

PAIN CATASTROPHIZING, MENTAL TOUGHNESS AND CHANGE IN AFFECT DURING ARM-SWING-EXERCISES BY KNEE OSTEOARTHRITIS PATIENTS

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Abstract

Background: Elderly Thai sufferers of knee osteoarthritis (OA) show a poor response to arms swing exercise (ASE), therefore mental toughness (MT), which is one's ability to deal with any state should be explored, including changes in negative affect at pre and post ASE (Δ NA). However, the mediating variable pain catastrophizing (PC) seems likely to have an impact of a positive/negative affect during ASE. **Aims:** This study investigated Δ NA, the relationship between MT and Δ NA in knee OA patients, and the mediation effect of PC on this relationship. **Methods:** 68 Thai overweight elders with knee OA were surveyed for MT and PC before swinging their arms for 10 min, and the Positive and Negative Affect Schedule (PANAS) was examined at pre and post ASE. T-test and simple mediation analyses were conducted for testing the relationship between all variables at the same time, and clarifying the degree to which PC mediates these relationships. **Results:** The patients reported a Δ NA decrease from pre to post ASE (0.38 ± 2.08), but it was not significant ($t_{(67)} = -1.39, p > 0.05$). High MT was negatively related to Δ NA in the patients, but this relationship was not significant ($b = -0.034, p = 0.070$). In a simple mediation analysis, MT exerts an effect on Δ NA, but PC showed no mediation effect, since the indirect effect size was a very small. **Conclusion:** ASE was not an obvious preference exercise to change patients' positive and negative affects, even when patients were high in MT.

Keywords: Mental toughness, pain catastrophizing, PANAS, arms swing exercise, knee osteoarthritis, Thai elders

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Introduction

The healthcare providers in Thailand provide arms swing exercise (ASE), which is a simple procedure and appropriate exercise, to Thai elderly people with knee osteoarthritis (OA). However, patients often decline this exercise prescription, which is a policy of the Ministry for Public Health of Thailand (Bureau of Policy and Strategy Ministry of Public Health, 2011). This is not surprising, since a study by Campbell *et al.* (2001) showed that half of knee OA patients do not follow their continuous exercise program, and do not meet the 150 min/weeks that was recently recommended (Brosseau *et al.*, 2017). What do they feel towards exercise? Perhaps they feel more knee pain and fear walking at high speed (Somers *et al.*, 2009). As a result, patients cannot complete the recommended exercise. ASE is an alternative exercise to these patients that is similar to yoga or Tai-Chi, in terms of being a complementary therapy, as rheumatologists recommended (Uhlir, 2012). ASE contributes to energy expenditure (Churproong *et al.*, 2015) for controlling patients' body weight and provides muscle strengthening. ASE may provide loading on knees, such as aerobic and resistance exercise (Richards and Fang 2004). However, standing and swinging the arms might make OA knee patients feel knee pain from body loading. Thus, those who perform ASE need a high level of mental toughness to complete this task.

The major concern for these patients is pain management (Bennell *et al.*, 2016). Therefore, decreasing knee pain and body mass index (BMI) are the focus goal of exercise prescription in overweight older knee OA patients (van Gool *et al.*, 2005). Consequently, the benefits of exercise recommendations will not work if patients fail to adhere to the therapies (Sabaté, 2003) because of pain. The genesis of pain in knee OA derives from multiple pathways, such as mechanical dysfunction and knee joint surface abrasion from the degeneration of articular cartilage, and pain catastrophizing (PC) - a constitutional factor of pain symptoms of knee OA. The negative mental set during pain

experience, causing an exaggeration of pain, is defined as PC, which relates to pain behavior and predicts pain intensity (Sullivan *et al.*, 2000). Moreover, the total score of 13 item-pain catastrophizing scales (PCS) significantly related to the pain rating scale (Keefe *et al.*, 2000). Therefore, the measurement of the 13 items of the PCS should be surveyed along with indicating the scale of pain at pre and post ASE. There is a multi-dimensional construction comprising of rumination (repetitive thinking carefully and for a long period about pain), magnification (the process of thinking about the pain being worse than it actually is) and helplessness (inability to do anything to help your own or anyone else's pain). These terms lead to the conclusion that pain catastrophizing reflects negatively on the sensation of pain or threat (Sullivan *et al.*, 1995). The total score of PCS was used for assessing the combination of PC constructs because the researcher gave an interesting overview of the catastrophizing effect. This would provide an idea of how the degree of experience of pain affects your moods while arm swing exercising. This examination may provide useful insights to predict of PC, regarding the goals of intervention for rehabilitation (Sullivan *et al.*, 2000). This means that PC is related to exercise adherence.

In particular, bad pain might block exertion, if mental toughness (MT) is not buffering this effect (Crust and Clough, 2005). In defining what MT actually is, there are many delineations that depend on the tasks people perform in different contexts (Gucciardi and Gordon, 2011). One's ability to deal with any state was defined by Loehr, 1986; Visram, (2012) and the author stated that MT reflects positive attitudes towards challenging and demanding situations (Loehr, 1986). Mental toughness is a good resource in challenging states that results in behavior leading to a successful performance (Moore, 2014). Although most previous studies examined mental toughness in athletes during sports events, many psychologists suggest that MT should be extended outside sports performance

(Crust, 2008; Gucciardi *et al.*, 2015). MT enables an individual to endure any tough situation, and overcome stress or obstacles in any context, (Gucciardi *et al.*, 2009a); for example, a big sporting competition, a difficult tasks in work or education, or an unfamiliar physical activity (Skakoon, 2015; Mutz *et al.*, 2017). Interpretations of MT seem to differ in meaning in different age groups, cultures, and genders (Fawcett, 2011). Sports psychologist have developed many tools for measuring MT.

An updated study by Gucciardi (2016) used a Mental toughness index (MTI) of 8 items to examine mental toughness in people with knee pain to potentially find a gap in the rehabilitation process, regarding the intention and behavior toward exercise after providing the home-exercise prescription to patients for preventing more knee pain. Gucciardi *et al.* (2015) developed this 8-item MTI, composed of a multifaceted concept to be an aggregate construction. The eight-item unidimensional model included attention regulation, self-belief, emotion regulation, optimism, success mind-set, the context of knowledge, and buoyancy. These characteristics influence patients to get through their bad feelings during ASE. That means MT is an important factor, which influences patients' compliance, because the regulation of behavior, intention, and thoughts is moderated by MT (Gucciardi, 2016), but a controlling behavioral would decline when people are getting older (Davies *et al.*, 2010). In addition, addressing mental toughness in elders would be a benefit to healthcare providers when they evaluate patients before promoting exercise programs to them. At the same time, people who were high in MT had a lower negative affect level during the performance (Mahoney *et al.*, 2014). In contrast, Tripp *et al.* (2007) stated that PC seemed to increase negative affect for rehabilitation. Therefore, PC also seemed to increase barriers for rehabilitation (Keefe *et al.*, 2000), because load-bearing exercise produces more knee pain in overweight knee OA patients, they fear to rehabilitation, suggesting PC related to fear (Youngcharoen *et al.*, 2016). Healthcare providers may need to give more support to the patients before

promoting the exercise programs in order to decrease pain in knee OA patients. This strategy might decrease healthcare costs because of decreased disabilities (Gerber *et al.*, 2013). Nicholls *et al.* (2008) concluded that individuals who were high in MT were associated with positive threat appraisal and able to cope with pain while undertaking a rehabilitation program better than individuals who were low in MT. For example, Jones and Parker (2014) stated that cyclists who were high in MT seemed to endure such pain, but the athletes might show a slow pace or run for a longer time period, when they practice PC, in order to reduce perceived exertion (Jones and Parker, 2015).

There are no studies directly examining the patients' perceptions, thoughts, and feelings towards ASE. This could be addressed by determining changes in negative and positive affects pre and post ASE. Therefore, a 10-min ASE has been chosen to be the intervention for assessing change in patients' psychological effects towards ASE, given that there are no previous studies directly examining this. Patients' compliance might improve if healthcare providers adopt an approach whose main consideration is the patients' feelings. The positive and negative affect schedule (PANAS) was used to assess the relationship between exercise and mood state in previous studies. The researcher decided to translate two dimensions of mood by the PANAS, 10-item scales of PA and 10-item scales of NA into the Thai language for this study. Accordingly, the original versions were offered due to high internal consistency reliability, good validity, stability, and the fact that the tools have a minor mood fluctuation when used in the modern day (Watson *et al.*, 1988). Most previous studies focused on the impact of exercise on negative affect (Tripp *et al.*, 2007; Palgi *et al.*, 2016), but Hou *et al.* (2015) mentioned that positive affect is sensitive to change towards exercise as well. Therefore, the score of the change in a 10-item NA and a 10-item PA at pre and post-exercise are the primary and the secondary outcome variables, respectively.

The aim of this study is to examine

changes in negative and positive affect, to assess whether mental toughness is related to changes in negative affect after 10 min of ASE, and to address whether pain catastrophizing mediates this relationship. The results would help practitioners understand patients' thoughts and feelings toward ASE. This is a gap in the literature, because previous researchers did not show any evidence regarding knee OA patients with ASE. The results of this study will therefore be meaningful for developing a rehabilitation program using ASE. This leads to the research question: What is the amount of the pain catastrophizing and how does this mediate the relationship between mental toughness and changes of negative affect during arms swing exercise in the elderly Thai people with knee osteoarthritis? This means that mental toughness (MT) is the independent variable, and change in negative affect (Δ NA) is the dependent variable, and pain catastrophizing (PC) is the mediator. Therefore, there are three objectives in this study: 1) comparing the score of NA at pre and post ASE, and 2) quantifying and determining the direction of the relationship between MT and changes in NA during ASE in knee OA patients, and 3) assessing the magnitude of the mediation effect of PC on this relationship. Likewise, changes in positive affect (Δ PA) are a secondary outcome variable that requires answers to similar questions.

The results will benefit to further patients' compliance and assess whether ASE would be a suitable exercise prescription for these patients after understanding patients' thoughts and feelings toward ASE.

Materials and Methods

Sixty-eight participants who met the inclusion criteria were recruited from Suranaree University of Technology Hospital, and primary health care units in Nakhon Ratchasima province, Thailand. The inclusion criteria in this study were as follows: 1) Participants were Thai people with ages of 60 years or more. 2) They had either unilateral

or bilateral knee OA diagnosed by clinical symptoms or radiography, and had not had a knee replacement operation. 3) They had a BMI exceeding 25 kg/m². 4) Participants were otherwise healthy without serious heart conditions, dyspnea, palpitation, chest pain, or brain dysfunction affecting their memories. 5) They had no previous upper limb injuries. 6) They were able to stand without assistive devices for longer than 10 min. 7) They were able to communicate well with others. Exclusion criteria in this study were as follows: 1) unable to stand and swing arms completely for 10 min to meet the requirements mentioned herein; and 2) unable to complete all parts of the questionnaire. The number of participants was recommended by G*power version 3.1 software, estimating the sample size based on F tests and using linear multiple regression regarding the fixed model, R² deviation from zero. The effect size was estimated at 0.15, alpha at 0.05, and power at 0.80, because the error that might occur was considered acceptable. The 68 participants were asked to sign a consent form confirming their voluntary role. There was no group allocation and only one visit for performing 10 min of ASE (Figure 1).

The protocol of ASE was similar to the conventional pattern of ASE (Anusorn, 1998). The steps of testing were as follows: Firstly, the participants refrained from any pain killer drugs and consuming alcohol for 24 h prior to undertaking the test. Secondly, the participants were asked to complete a questionnaire with the following: 1) Personal information with anonymity; for example, age, BMI gender, comorbidity, and medical and exercise conditions. 2) 13 items of PCS with a rating scale (0-4 per each item); the PCS was evaluated as a measure of the participants' self-reported thoughts and feelings about pain regarding any previous painful experiences, especially knee pain. The yield of total PCS reliability had a Cronbach's coefficient alpha of 0.87 (Sullivan *et al.*, 2009). 3) 8 items of MTI with a rating scale (1-7 per each item). The MTI revealed strong internal reliability in multiple groups of samples in previous studies ($p = 0.86$) (Gucciardi *et al.*, 2015). 4) A mood scale using

20 items of PANAS; 10 items of PA, and 10 items of NA. Internal consistency of PA and NA showed good reliability, Cronbach's coefficient alpha was 0.86 to 0.90, and 0.84 to 0.87 for PA and NA, respectively (Watson *et al.*, 1988). 5) Pain score using a numeric rating scale (NRS): 0-10 without a cutting point. The reliability of test-retest in previous studies for illiterate outpatients with rheumatologic symptoms was excellent ($r = 0.95$) (Chuang *et al.*, 2015). The measurement of the PCS, the MTI, the PANAS, and the scale of pain was completed before performing the arms swing for 10 min according to the ASE protocol provided. Thirdly, the participant was able to voice any discomfort while performing ASE, and they expressed the rating of perceived exertion scale (BORG scale): The

9 scale of Borg's ratings range from 6 (no exertion) to 14 (almost hard exertion) was used in this study. The rating of perceived exertion (RPE) scale has been shown to be valid by comparison with respiratory rate, heart rate, and a percentage of intensity in healthy people at coefficients of 0.72, 0.62, and 0.64, respectively (Chen *et al.*, 2002). The assessor counted the number of arm swings performed using a hand tally counter. The number of arm swings, and the RPE were recorded after completion of the ASE. Then, participants were seated for a few min before answering the PANAS and expressing the scale of pain (NRS) again, as shown in the diagram of data collection in Figure 2. In addition, the assessor orally obtained the answers, in the case of illiterate participants.

The caregivers' opinions might have a confounder effect. Therefore, the researcher controlled this confounder effect by separating the caregiver from the patient while testing, which allowed the assessor to help the elders instead. Ethics approval was obtained from the ethics committee of Suranaree University of

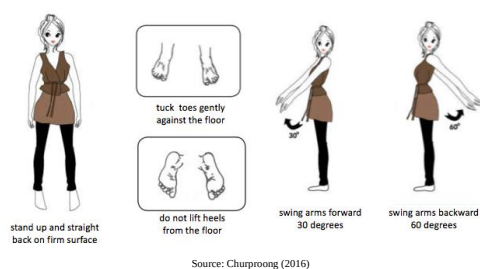


Figure 1. Illustration of the motion pattern of arms swing exercise used in this study, which was as follows; 1) Stand up with a straight back on a firm surface with the feet shoulder width apart and put your arms loosely straight beside the body. 2) Swing the arms forward 30 degrees and backward 60 degrees; this is signified as one repetition or one rep. Do not bend the elbow while swinging the arms. Swing easily by thinking of both arms as a pendulum, moving smoothly back and forth. 3) Tuck in the toes gently against the floor but do not lift the heels. 4) Contract both thighs (quadriceps) while swinging your arms but do not bend the knees. 5) Be aware to breathe in and out deeply and smoothly through the nose during the arm swings and, focusing only on breathing, let everything else go from the mind

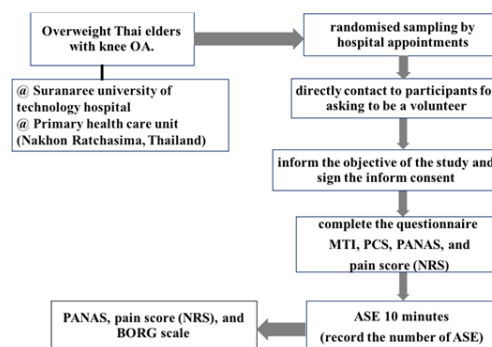


Figure 2. Illustration of the flow chart of data collection, which was as follows; 1) Recruited participants who met the inclusion criteria, and randomized sampling by hospital appointments 2) Asked for a volunteer and proposed the inform consent. 3) Completion of the personal information, the MTI, the PSC, and the PANAS, expressed the pain score. 4) Performed 10 minute of ASE, and 5) Answered the PANAS, pain score, and expressed BORG scale

Technology, prior to collecting the data.

In this study, all parts of the survey were translated to a Thai version. Thus, the questionnaires had to be proposed to 16 Thai elders who would not meet the criteria to be participants, in order to quantify the internal reliability. Cronbach's α values for PCS, MTI, the PA, and the NA of the Thai version were calculated as 0.971, 0.945, 0.87, and 0.73, respectively. The reliability of all questionnaire was acceptable for data collection after Thai words were modified by a language expert.

The experimental data analysis was divided into three parts as follows: 1) Descriptive statistics were used for reporting all scoring, including personal information. 2) The paired samples t-test was used for quantifying the difference between NA, PA and pain score (NRS) at pre and post ASE. 3) A simple mediation analysis was conducted, using regression analysis by adding PROCESS to the SPSS program version 23 (Hayes, 2013). The 95% confidence interval for the indirect effect being different from zero was determined based on the 10,000 bootstrap procedure (Preacher and Hayes, 2004). In order to show the direction of all relationships; for example, the impact of MT to PC, the impact of PC to Δ NA, and the impact of PC to Δ PA were evaluated. Then, the relationship between MT and Δ NA, and the relationship between MT and Δ PA during the participants ASE were clarified, facilitating a measure of the mediation effect of PC. The paths of simple mediation effects were applied in this study as a conceptual diagram of a simple mediation model (Figure 3).

Results and Discussion

The 68 participants that met the criteria of recruitment, 16 (23.5%) males and 52 (76.5%) females, were free of risk for undertaking physical activity. Only 13 (19.1%) participants had comorbid diseases, such as hypertension, diabetes, gout, dyslipidemia, and anemia. Participants' backgrounds are shown in Table 1.

This study was designed in order to examine the relationship between MT and Δ PA through PC during ASE in elderly Thais with knee OA. There were three major hypotheses in this study: 1) The participants would report a decrease in Δ NA, but an increase in Δ PA at pre and post ASE; 2) MT would be negatively related to Δ NA, but positively related to Δ PA; and 3) PC would mediate these relationships. This would give an idea of how the degree of experience of pain affects the mood during arm swing exercises. The psychological aspects of the elders with knee OA regarding arm swing exercise are described below.

Firstly, the results of the mean score of all items of PCS, MTI, PA, NA, and pain score at pre ASE, and PA, NA, pain score, the number of arm swings, and BORG scale at post ASE can be seen in Table 2. The mean score of Δ PA and Δ NA were -0.75 ± 4.45 , and -0.38 ± 2.08 , respectively. Paired samples t-tests indicated that the differences were not significant for Δ PA and Δ NA ($t_{(67)} = -1.52$ with 95% CI -0.886 to 0.121, and $t_{(67)} = -1.39$ with 95% CI -1.827 to 0.327, respectively). However, the mean of changes in pain score (Δ Pain score) was 0.37 ± 1.51 , and there was a significant difference in Δ Pain score ($t_{(67)} = 2.01$ with 95% CI 0.003 to 0.732), as is also shown in Table 2. Even though there was not a significant difference in Δ NA and Δ PA, participants reported a decrease in both affects when they performed ASE. The main cause might be patients feeling more knee pain

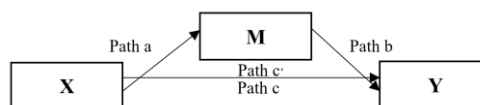


Figure 3. A simple mediation model with a single mediator variable M causally located between X and Y . Path a = the impact of X to M , and path b = the impact of M to Y , which ($a \times b$ = indirect effect). Path c' = the impact of X to Y (direct effect), and path c = X exerts an effect on Y directly through M (total effect) (Hayes, 2013)

Table 1. Showing participants' background

Participants' background (N=68)	Min	Max	Mean±SD
Age (years old)	60	83	67.4 ± 5.4
BW (kg)	55.8	99.0	67.9 ± 8.7
Height (m)	1.40	1.75	1.54 ± 0.06
BMI (kg/m ²)	25.0	39.7	28.5 ± 3.0

Table 2. Showing the results of mean score of PCS and MTI at pre ASE, and number of ASE and BORG scale at post ASE, and comparison in mean of PA, NA, and pain score at pre and post ASE

Pre ASE (N=68)		Post ASE (N=68)		t (p-value)
Items	Mean±SD	items	Mean±SD	
PCS	20.4 ± 11.6	_____	_____	
MTI_score	44.1 ± 13.6	_____	_____	
PA_score_before	34.7 ± 9.8	PA_score_after	34.0 ± 8.5	-1.52 (.134)
NA_score_before	12.6 ± 4.3	NA_score_after	12.2 ± 3.3	-1.39 (.169)
Pain_score_before	3.3 ± 1.6	Pain_score_after	3.6 ± 2.7	2.01 (.048)*
_____	_____	Number of ASE	44.3 ± 6.7	
_____	_____	BORG_scale	7.6 ± 2.0	

* $p < 0.05$

during ASE, because the difference in knee pain score at pre and post ASE significantly increased in the participants. According to Campbell *et al.* (2001), perceived severity of knee symptoms and individual attitudes are factors that influence compliance with knee rehabilitation in patients with knee OA, from the patients' perspective. This point is interesting, because the result of this study might relate to patients' compliance toward exercise prescription. However, the results of Δ NA and Δ PA were similar to the investigation of Miller *et al.* (2005) who found that there was no difference in negative affect at pre and post-exercise in a variety of exercises, such as tai chi, yoga, weight training, cycling, aerobic dancing, running, swimming, and short walks. Alternatively, positive affect was improved at post-high preference exercise mode (Miller *et al.*, 2005). It is then possible to say that ASE is not an obvious preference exercise to change participants' affect, because the procedure is not quite challenging enough to perform and it is a light intensity exercise (Leelayuwat *et al.*, 2008). Nevertheless, an international short-form of the PANAS (a new 10-item I-PANAS-SF) is an optional questionnaire (Thompson,

2007) to investigate mood change in Thai participants, which might facilitate identifying a significant difference at pre and post ASE. Because of this, it is easy to translate it to the Thai version, which simplified understanding for the participants. Therefore, the modified questionnaires were translated to the Thai version by language experts and it was checked for reliability before use. The use of these processes in this study should possibly decrease the confounder effect.

Secondly, the participants significantly reported a high score of PA toward ASE rather than NA at both pre and post ASE. It seems that most participants were interested, inspired, and attentive toward ASE. Although scoring of positive affect seems to decrease after performing ASE, it is still much higher than the negative affect score, and there was a significant difference between PA and NA at pre and post ASE ($t_{(67)} = 16.54$ and 19.46 , respectively, $p < 0.001$), as shown in Table 3. Berger and Motl (2000) supported the idea that mood alteration depends on individuals' characteristics and the exercise environment. Although the general population are more likely to change positively during exercise (Berger and Motl, 2000), reduction of negative

Table 3. Show the result of comparisons in mean change between PA and NA at pre and post ASE

Scoring (N=68)	Paired samples t-test Between PA - NA		Difference 95% confidence interval		
	Mean±SD	df	Lower	Upper	t (p-value)
At pre ASE	22.2±11.0	67	19.50	24.852	16.5 (0.000)*
At post ASE	21.8±9.2	67	19.57	24.946	19.5 (0.000)*

* $p < 0.001$

affect was reported after exercising for approximately 30 min (Lane and Lovejoy, 2001). Performing focused exercise for approximately 10 min usually enables people to feel a less negative affect and begin feeling an anxiolytic effect (Petruzzello and Landers, 1994). These previous results implied that good feeling and enjoyment in an exercise depends on the individuals' preference, duration, and type of exercise. Therefore, swinging the arms for 10-min may be enough to show a change in patients' feelings in both negative and positive affect. Cycling with moderate intensity is more beneficial to mood effect than cycling with high intensity (Berger and Motl, 2000). Possibly, the light-intensity of ASE enables the elders to meet the exercise guideline better than a higher level of intensity of exercise.

Thirdly, a simple mediation analysis was conducted using ordinary least squares path analysis to find the primary outcome variable: Δ NA. Thai elderly people with knee OA who were high in MT reported low PC and the correlation was negative, as predicted by the hypotheses (path a), $b = -0.183$, 95% Bca CI [-0.388, 0.023], but this relationship was not significant. What this means is that people who had high MT were able to cope with pain better than low MT individuals, which is similar to previous studies (Nicholls *et al.*, 2008). However, the result in this study showed no significant relationship between MT and PC, which is different from the results of Jones and Parker (2014) who showed a significant relationship in British cyclists. The researcher assumed that Thai elders may have had numerous experiences in the Buddhist way of meditation, even though there was a small effect size of mindfulness mediating the relationship between MT and PC (Jones and

Parker, 2014). However, healthcare professionals need to explore patients' environmental factors and family background, including any previous experiences that involved the complicated process of MT (Jones *et al.*, 2007), in order to investigate the likeliness of this assumption. Therefore, MT enables patients to motivate themselves, in terms of positive attributes that benefit from developing MT (Gucciardi *et al.*, 2009b), and there is a possibility to improve their affects during exercise. However, PC might impede this relationship. In terms of assessing the impact of this mediator, patients' PC was negatively related to Δ NA (path b), $b = -0.017$, 95% Bca CI [-0.061, 0.027], but this relationship was not significant. The direction of the indirect effect of path b was not in the predicted direction.

Fear of rehabilitation often happens with the elderly patients with knee OA and is related to PC as well (Youngcharoen *et al.*, 2016). This leads them to lose confidence; therefore, the PC seemed to increase NA for rehabilitation in a previous study (Tripp *et al.*, 2007). In this study, participants reported lower score in NA at post ASE than pre ASE. Perhaps, energy expenditures of 1.17 METs of ASE (Leelayuwat *et al.*, 2008) did not produce enough more pain to report an increase in NA, and stress effects were buffered by MT (Crust and Keegan, 2010). Furthermore, ASE is a safe exercise to perform, and no injuries were reported in previous studies (Jewpattanakul *et al.*, 2012). The pattern of ASE and the influence of MT possibly led to the negative relationship between PC and Δ NA. There was no significant indirect effect of MT on Δ NA through PC (path ab), $b = 0.0032$, 95% Bca CIs [-0.0034, 0.0234], based on 10,000 bootstrap samples which straddled zero. This

result indicated that there was no-effect (non-mediation), because the direct effect and the indirect effect were not significant (Zhao *et al.*, 2010), and the effect size was very small (less than 0.02). There was no significant direct effect of MT on Δ NA (path c'), $b = -0.037$, 95% Bca CI [-0.075, 0.001], and the direction of path c' showed a negative relationship. The total effect of MT on Δ NA through PC was not significant (path c), $b = -0.034$, 95% Bca CIs [-0.071, 0.003], $p = 0.070$, and the direction of path c showed a negative relationship, as can be seen in Figure 4 and Table 4. Bca of 95% CIs represents a 95% bias-corrected bootstrap confidence interval. This result indicated non-

mediation, and the indirect effect size was very small.

Alternatively, a simple mediation analysis for secondary outcome variables identified Δ PA. Thai elderly people with knee OA reported a high score of total PCS, which was negatively related to Δ PA (path b), $b = -0.052$, 95% Bca CI [-0.146, 0.042], but this relationship was not significant. The direction of the indirect effect of path b related to the hypotheses. A decrease in Δ PA might be caused by pain, since participants reported significantly higher knee pain and there was a significant difference in pain score at pre and post ASE. In addition, for participants who were high in MT, a PA decrease was reported as well. There was a significant direct effect of MT on Δ PA (path c'), $b = -0.085$, 95% Bca CI [-0.165, -0.005], and the direction of path c' showed a negative relationship, which does not correlate with the hypothesis. Actually, high MT may have influenced people to report a high score of PA at pre and post ASE, even though Δ PA decreased. These results relate to the study of Mahoney *et al.* (2014), who proposed that athletes reporting high score of mental toughness would report high score of positive affect, but a low score of negative affect. However, athletes' affects were not compared for defining Δ PA and Δ NA during task operation. Although the result in this study did not support that MT represents a positive attitude or mindset, and optimistic thinking (Jones *et al.*, 2007; Anthony *et al.*, 2016), it might be the main reason for this result. MT was claimed to be a resilience resource, which

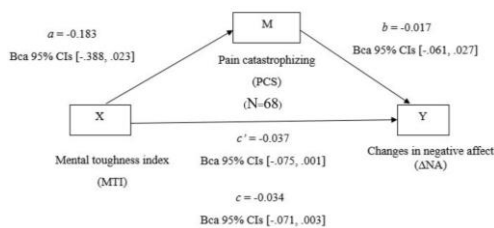


Figure 4. A simple mediation of PCS influence the relationship between mental toughness index (MTI) and changes in negative affect (Δ NA). The path a = the impact of MTI to PCS, path b = the impact of PCS to Δ NA, which ($a \times b$ = indirect effect). Path c' = the impact of MTI to Δ NA (direct effect), path c = MTI exerts an effect on Δ NA directly through PCS (total effect). Bca 95% CIs = a 95% bias-corrected bootstrap confidence interval

Table 4. Showing model coefficients for total PCS that influences the relationship between MTI and Δ NA

Antecedent (N=68)		Consequent						
		M (PCS)			Y (Δ NA)			
		Coeff.	SE	p	Coeff.	SE	P	
X (MTI)	a	-0.183	0.103	0.080	c'	-0.037	0.019	0.054
M (PCS)		—	—	—	b	-0.017	0.022	0.437
Constant	i_1	28.5	4.7	<0.001	i_2	1.606	1.056	0.134
$R^2 = 0.046$				$R^2 = 0.058$				
$F(1,66) = 3.157, p = 0.080$				$F(2,65) = 1.993, p = 0.145$				

* $p < 0.05$

enables one to cope with stress (Gerber *et al.*, 2013). It is then possible to say that positive attributes can reduce NA during ASE, whereas they have a direct impact on Δ PA, as MT would contribute to PA rather than NA. This point seems to be the cause of the significant relationship between MT and Δ PA. However, a negatively charged mood towards pain becomes a coping mechanism in the elderly community with knee OA (Sinikallio *et al.*, 2014). Not surprisingly, elders with high MT did not report a positive Δ PA. There was no significant indirect effect of MT on Δ PA through PC (path ab), $b = 0.0095$, 95% Bca CI [-0.0041, 0.0437], based on the analysis in which 10,000 bootstrap samples straddled

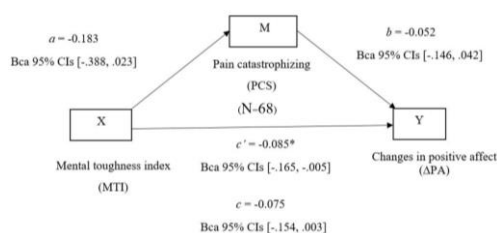


Figure 5. Diagram showing the simple mediation of PCS in the relationship between mental toughness index (MTI) and changes in positive affect (Δ PA). The path a = the impact of MTI to PCS, path b = the impact of PCS to Δ PA, which ($a \times b$ = indirect effect). path c' = the impact of MTI to Δ PA (direct effect), path c = MTI exerts an effect on Δ PA directly through PCS (total effect). Bca 95% CIs = a 95% bias-corrected bootstrap confidence interval

zero, Sobels' test ($p > 0.05$). This result indicated non-mediation, because there was a significant direct effect, but no significant indirect effect (Zhao *et al.*, 2010), and the effect size was very small (less than 0.02). The total effect of MT on Δ PA through PC was not significant (path c), $b = -0.075$, 95% Bca CIs [-0.154, 0.003], $p = 0.059$, and the direction of path c showed the negative relationship, as can be seen in Figure 5 and Table 5.

For other outcome variables, there were no significant association of the impact of the scoring of MTI with negative affect (NA) at pre and post ASE, $b = 0.055$, $p = 0.161$ and $b = 0.021$, $p = 0.484$, respectively. There was no significant relationship between MT and Δ Pain score ($b = -0.006$, $p = 0.059$). There was no significant relationship between MT and RPE after performing ASE, $b = -0.012$, $p = 0.510$, respectively. However, the scoring of MTI was positively correlated to the number of ASE, while positive affect (PA) increased significantly from pre to post ASE ($b = 1.614$, $p = 0.007$; $b = 0.312$, $p < 0.001$ and $b = 0.237$, $p = 0.001$), respectively.

Finally, the results of the relationship between MT and the difference in negative mood during ASE in knee OA patients (direct effect) was not a significant, although the small and potentially meaningless effect correlates with the hypothesis. Coping strategies were associated with short-term Δ PA and Δ NA (Blouin-Hudon *et al.*, 2016). This implies that unpleasant engagement with ASE declined when knee OA patients can cope with pain. Alternatively, MT exerts an effect on Δ PA, in a significant direct effect only, which also indicated non-mediation. There are multifactorial

Table 5. Model coefficients for mediator of pain catastrophizing scale (PCS) that influence the relationship between mental toughness index (MTI) and changes in positive affect (Δ PA)

Antecedent (N=68)		Consequent					
		M (PCS)			Y (Δ PA)		
		Coeff.	SE	p	Coeff.	SE	p
X (MTI)	a	-0.183	0.103	0.080	c'	-0.085	0.040
M (PCS)		—	—	—	b	-0.052	0.047
Constant	i_1	28.497	4.741	<0.001	i_2	4.047	2.250
$R^2 = 0.046$				$R^2 = 0.070$			
$F(1,66) = 3.157$, $p = 0.080$				$F(2,65) = 2.452$, $p = 0.094$			

* $p < 0.05$

causes to this result. For example, the small sample size was not enough to facilitate a mediation effect and show the significant outcome in this study, and the duration of ASE possibly confounds this relationship. Perhaps, the results might change if these patients perform ASE for 30 min or until they perceive that their physiologic change takes effect. In which case, the psychological effect might happen later. Any hidden patient's agenda could be clarified, and extending the sample size should be considered in any further study.

However, ASE is one rehabilitation procedure for OA knee patients, which was not previously used to evaluate the association of MT, PC, or Δ NA. Therefore, it is quite hard to estimate the sample size for the pilot study. The effect size was not assumed to be very small, similar to the effect size from previous studies. For example, PC showed a weak mediation effect on pain treatment in a previous study (Smeets *et al.*, 2006). Jones and Parker (2014) investigated the magnitude of mindfulness mediating the relationship between MT and PC, and showed a small effect size. A more up-to-date study by Mutz *et al.* (2017) showed a small effect of the relationship between MT and mood changes being mediated by emotion regulation. However, pain is a major concern for knee OA (Keefe *et al.*, 2000), and pain intensity related to PC with a large effect size, similar to the relationship between PC and negative mood (Craig *et al.*, 2017), even though the two studies used the different methods. Therefore, the parameters of effect size were adjusted to medium effect size, since there were no studies directly defining the effect size of PC mediating the relationship between MT and Δ NA during arm swing exercise in elderly participants

Conclusions

There was a non-mediation effect of PC on the relationship between MT and Δ NA and Δ PA, while there was only a direct effect of MT on Δ PA. Additionally, the direction of the paths between all variables was negative, and there

was no indirect effect in both outcome variables, Δ NA, and Δ PA. It is hard to say whether there was a very small effect for PC mediation of the relationship between MT and Δ NA during arm swing exercise in the elderly Thai people with knee OA. Further study is required to clarify the effects.

All results have meaning and are beneficial to healthcare providers in exploring patients' agenda before promoting ASE. At first, it seemed that ASE is not suitable for Thai elders with knee OA, because the outcome variables in this study focused on Δ NA and Δ PA during ASE and there were no significant changes. Nevertheless, ASE is perhaps better than walking at high speed, which made knee OA patients fear to exercise (Somers *et al.*, 2009). Moreover, participants reported less NA but greater PA after making an effort toward ASE. It might imply that most people prefer to do ASE if their knee pain improved. Improvements to the study could include: extending the sample size and decreasing confounding factors. For example, reviewing patients' previous physical activities that cause knee OA patients to feel more knee pain, and surveying their experience of ASE before testing might influence their thoughts and feelings. In addition, the use of an international short-form of the PANAS for simplifying the language for Thai participants could result in fewer confounding factors. The results would then possibly show some effect of PC mediation in the relationship between MT and Δ NA in a simple mediation analysis. Finally, the results of this study do not represent Thai elders with knee OA as a whole.

In brief, this model attempted to explain all factors that influence patients' compliance. Unpleasant experiences with any painful situation may not impede mood response during ASE in the participants who are high in MT. However, exploring MT and addressing PC might help to improve individuals' responses. If participants are healthy people who are physically fit and without any pain, would they prefer to perform ASE? This curiosity leads to further investigation. Before the conceptual framework is applied in future studies to other patient groups or a different

population, we should correct the gap of this study and reconsider the theoretical model.

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