Which Positive Psychological Intervention would work for Osteoarthritis? A study identifying positive traits that are associated with physical and psychological well-being.

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Introduction

Knee osteoarthritis (OA) is one of the leading causes of global disability¹. It is estimated that almost half of the people (44.7%) will develop symptomatic knee OA in their lifespan². The annual disease costs per individual were estimated to be \$5700 USD in the year of 2000 in US³. Knee OA has been a substantial economic burden to the medical system.

Pain is the primary symptom of the disease and contributes to functional limitations, mental health issues, and reduced quality of life⁴⁻⁸. Current drug treatments (like non-steroid anti-inflammatory drugs NSAIDs) yield only small to moderate effect in pain reduction with various negative side effects^{9,10}. This urges the development of safe and effective non-pharmaceutical treatment for knee OA patients to relief their pain and improve their quality of life.

Furthermore, substantial discrepancy between the radiographic findings and reported levels of knee pain in knee OA patients were recognized^{5,11,12}. This highlights pain is not only a physiological experience. As pain is defined as “unpleasant sensory and emotional experience”¹³, the psychological component of pain should also be considered in the design of pain treatment.

Positive Psychology Intervention (PPI) was emerged in the past decade and has been applied to different populations. Contrast to traditional psychological intervention, which targeting individuals' deficits, PPI focuses on promoting well-being by targeting positive traits, such as gratitude and optimism. A

typical PPI programme usually compose of several positive psychology exercises, with each features promoting a positive trait. For example, “act of kindness” exercise, in which participants are required to do 5 acts of kindness in a single day, features the positive trait of kindness. A recent meta-analysis supports PPI short-term and long-term effectiveness in improving psychological well-being and alleviating depressive symptoms in vast population^{14,15}.

Furthermore, most PPI exercises are brief and cost-effective and can be delivered online or with minimal human interaction¹⁶. These makes PPI a compelling candidate as a pain treatment for Knee OA patients who usually have restricted mobility to attend traditional face-to-face therapy. Laboratory research has identified the association of positive affect^{17,18} and several positive traits, such as optimism¹⁹, kindness²⁰, and humour²¹, to pain sensitivity in health subjects. Several clinical trials have also been run and successfully demonstrate the effect of PPI in relieving pain in chronic pain patients²²⁻²⁴. For example, Muller and colleagues (2016) asked participants with chronic pain to select 4 out of 10 PPI exercises which targeting different positive traits, such as kindness, gratitude, savouring, mindfulness, spirituality, and optimism. They reported a significant post-treatment reduction of pain level in the PPI group, compared to an active control group²³.

However, a recent large scale randomised clinical trials failed to replicate the effect on knee OA patients^{25,26}. Hausmann and colleagues (2017;2018) tested the effect of a PPI that is composed of PPI exercises that targeting gratitude, kindness, mindfulness, and savoring to patients with OA. Although they found a significant reduction of pain intensity in the PPI group, such reduction is not significant different from what observed in the active control group^{25,26}.

The mixed results suggested more research is needed to how positive traits are associated with pain intensity perception in the knee OA patients. To the best of our knowledge, while there is a body of research on studying the association between positive traits and pain intensity in general population, limited research has been done on examining such association in OA patients.

The present study aim to provide empirical evidence to guide the design of PPI for pain reduction customised for knee OA patients by identifying positive traits that are associated with pain intensity in this population.

Methods

Participants

One hundred fifty-six individuals who were referred to Joint Replacement Center, Alice Ho Miu Ling Nethersole Hospital were recruited as part of an ongoing project at the Chinese University of Hong Kong and the University of Hong Kong studying psychology in osteoarthritis patient between February and May 2018. All patients that could be communicated with Chinese or English were

recruited. Assistant were provided to illiterate patients. The study was approved by the Institutional Review Board (CREC-CUHK 2018.113).

Participants presented with unilateral or bilateral symptomatic knee OA based upon the American College of Rheumatology criteria²⁷. Participants were excluded if they had 1) prosthetic knee replacement or other clinically significant surgery of the affected knee; 2) systemic rheumatic disorders (i.e., rheumatoid arthritis, systemic lupus erythematosus, fibromyalgia); 3) cognitive impairment; 4) hospitalization within the preceding year for psychiatric illness.

General Study Procedures

Participants were invited to the study from the clinic during their intake visit after their consultation with orthopedics surgeons. Of these consecutive 180 patients, 156(87%) patients agreed to participate in the study. All participants gave informed consent prior to participation. A structured interview was then conducted for each participant by a trained researcher. For the participants who did not read Chinese, a trained researcher would read out each question of the whole questionnaire and record the response. Participants usually take less than 40 minutes to complete the questionnaire.

Measures

Demographics

Demographic information collected included age, sex, ethnicity, education, and marital status.

Assessments of Knee Osteoarthritis

Radiographic findings

Radiographic evaluations were conducted with use of three radiographs (a weight-bearing anteroposterior radiograph, a lateral radiograph, and a skyline view). All radiographic images were digitally acquired and were evaluated by two operating orthopaedic surgeons, who was blinded to other information on the study subjects, with use of the Kellgren-Lawrence grading scale for osteoarthritis severity²⁸. The radiographs of each knee were divided into medial, lateral, and patellofemoral compartments, and each compartment was graded according to the presence of osteophytes, joint-space narrowing, sclerosis, and cysts (Grade 0, no features of osteoarthritis; Grade 1, small osteophyte of doubtful importance; Grade 2, definite osteophyte but an un- impaired joint space; Grade 3, definite osteophyte with moderate diminution of joint space; and Grade 4, definite osteophyte with substantial

joint-space reduction and sclerosis of subchondral bone). To ensure the accuracy of radiographic assessments, we followed established reading criteria^{28,29}. Joint-space narrowing was defined to be present when the minimal joint-space width was <3 mm for the tibiofemoral joint and <5 mm for the patellofemoral joint. The three compartments were graded separately with use of these criteria³⁰. Similarly, when the grades of right and left knee joints in an individual differed, the more severe grade was used³⁰.

Intra-observer and interobserver reliabilities of radiographic grade assessments were tested with use of kappa coefficients. Intraobserver reliability was evaluated by having all radiographic assessments repeated by an examiner after a period of three weeks, and interobserver reliability was assessed by having two examiners each read fifty radiographs in isolation. Kappa coefficients for intraobserver and interobserver reliability were 0.912 and 0.906, respectively.

Clinical Knee Assessment

In clinical knee assessment, we take reference of the Knee Society score (KSS), which is a widely used outcome measures for knee osteoarthritis and total knee arthroplasty patients³¹. The KSS is a clinical assessment instrument developed by the consensus of the Knee Society and uses variable weighting of questions. It comprises, a “Knee score” and a “Functional score.” The Knee score assesses ‘pain’, ‘stability’, and ‘range of motion’. A maximum score of 100 is achieved by a painless, well-aligned knee with 125° range of motion, with neither anteroposterior nor mediolateral instability. Deductions are made for ‘flexion contracture’, ‘extension lag’, and ‘malalignment’. The Functional score assesses walking distance and stair climbing. A maximum score of 100 is assigned to individuals who can walk unlimited distances and can climb up and down stairs normally. Deductions are made for use of a walking stick or crutches.

In order to analyze the correlation of pain with individual clinical and psychological components of the patients, we breakdown components of the knee scores and analyze them separately. We substitute the ‘pain’ part with visual analog scale (VAS). In our cohort, most patients are suffering from end stage osteoarthritis with stiffness but no laxity. And the range of active and passive maximum flexion & extension are comparable. Therefore, we use VAS, passive range of flexion/extension motion and alignment in our subsequent analysis.

Psychological Measures

Character Strengths

Peterson and Sigleman (2004) has classified psychological strengths into 24 positive traits called Character strengths and developed the Values in Action Inventory of Strengths VIA-IS to measure

them³². In this study, a brief version of the VIA-IS, VIA-72, is used to measure some of the positive traits that are commonly targeted in PPI. The VIA-72 is a 72-item self-report questionnaire on which respondents report the extent to which statements apply to them. Items are rated on a five-point Likert scale ranging from 1 (very much unlike me) to 5 (very much like me). The VIA-72 has acceptable internal consistency and test-retest reliability (mean Cronbach's alpha = .75)³². In the present study, the following 5 character strengths were included in the statistical analyses: "Forgiveness", "Gratitude", "Hope", "Humor", and "Kindness".

Positive Trait Affects

The 10-item positive affects subscale of the Positive and Negative Affect Schedule (PANAS) on a 5-point Likert scale ("Very slightly or not at all" to "Extremely") were used to measure the positive trait affects³³. Respondents rate the extent to which they have experienced each affect descriptor during the past week. Higher scores mean higher positive affect. The PANAS is a commonly used measure of positive and negative affect, with substantial evidence supporting its validity and reliability³⁴.

Results

Descriptive Statistics

The descriptive statistics of the variables measured were summarized in Table 1. The sample was made up of 152 patients (96 female and 56 male) with knee osteoarthritis. The mean age of the patients was 66.50 (SD = 7.10). The rates of highest education received were: 14% no formal education, 45% primary school graduate, 36% high school graduate, 5% college graduate or higher. All patients in the current sample were Chinese and spoke fluent Cantonese.

Correlational Analyses

Table 1 also summarizes the results of the correlational analyses. Correlations were computed to examine the relationship between demographic characteristic, physiological conditions, psychological variables, and knee functionality to pain intensity. Pain intensity was significantly correlated with Humor ($r = -.29$, $p < .01$).

Hierarchical Linear Regression

A hierarchical linear regression analysis was conducted to examine the contribution of Humor to pain intensity. Pain intensity was set to be the outcome variable. Demographic characteristics were entered in Step 1. Medical variables were entered in Step 2. Humor was entered in Step 3. The results were summarized in Table 2. The overall model is significant and accounted for 17.6 % of the total variance

in pain intensity. Furthermore, Humor was significantly independently associated with pain intensity ($\beta = -.33, p < .01$), accounting for an additional 9.4 % of the variance ($p < .01$).

Discussion

The present study examined the relationship of common PPI targets and pain intensity in individuals with Knee OA. Among 6 common PPI target traits, only Humour was associated with pain intensity. No other PPI target traits were found to be significantly associated with pain intensity. Furthermore, the association between Humour and pain remained significant when demographical variables and disease conditions were controlled for.

Consistent with previous findings³⁵, radiographic knee OA severity was weakly associated with knee joint pain, accounted for 4% of the variance, in the current study. It aligns with the biopsychosocial model of chronic pain, which suggests that pain is an experience determined by not only biological factors but also psychological and social factors^{36,37}.

Humour was particularly important in explaining variance in pain intensity. Humour was significantly associated with pain intensity, accounting for 8.4% of the variance. After controlling for demographic and disease conditions, Humour even accounted for 9.4% of the variance. The findings are consistent with previous findings that Humour and the induced social laughter can elevate pain threshold by triggering endogenous opioid release^{21,38}. It supports prior findings that Humour therapy, which focuses on improving participants' sense of humour and use of humour in daily lives, can reduce chronic pain in older adults²². It also extends prior research by showing that the effect of humour to pain intensity is not because of the difference in demographic variables and medical conditions associated with humour.

Gratitude, Kindness, Forgiveness, and Hope were not found to be associated with pain intensity in the current study. This is consistent with previous findings that Hope / Optimism was associated with functionality but not pain intensity in patients with musculoskeletal pain³⁹. This also suggests that PPI which involves only tasks targeting the 4 constructs were less likely to be effective in pain reduction, consistent with previous PPI clinical trials results^{25,26}.

No association of positive affects to the pain intensity was observed in the current study. This may seem somewhat surprising given a body of research has demonstrated PA induction, compared with NA induction, can elevate pain threshold in laboratory settings¹⁸. The reason may lie on the type of the PA measured or manipulated. State PA was manipulated in most, if not all, laboratory setting experiments (citation), while trait PA was assessed in the current study. The findings in regard to the association of trait PA to pain intensity are consistent with prior findings that state PA, but not trait PA, was a significant predictor of pain in Knee OA patients¹⁷.

The present study has several limitations. This study used cross sectional data to the association between pain intensity and positive traits, which limits our ability to infer causal relationships. Future laboratory or clinical research is needed to examine the causality and the directionality of the relationships. Another limitation is that this study included a convenience sample of patients from a specialist clinic in which all patients were diagnosed with Knee OA and referred for joint replacement. Most of them (80%) were suffered from moderate to severe pain (VAS > 6)⁴⁰, this limits whether our findings can be generalised to patients with mild chronic pain or chronic pain caused by other conditions. Also, this study collected only treatment data directly related to their knee OA, participants' other physical and mental condition (e.g. obesity or depressive symptoms) are not collected. Future research should consider to assess if other physical and mental conditions may interact with the positive constructs in reducing pain intensity. Lastly, this study only examined the association of selected positive strengths to one outcome variable, pain intensity. Given the development of new positive psychological intervention tasks that targeting different traits. Future study should consider to include more positive traits and more outcome variables, e.g. psychological well-being, disability, to get a more comprehensive picture on the association between positive traits to general well-being in chronic pain patients.

To the best of our knowledge, this study is the first study to investigate how positive traits are associated with chronic pain, which has been shown to be a strong predictor of depressive symptoms, disability, and general wellbeing^{41,42}. This study provides an empirical evidence to guide the development of PPI for chronic pain patients. Specifically, this study has shown that humour related exercise should be considered when designing PPI for reducing pain in chronic pain patients. Future clinical study should consider to design and test humour-based PPI for chronic pain patients. Future Empirical study to investigate the mechanism of the association of Humour to pain intensity is also advised. This study also sheds light on why previous study on applying PPI into chronic pain patients show seemingly inconsistent results^{22,23,25,26,43}.

Ethics Statement

The Joint Chinese University of Hong Kong – New Territories East Cluster Clinical Research Ethics Committee (The Joint CUHK-NTEC CREC) and Departmental Research Ethics Committee of the Department of Psychology, The University of Hong Kong provided approval. These studies were carried out in accordance with the recommendations of the Ethical Principles of Psychologists and Code of Conduct (APA) with informed consent from all subjects. All subjects gave informed consent in accordance with the Declaration of Helsinki.

Author Contributions

LCML and JCKC: conception or design of the work, data collection, data analysis and interpretation, and final approval of the published version. JC: data collection. LCML and JCKC: drafted the article. HL and FCHJ: critical revision of the article.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Table 1

Correlations Among and Descriptive Statistics For Key Study Variables

Variables	<i>M</i> (<i>SD</i>)	Sex	Age	Educ.	ROM.	Ext.	Flex.	Align.	Bilat.	KLG.	Pain	Pos. Aff.	Forg.	Grat.	Hope	Humor	Kind.
Sex	.37 (.48)	-	-.01	.09	.03	.04	.10	.08	-.01	.13	-.16	.11	-.08	-.04	.08	.22**	.01
Age	66.69 (6.67)		-	-.14	.00	-.05	.08	-.01	-.16	-.02	.02	.02	-.03	.17*	.05	.11	-.02
Educ.	1.32 (.78)			-	.16*	-.06	.10	-.13	.04	-.08	-.06	.24**	.23**	.17*	.10	.11	.19*
ROM.	111.39 (14.85)				-	-.51**	.85**	-.37**	-.02	-.30*	-.17	.15	-.03	-.12	-.07	-.06	.01
Ext.	3.68 (5.27)					-	-.37**	.32**	.12	.33**	.06	-.11	.15	.21**	.13	.00	.05
Flex.	110.89 (14.96)						-	-.39**	-.03	-.28*	-.14	.13	-.01	-.13	-.07	.07	-.01
Align.	4.97 (4.17)							-	.12	.69**	.10	-.06	.00	.22**	.07	.04	.13
Bilat.	0.33 (.47)								-	.06	-.05	-.10	-.17	-.07	-.12	-.12	-.06
KLG.	2.62 (1.06)									-	.11	-.05	.00	.26**	.15	.04	.16
Pain	6.65 (1.85)										-	-.15	-.08	-.03	-.01	-.29**	-.16
Pos. Aff.	2.55 (0.67)											-	.87	.33**	.46**	.32**	.38**
Forg.	3.59 (.70)												-	.82	.61**	.42**	.59**
Grat.	3.58 (.70)													-	.89	.46**	.62**
Hope	3.58 (.73)														-	.44**	.58**
Humor	2.96 (.78)															-	.45**
Kind.	3.60 (.64)																-

Notes. *N*'s range from 136 to 152 due to occasional missing data. For sex, 0 = female, 1 = male. For bilateral, 0 = unilateral, 1 = bilateral knee OA. Educ. = education. ROM. = Range of Movement. Ext. = Extension. Flex. = Flexion. KLG. = Kellgren-Lawrence grading. Pos. Aff. = Positive Affect. Forg. = Forgiveness. Grat. = Gratitude. Kind. = Kindness. Number on the main diagonal denote Guttman's Lambda 6 as measures of internal consistency.

* $p < .05$. ** $p < .01$.

Table 2

Regression results using VAS as the criterion

Predictor	<i>b</i>	<i>b</i> 95% CI [LL, UL]	<i>beta</i>	<i>beta</i> 95% CI [LL, UL]	<i>sr</i> ²	<i>sr</i> ² 95% CI [LL, UL]	<i>r</i>	Fit	Difference
(Intercept)	7.46**	[4.25, 10.68]							
Sex	-0.71*	[-1.36, -0.05]	-0.19	[-0.36, -0.01]	.03	[-.03, .10]	-.19*		
Age	-0.01	[-0.05, 0.04]	-0.02	[-0.20, 0.15]	.00	[-.01, .01]	-.01		
Education	-0.11	[-0.52, 0.29]	-0.05	[-0.22, 0.13]	.00	[-.01, .02]	-.06		
								<i>R</i> ² = .039 95% CI[.00,.10]	
(Intercept)	8.90**	[4.30, 13.49]							
Sex	-0.81*	[-1.49, -0.13]	-0.21	[-0.39, -0.03]	.04	[-.02, .11]	-.19*		
Age	-0.01	[-0.06, 0.04]	-0.05	[-0.22, 0.13]	.00	[-.01, .02]	-.01		
Education	-0.02	[-0.44, 0.40]	-0.01	[-0.19, 0.17]	.00	[-.00, .00]	-.06		
KL.G.	0.18	[-0.23, 0.59]	0.10	[-0.14, 0.34]	.01	[-.02, .03]	.11		
Bilateral	-0.39	[-1.07, 0.29]	-0.10	[-0.28, 0.08]	.01	[-.02, .04]	-.08		
ROM.	-0.03	[-0.07, 0.01]	-0.25	[-0.61, 0.11]	.01	[-.02, .05]	-.16		
Alignment	0.00	[-0.10, 0.11]	0.01	[-0.23, 0.25]	.00	[-.00, .00]	.08		
Extension	-0.01	[-0.08, 0.06]	-0.03	[-0.24, 0.18]	.00	[-.01, .01]	.07		
Flexion	0.02	[-0.02, 0.06]	0.14	[-0.19, 0.48]	.01	[-.02, .03]	-.13		
								<i>R</i> ² = .083 95% CI[.00,.12]	ΔR^2 = .044 95% CI[-.02, .11]
(Intercept)	10.36**	[5.92, 14.80]							
Sex	-0.63	[-1.28, 0.03]	-0.16	[-0.34, 0.01]	.02	[-.02, .07]	-.19*		
Age	-0.00	[-0.05, 0.04]	-0.01	[-0.18, 0.16]	.00	[-.00, .00]	-.01		
Education	0.11	[-0.29, 0.52]	0.05	[-0.13, 0.22]	.00	[-.01, .02]	-.06		
KL.G.	0.18	[-0.22, 0.57]	0.10	[-0.13, 0.33]	.01	[-.02, .03]	.11		
Bilateral	-0.54	[-1.19, 0.11]	-0.14	[-0.31, 0.03]	.02	[-.02, .06]	-.08		
ROM	-0.05*	[-0.09, -0.01]	-0.40	[-0.75, -0.05]	.03	[-.02, .09]	-.16		
Alignment	0.02	[-0.08, 0.12]	0.04	[-0.19, 0.27]	.00	[-.01, .01]	.08		
Extension	-0.02	[-0.08, 0.05]	-0.05	[-0.25, 0.15]	.00	[-.01, .01]	.07		
Flexion	0.03	[-0.01, 0.07]	0.29	[-0.05, 0.62]	.02	[-.02, .06]	-.13		
Humor	-0.78**	[-1.19, -0.36]	-0.33	[-0.51, -0.15]	.09	[.00, .18]	-.29**		
								<i>R</i> ² = .176** 95% CI[.02,.23]	ΔR^2 = .094** 95% CI[.00, .18]

Note. A significant *b*-weight indicates the beta-weight and semi-partial correlation are also significant. *b* represents unstandardized regression weights. *beta* indicates the standardized regression weights. *sr*² represents the semi-partial correlation squared. *r* represents the zero-order correlation. *LL* and *UL* indicate the lower and upper limits of a confidence interval, respectively. ROM. = Range of Movement. KL.G. = Kellgren-Lawrence grading.

* indicates $p < .05$. ** indicates $p < .01$.

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