affect, representing about 8.5% more steps from a mean of 8400 steps per day. Increasing daily walking by this amount is clinically meaningful as it could mean attaining a higher level of physical activity based on pedometer-determined physical activity indices (e.g. being sedentary or at a low active level of physical activity)(36). In contrast, respondents without knee pain walked a similar amount per day whether or not they had high or low positive affect. These findings suggest that the absence of depressive symptoms may not suffice to

promote daily walking in people with knee pain. Rather high positive affect is an important psychological feature associated with daily walking and may be needed to increase daily walking among people with both knee OA and knee pain.

Our findings highlight that knee pain modifies the relationship between positive affect and walking among adults with knee OA. Positive psychological factors could be particularly important when health is challenged, and may be why positive affect was associated with daily walking in respondents with knee pain, as opposed to those without knee pain. These findings support the 'broaden and build' theory, which hypothesizes that persons with positive affect are able to better marshal a broad range of physical and psychological resources in response to stress compared to persons without positive affect.(37, 38) For example, it may be that people with high positive affect are better able to cope to 'work through' knee pain and achieve more daily walking compared to people with low positive affect. However, given the cross-sectional nature of our study, we cannot determine the temporal relationships between positive affect and walking; longitudinal studies are needed to better understand this association.

Our results are consistent with previous observational studies that found protective effects for positive affect with health related outcomes in older adults.(10, 11, 37) Evidence exists that negative psychological attributes, such as fear-avoidance beliefs and catastrophizing, influence functional outcomes in adults with low back pain .(39) Our findings extend this research to positive psychological attributes influencing beneficial health behaviors among adults with knee OA. These findings have important clinical implications. In contrast to theories that view positive affect as a trait and therefore unlikely to be modifiable, recent intervention studies have increased positive affect in persons with cardiopulmonary disease(40) and with newly-diagnosed HIV.(41) Moreover, recent trials have shown that interventions aimed at increasing positive affect resulted in increased physical activity in people with asthma(42) and adults after percutaneous coronary intervention(43), as well as increased adherence to medication in African Americans with hypertension.(44) These studies suggest that people with OA could be taught techniques to increase positive affect and other positive emotions, which might improve walking and other health behaviors, in addition to psychological well-being.

We found that depressive symptoms were associated with less daily walking among respondents without knee pain, which is consistent with previous studies.(45, 46) However, we did not find this association among people with knee pain. One possible reason for this was that walking overall decreased for people with knee pain, and there was little difference in walking between those with low positive affect and depressive symptoms. For instance, in crude analysis people with low positive affect walked 9168.5 steps/day without knee pain, and 7383.8 steps/day with knee pain. For those with depressive symptoms, there was less difference between those with and without knee pain. Hence, using persons with low positive affect as the referent group may have led to larger observed differences in walking in the group with depressive symptoms without knee pain, and smaller differences in the group with depressive symptoms with knee pain. Nonetheless, the crude analyses showed that persons with depressive symptoms walked less than other respondents in each subgroup, suggesting that depressed persons with knee OA walk less than other respondents, regardless of the amount of knee pain.

The observed step counts in this sample were comparable to previous studies in older adults measured with a StepWatch. For instance, Cavanaugh et al reported an average of 9981 steps/day among healthy older adults and 7681 steps/day among older adults with self reported functional limitations.(47) Our sample took on average 8395 steps per day, fitting between the healthy and functionally limited groups. This result was expected given that our

sample was comprised of respondents with and without functional limitation.(48) Furthermore, it is important to note that step/day collected in our study cannot be easily compared with previous studies utilizing pedometers. Pedometers are known to underestimate the number of steps taken at slow speeds up to 33% compared with a StepWatch.(49) Hence, step counts in our study are higher than those reported for pedometer-based studies.

Limitations of our study should be acknowledged. First, 24% of the MOST study cohort with radiographic knee OA who attended the 60-month visit chose not to wear the accelerometer or had insufficient data for these analyses. Those included in our study were more likely to have better health indicators compared to those not included in the analysis. Hence, our study findings may have limited generalizability to all people with knee OA. Second, we defined the presence of knee pain using the presence of pain at two time points, a clinic visit and a preceding telephone screen. We performed a sensitivity analysis defining knee pain using severity measured on a Visual Analogue Scale with a cut-point of 10/100, and found similar results. Furthermore, we repeated analysis including all study participants, irrespective of whether they had radiographic knee OA, and found similar results among those with knee pain defined both ways. Third, in addition to knee pain, lower body pain at the feet, ankles, or hips can also alter daily walking. Though we adjusted for widespread pain in our analyses, this may not fully account for lower body pain. We performed a sensitivity analysis adjusting for the presence of lower body pain and found similar results. Fourth, participants may have changed daily walking habits with the knowledge that their habitual walking was being recorded. Previous research suggests that this "testing effect" is greatest when participants wear an unsealed monitor, i.e., when participants are aware of how many steps are being recorded.(50) We believe any increases in daily walking due to a testing effect were minimized since the StepWatch did not display recorded data to study participants. Fifth, other measures of positive affect exist,(51) however these measures were not available within the MOST 60 month exam. Using questions from the CES-D has been found to be a valid measure of positive affect(52) and has been employed as such in previous studies.(10, 37) Lastly, our study was cross-sectional, which precluded inferring causality from our findings.

Despite these limitations, our study had several important implications. Our findings support the notion that positive affect is associated with daily walking, though this association appears dependent on the presence of knee pain. Furthermore, people with high positive affect and low positive affect walk considerably more if they do not have knee pain. Thus, in the context of knee pain, high positive affect enhances walking among persons with knee pain. Thus, future research examining the association of psychological health with physical activity or other health outcomes in older adults should consider the effect of pain as a potential modifier.

In conclusion, we found that high positive affect was associated with daily walking among adults with knee OA and knee pain. Given that physical activity is recommended to reduce the risk of poor health outcomes in adults, it is important to identify factors such as high positive affect, to promote an active lifestyle. Our findings suggest that the absence of depressive symptoms may not be enough to promote daily walking and that high positive affect may be an important factor among older adults with knee pain. Longitudinal studies are needed to investigate the temporal relationship between positive affect and daily walking among older adults.

Acknowledgments

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SIGNIFICANCE AND INNOVATION

- Among persons with knee pain, those with high positive affect walked more steps/day compared with those with low positive affect.

- The absence of depressive symptoms alone may not be enough to encourage daily walking among people with symptomatic knee osteoarthritis, rather positive affect should be considered

Table 1

Summary baseline characteristics of participants included and not included in analyses

	Participants included (n=1018)	Participants not included (n=325)	p-value
Age in years [Mean (sd)]	63.1 (7.8)	63.0 (8.1)	0.81
Female [%]	60	68	0.009
White [%]	89	64	<0.0001
Living situation [% lives alone]	19	25	0.01
Education [% with at least some college]	43	43	0.96
BMI [kg/m] [Mean (sd)]	31.7 (6.3)	33.4 (7.4)	0.0006
Strength [Nm/kg]	0.95 (0.40)	0.84 (0.38)	0.006
No Comorbidity [%]	54	49	0.14
Widespread pain [%]	43	50	0.03
Site [% from Alabama vs Iowa]	39	85	<0.0001
Frequent knee pain [%]	41	49	0.02
Knee pain severity (VAS 0-100) [Mean (sd)]	23.7 (22.4)	32.9 (27.8)	<0.0001
CES-D [Mean (sd)]	6.6 (6.8)	9.5 (8.6)	<0.0001
High Positive Affect [%]	63	52	
Low Positive Affect [%]	27	27	
Depressive Symptoms [%]	10	20	

Table 2

Association of Positive Affect with daily walking measured as the number of steps taken per day on average

	n	Mean steps per day (sd)	Beta [95% CI]	Adjusted Beta [95% CI]
Positive Affect				
High Positive Affect	640	8560.3 (3317.5)	158.5 [−327.9, 644.9]	−32.6 [−458.9, 393.8]
Low Positive Affect	279	8401.8 (3864.2)	Reference	Reference
Depressive Symptoms	99	7305.9 (3083.9)	−1095.9 [−1889.0, −302.8]	−579.1 [−1274.9, 116.7]
Age [10 year increase]				−129.3 [−156.3, −102.3]
Sex [men vs women]				576.2 [189.7, 962.6]
Race [White vs non-White]				38.8 [−612.5, 690.1]
BMI				
25 'healthy weight'				Reference
25-30 'overweight'				−764.6 [−1400.1, −129.2]
30-35 'obese class I'				−1826.2 [−2479.2, −1173.2]
35 'obese class II - III'				−3010.6 [−3708.3, −2312.9]
Comorbidity [1 vs none]				−588.0 [−981.2, −194.9]
Knee extensor strength				
Strongest tertile				Reference
Middle tertile				−361.2 [−901.7, −179.3]
Weakest tertile				−1066.6 [−1624.7, −508.6]
Knee Pain Severity [10 point increase]				−14.7 [−23.7, −5.7]
Widespread pain [yes vs no]				−232.3 [−163.6, 628.2]
Study Site [Iowa vs Alabama]				1125.1 [709.6, 1540.6]

Table 3

Association of Positive Affect with daily walking stratified by people with and without knee pain [*]

	n	Mean steps per day(sd)	Beta [95% CI]	Adjusted Beta[**] [95% CI]
Knee pain n=393				
High Positive Affect	235	8541.5 (3268.0)	1157.7 [431.2, 1884.1]	711.0 [55.1, 1366.9]
Low Positive Affect	109	7383.8 (3090.8)	Reference	Reference
Depressive Symptoms	49	7324.3 (3007.3)	−59.5 [−1137.7,1018.7]	85.2 [−871.6, 1042.1]
No knee pain n = 588				
High Positive Affect	367	8646.3 (3403.6)	−514.7 [−1201.7, 172.3]	−523.7 [−1129.0, 81.5]
Low Positive Affect	151	9168.5 (4211.8)	Reference	Reference
Depressive Symptoms	44	7405.1 (3277.1)	−1755.9 [−2975.3, −536.6]	−1196.7 [−2278.6, −114.8]

[*] Knee pain was defined present in respondents who reported as pain on most days of the previous 30 days at the clinic visit and a telephone screen 30 days prior.

[**] Adjusted for age, sex, race, BMI, comorbidity, knee extensor strength, knee pain severity, widespread pain, and study site.