Running head: Knee pain and planning

Effects of a brief action and coping planning intervention on completion of preventive exercises prescribed by a physiotherapist among people with knee pain

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Abstract

Objectives: The present study aimed to test the efficacy of action and coping planning in promoting engagement with preventive exercises among a sample of people with knee pain.

Design: Experimental trial.

Methods: Individuals who presented to a physiotherapist with knee pain (N = 373, 57% female; *M* age = 31.54, *SD* = 10.06, age range = 18 to 69 years) completed two assessments separated by 14 days. At baseline, participants completed measures of severity of problems associated with the knee (e.g., pain, symptoms) and past behavior. Subsequently, participants were randomly assigned to an action and coping planning or control group. Two weeks later, participants retrospectively reported their preventive exercise behavior over the past 14 days. Analyses revealed that the experimental group reported a higher number of preventive exercise sessions over the 14 day period when compared with the control group.

Results: Participants who planned action and coping strategies reported a greater frequency of completed preventive exercises over a 2-week period than people who did not.

Conclusions: The results of this study underscore the importance of action and coping planning for the enactment of preventive exercises that are designed to manage or prevent knee pain.

Keywords: behavior change technique; implementation intentions; knee osteoarthritis; self-regulation

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Pain in the knee joint is often associated with joint arthritic changes and knee pathologies[1]. Early management of knee pain is paramount to reduce global burden secondary to chronic disabling conditions such as osteoarthritis of the knee, one of the leading causes of disability globally[2,3]. Exercise rehabilitation plays an important role in non-surgical management of knee pain, showing clinically significant improvements in alleviation of pain, functional capacity and quality of life through various forms of exercise programs[4,5]. Home-based exercise programs (HEP), which empower patients to actively self-manage their conditions through exercises, have shown favourable results in the management of pain and disability in patients with arthritis[4,6]. However, 60-80% of physiotherapy patients admit to non-adherence to HEP[7]. As long-term adherence to exercise programs maximizes their benefits[7], additional research is required to test simple, yet effective behavior change techniques that can increase patient adherence to clinician prescribed preventive exercises.

Given the high face validity among users[8], action and coping planning (ACP) represents an important opportunity to enhance patient adherence to physiotherapist prescribed self-management strategies. Action planning involves specifying when, where and how to execute an intended behavior in advance creates situational cues that elicit responses automatically and with little conscious intent[9]. Individuals can also plan to cope with situational demands or barriers that may reduce the likelihood of efforts to initiate and maintain behavior through proactive efforts to anticipate possible barriers and their solutions[10]. Volitional regulatory strategies designed to translate intentions into behavior are the primary type of post-intentional factor depicted in most theories of health behaviors[11]. Meta-analyses support the utility of ACP in promoting behavioral enactment in health behavior[12].

ACP is a behavior change technique[13] that is practical, feasible, and inexpensive to implement and integrate within clinical practice. For example, clinicians encourage patients to complete action and coping plans related to their individualized treatment plan at the end of a session; these plans can be revisited at the start of their next session (e.g., 1-2 weeks later). The only study to date on the usefulness of action and coping plans for exercise adherence utilized by people with lower limb osteoarthritis revealed and found no effect[14]. However, this pilot study was unable to provide insight into the usefulness of ACP for *changes* in exercise behavior as this variable was not assessed prior to the intervention, and was inadequately powered to detect a meaningful difference between the two groups (N = 25). As such, this study was designed to overcome these methodological limitations. In contrast to O'Brien et al., we focused on individuals who presented with early signs and symptoms of osteoarthritis but had not yet been diagnosed. Specifically, the purpose of this study was to test the efficacy of ACP intervention in promoting engagement with preventive exercises among people with knee pain. We expected individuals who planned action and coping strategies to report a greater frequency of completed preventive exercises over a 2-week period than people who did not.

Methods

This study was powered for the primary purpose of examining the effects of an ACP activity on exercise preventive behavior. Based on an estimated effect size of d = .31 from related work on physical activity[15], the required sample size in each condition, with a power of 80% at $p < .05$, was 132 (a total of 264 participants). People who had experienced knee pain accompanied by morning stiffness lasting less than 30 minutes, crepitus on active movements, and tenderness of the bony margins of the knee joint in the past month were eligible to participate. For ethical considerations (e.g., safety), we required that participants had consulted a physiotherapist about their knee pain and were provided with advice regarding individualized preventive exercises. Participants were excluded if they had ever experienced a cardiac event (e.g., heart attack) or had surgery involving any structures of the knee, bones or joints (e.g., ligament reconstruction), or a BMI greater than 35[16].

Participants self-reported their age, gender, height, and weight. The Knee Injury and Osteoarthritis Outcome Score[17] was used to measure knee function with the subscales of pain, symptoms and function in activities in daily living. Behavior was assessed using a self-report measure in which participants indicated the frequency of preventive exercises performed on average for 30 minutes over the past two weeks. The duration of 30 minutes is consistent with recommendations for the rehabilitation of people with knee OA[5]. Preventive exercises were defined as those activities that are intended to reduce the amount of pain experienced and/or strengthen those muscles that support the knee and surrounding areas with the view of preventing future knee pain.

The manipulation in this study was an ACP activity that was embedded as part of the online survey. The 'action' component of the planning activity required participants to specify when, where and how they would enact their behavioral intentions, whereas the 'coping' aspect entailed the anticipation of the most likely obstacle that would prevent them from engaging in the exercise as well as the identification of a strategy to overcome the difficulty[18] (see Figure S1 of the supplementary material). Participants were provided with space to create up to 3 plans, together with a completed example to facilitate comprehension of the planning activity.

All study procedures were approved by [blinded for peer-review] human research ethics committee. Participants were recruited and completed the study via SocialSci (www.socialsci.com), which is an online survey platform where individuals sign up to take part in academic research in return for credits (e.g., Amazon). The participant pool is available only to academic researchers with human research ethics approval. The first section of the survey contained measures to ascertain an individual's eligibility for the study. Eligible and consenting participants provided demographic details and self-reported the frequency of preventive exercises completed over the past two weeks before being randomly allocated to the experimental or control group using a computer generated sequence embedded within the online platform. The control group finished the first part of the study at this point, whereas the experimental group completed the experimental manipulation. Two weeks later all participants self-reported their exercise behavior over the preceding 14 days.

Data were initially screened for missing cases, violations of assumptions of normality, and outliers. First, to examine the possibility of an attrition bias, we used analysis of variance (ANOVA) to test for differences in demographic factors and knee function characteristics at time 1 between those participants who completed the time 2 survey and those who did not respond. We performed these analyses with SPSS 21. Second, the effectiveness of the ACP intervention was tested in accordance with the intention-to-treat principle whereby all randomized participants are retained in the analysis[19] and compared with a per protocol analysis that excludes non-adherence, protocol violations, and missing measurements[20]. For the purposes of the per protocol analysis, completed action and coping plans were screened by the researchers prior to analysis to ensure that participants utilized the technique in the intended manner; only participants who reported complete and relevant plans were retained for the primary analyses[18]. We used full information maximum likelihood (FIML) estimation within M*plus* 7.4 to handle missing data, which uses all available information and produces standard errors and tests of fit that are robust in relation to non-normality of observations[21]. As preventive exercises were measured pre- and post-intervention, we modeled participants' starting point (intercept) and difference between assessment points (slope) for each individual as latent variables[22]. This approach permitted an examination of intra-individual change in preventive exercises over time as well as inter-individual differences (e.g., gender, intervention group) in the initial starting point (intercept) and intra-individual change (slope). We created dummy codes for experimental group (0 = control, 1 = experimental) and gender (0 = female, 1 = male). A visual display of this model is provided in the supplementary material (see Figure S2). In the presence of a significant *p* value, established criteria were used to assess model fit, namely the χ^2 goodness-of-fit index, comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA), with evidence of adequate fit indicated by CFI/TLI ≥ .90 and RMSEA ≤ .08[22]. We performed these analyses with M*plus* 7.4[24]; a copy of the syntax is provided in the supplementary material (see Table S1).

Results

The flow of participants through the experimental procedures is shown in Figure 1. In total, 373 participants were randomized to the experimental group (n = 180) or control condition (n = 193). Approximately 73% of the experimental group completed the time 2 survey; however, for the purposes of the per protocol analysis, 13 participants were excluded because of an incomplete or poor quality ACP (e.g., space left blank, statements such as “I don’t know” or “exercise”), leaving 118 participants in the experimental group (57% female). In terms of preventive exercise, participants reported muscle and/or joint strengthening exercises (e.g., knee bends, squats) and low-to-moderate intensity physical activities (e.g., walking, swimming). Of the 167 participants who were randomized to the experimental group and provided a valid ACP, 77% reported 1 ACP, 13% reported 2 ACP, and 2% reported 3 ACP. Approximately 70% of the control group completed the time 2 survey (n = 136; 50% female). An overview of baseline demographic and clinical characteristics for the experimental and control groups for the intention-to-treat and per protocol samples is detailed in Table 1.

Data screening revealed no violations against assumptions of multivariate outliers (i.e., using a p <.001 criterion for Mahalanobis D^2), skewness (all variables between -1.50 and 1.50), and kurtosis (all variables between -2.40 and 2.40) for subscales of all study variables. However, 10 univariate outliers were identified with regard to the motivational and social-cognitive variables (i.e., z score > $\pm$ 3.29). As the exclusion of these outliers did not alter the results of the main analyses, they were retained for all analyses and the reported findings. Missing data was minimal (0.001%) and therefore considered missing completely at random. We controlled for age, gender, BMI and knee factors (pain, symptoms, function) in the main analyses.

An overview of the ANOVA summary statistics is detailed in Table 2 (for an explanation of the use of 90% confidence intervals for eta squared, see Steiger[25]). Participants who responded at both time points reported lower levels of daily function and lower symptoms associated with their knee pain when compared with individuals who dropped out of the study; there were no other differences on the study variables.

The fit statistics indicated acceptable model-data fit for the intention-to-treat analysis, $\chi^2(6) = 3.96$, $p = .68$. The regression of experimental group on the mean of the latent intercept factor ($\tau = .94$ [95% CI = .56, 1.32]) indicated that the difference in the baseline levels of preventive exercises between the two groups was not significant ($\gamma = -.24$ [95% CI = -.68, .19]). Age, gender, BMI, knee pain, knee symptoms and knee function were not associated with baseline levels of preventive exercises (see Table S2 of the supplementary material). Collectively, these variables accounted for 6% of the variance in the latent intercept factor. The mean of the latent slope factor ($\tau = 1.22$ [95% CI = .42, 2.01]) is equivalent to the overall mean difference between the time 1 and 2 surveys[22]. The regression of experimental group on the latent slope factor indicated that participants in the experimental group reported a larger improvement between the time 1 and 2 surveys than the control group

(γ = .92 [95% CI = .07, 1.77]). In other words, on average, the control improved 1.22 units when compared with an increase of 2.14 units for the experimental group. Age (γ = -.42 [95% CI = -.73, -.10]) but not gender, BMI, knee pain, knee symptoms and knee function was associated with the difference in completion of preventive exercises (see Table S2 of the supplementary material). Collectively, the study variables accounted for 5% of the variance in the latent slope factor. Subgroup analyses indicated that neither the type (strengthening/stretching or ow-to-moderate intensity physical activity) nor amount (1 or 2) of preventive exercises detailed in the plans was a statistically significant determinant of the intercept (γ_{number} = -.01 [95% CI = -.02, .01]; γ_{type} = .01 [95% CI = -.01, .02]) or slope (γ_{number} = .01 [95% CI = -.01, .03]; γ_{type} = -.01 [95% CI = -.03, .01]) among the experimental group.

The fit statistics indicated acceptable model-data fit for the per protocol analysis, $\chi^2(6) = 9.60$, p = .14. The regression of experimental group on the mean of the latent intercept factor (τ = .73 [95% CI = .37, 1.08]) indicated that the difference in the baseline levels of preventive exercises between the two groups was not significant (γ = -.13 [95% CI = -.61, .35]). Age, gender, BMI, knee pain, knee symptoms and knee function were not associated with baseline levels of preventive exercises. Collectively, these variables accounted for 6% of the variance in the latent intercept factor. The regression of experimental group on the latent slope factor (τ = 1.29 [95% CI = .55, 2.03]) indicated that participants in the experimental group showed a larger improvement between the time 1 and 2 surveys than the control group (γ = 1.06 [95% CI = .19, 1.93]). In other words, on average, the control improved 1.29 units when compared with an increase of 2.56 units for the experimental group. Age (γ = -.35 [95% CI = -.68, -.02]) but not gender, BMI, knee pain, knee symptoms and knee function was associated with the difference in completion of preventive exercises (see Table S2 of the supplementary material). Collectively, the study variables accounted for 6% of the variance in the latent slope factor.

Discussion

This study builds on pilot work[14] that examined the feasibility of ACP as a practical, feasible, and inexpensive behavior-change technique designed to promote adherence to physiotherapist prescribed self-management strategies for people with knee pain. Consistent with expectations, we demonstrated for the first time that ACP is beneficial for the enactment of preventive exercises that are designed to manage or prevent knee pain. As preventive or rehabilitation programs for knee osteoarthritis often involve intensive supervision and sophisticated equipment[4], empowering individuals to actively manage their conditions through HEP and maximizing their adherence through simple, yet effective behavior change techniques such as ACP is an important public health issue.

Meta-analytic data indicate that ACP helps minimize the intention-behavior gap in physical activity[12]. Results of the current study show the benefits of ACP among people with knee pain, thus adding support for the generalizability of these effects. Previous research has examined the usefulness of ACP for sustaining exercise behavior in people with knee osteoarthritis within a 12 week program[13]. O'Brien et al.[14] found that the intervention group improved on four physical measures (functional mobility, maximal walking speed, limb strength and dynamic balance, physical function). However, the planning intervention did not result in meaningful differences between the intervention and control groups on both clinic-based (i.e., supervisor rated exercise adherence) and home-based (i.e., stretching, walking) activities. In contrast, we demonstrated the usefulness of ACP among individuals who presented with early signs and symptoms but had not yet been diagnosed with osteoarthritis. These findings provide preliminary evidence for the utility of this behavior change technique with regard to preventive exercises for the early management of knee pain. Nevertheless, despite the encouraging finding in this study, the increase in the number of 30-minute preventive exercise sessions to approximately three over a 2-week period for the experimental group represents half of the minimum recommendation of three sessions for people knee osteoarthritis[5]. As coping planning assumes that individuals have the required self-regulatory coping responses at their disposal[10], it may be that participants did not possess these resources and therefore were unable to deal with barriers over the 2-week period.

The key strengths of this study included a sufficiently powered design and experimental inducement of ACP. Nevertheless, this study is not without limitations and these areas might serve to inform future research. Our reliance on retrospectively reported preventive exercise behavior can be addressed in future research through daily diary entries or with the use of objective measures (e.g., instruct participants to video record each preventive exercise session using an iPad). In addition, we did not collect information on the specific preventive regimen participants were prescribed by their physiotherapist. Although a key recommendation for the management of knee osteoarthritis is to exercise for between 15 and 30 minutes[5], some participants may have been prescribed a preventive program where the temporal dimension was different to our measurement focus (e.g., 15 minute sessions). Second, as we did not measure knee function at the second time point, we are unable to determine whether or not the additional exercises performed by intervention group resulted in clinically meaningful changes. Third, the inclusion of only two time points limited our analyses to a linear effect over a short period of time; additional research is required to examine the generalizability of these findings over an extend timeframe (e.g., 3-6 months) and with alternative growth trajectories (e.g., quadratic), particularly for health behaviors such as the one targeted in this study which require maintenance over longer periods of time. Fourth, a factorial design in which separate groups of participants received either planning component, or both, would permit evaluation of the additive and interactive effects of both planning types. Finally, as the control group experienced a small increase in exercise behavior, we cannot discount the potential of the mere measurement effect[26].

Conclusions

Current findings underscore the importance of self-regulatory strategies for the enactment of preventive exercises that are designed to manage or prevent knee pain. Future research is required to replicate this work with improved methodological features and test the efficacy of ACP across a range of clinical conditions.

Practical Implications

• ACP promoted greater adherence to physiotherapist prescribed self-management strategies for people with knee pain

• Clinicians can work with patients at the end of a session to devise ACP strategies to enact the prescribed exercises between visits; patients' reflections on their efforts can be discussed at the start of each session

• Building resources or working on coping strategies may also be required to maximize the benefits of ACP

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Figure 1. Flow of participants.

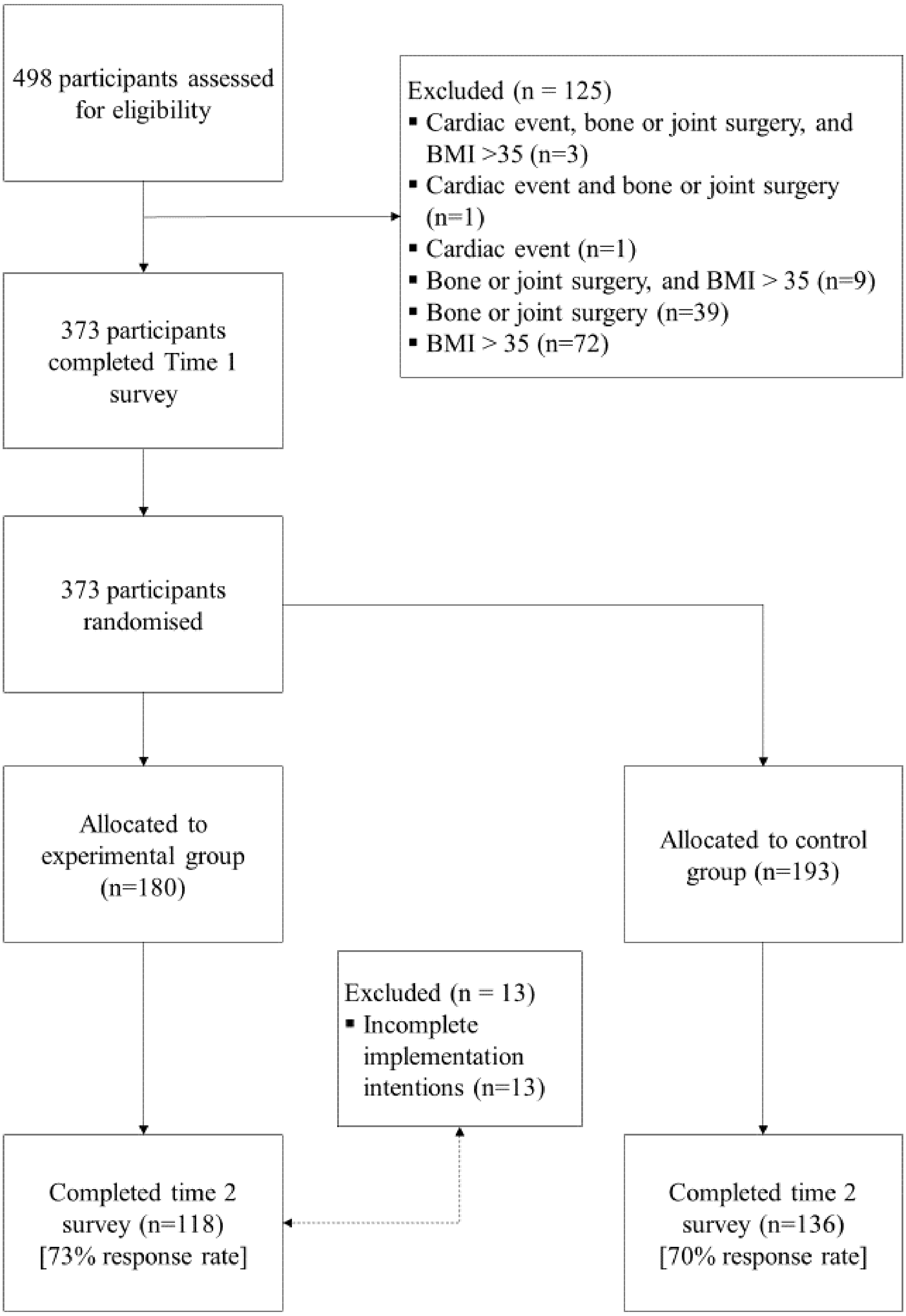

Table 1. *Demographic and clinical characteristics of control and experimental groups at baseline for intention-to-treat and per protocol analyses.*

	Intention-to-Treat Analysis					
	Control group (n=193)			Experimental group (n=180)		
	M	SD	95% CI	M	SD	95% CI
Age	30.79	9.39	29.46, 32.13	32.50	10.70	30.77, 33.92
BMI	24.43	4.88	23.74, 25.13	24.86	4.40	24.21, 25.51
Symptoms	49.62	12.08	47.91, 51.34	48.91	12.71	47.04, 50.78
Pain	76.11	16.14	73.82, 78.40	74.14	15.93	71.79, 76.48
Daily function	82.50	17.98	79.95, 85.06	81.16	16.63	78.71, 83.60
Exercise behavior (time 1)	.97	2.40	.63, 1.31	.77	1.87	.50, 1.05
	Per Protocol Analysis					
	Control group (n=136)			Experimental group (n=118)		
	M	SD	95% CI	M	SD	95% CI
Age	30.81	9.80	29.15, 32.48	32.43	10.38	30.53, 34.32
BMI	24.42	4.85	23.60, 25.24	25.01	4.60	24.18, 25.86
Symptoms	50.16	11.59	48.19, 52.12	47.21	12.02	45.02, 49.41
Pain	75.93	15.54	73.30, 78.58	72.34	16.30	69.37, 75.31
Daily function	81.10	18.07	78.03, 84.17	79.43	17.12	76.31, 82.56
Exercise behavior (time 1)	.90	2.19	.53, 1.27	.77	1.60	.48, 1.06

Note: Scores for the subscales of the KOOS (symptoms, pain, daily function) are transformed to a 0 to 100 scale, with 0 representing extreme knee problems and 100 signifying no knee problems. Full scoring details for the KOOS is provided at their website (http://www.koos.nu).

Table 2. *Overview of ANOVA summary statistics for attrition bias analyses. Note: * = statistically significant finding at p <. 05; for an explanation of the use of 90% confidence intervals for eta squared, see Steiger[24]).*

	Drop outs (n=106)			Continuers (n=267)			ANOVA (df = 1, 371)		
	M	SD	95% CI	M	SD	95% CI	*F*	*p*	η^2 [90% CI]
Age	30.57	8.77	28.88, 32.88	31.93	10.52	30.66, 33.19	1.37	.24	.004 [.00, .021]
BMI	24.65	4.56	23.77, 25.53	24.63	4.70	24.06, 25.20	.00	.97	.00 [.00, .00]
Symptoms (normalized)	71.09	16.49	67.91, 74.36	67.35	15.90	65.43, 69.26	4.12*	.04	.011 [.0002, .035]
Pain (normalized)	76.91	16.22	73.79, 80.03	74.46	15.96	72.53, 76.38	1.78	.18	.005 [.00, .023]
Daily function (normalized)	85.56	15.87	82.50, 88.63	80.38	17.69	78.24, 82.51	6.90*	.01	.018 [.002, .047]
Exercise behavior (time 1)	.99	2.67	.47, 1.50	.83	1.92	.59, 1.05	.43	.51	.001 [.00, .014]

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Supplementary Material

Table S1. *Mplus syntax for primary analysis of the efficacy of action and coping planning*. (Note: code preceded by an exclamation mark is not read by Mplus when the run is executed).

```
TITLE: Latent growth model to test pre-post differences in efficacy of action and coping
planning

DATA: FILE = Knee pain study.csv;

DEFINE: STANDARDIZE age BMI symp_nm pain_nm func_nm;

VARIABLE: NAMES = part_ID
ex_30 ex_30_t2 exp_grp
! experimental group (0 = control, 1 = experimental)
age gender BMI symp_nm pain_nm func_nm;
! gender (0 = female, 1 = male)

USEVARIABLES = ex_30 ex_30_t2 exp_grp
age gender BMI;
MISSING = ALL (999999);

MODEL:
int BY ex_30@1 ex_30_t2@1;
diff BY ex_30@0 ex_30_t2@1;

ex_30@0;
ex_30_t2@0;

[ex_30@0];
[ex_30_t2@0];

[int*];
[diff*];

int WITH diff;
int ON exp_grp age gender BMI symp_nm pain_nm func_nm;
diff ON exp_grp age gender BMI symp_nm pain_nm func_nm;

age gender BMI symp_nm pain_nm func_nm WITH
age gender BMI symp_nm pain_nm func_nm;

ANALYSIS: ESTIMATOR = MLR;

OUTPUT: STDYX CINTERVAL;
```

Table S2. *Parameter estimates of latent growth models for intention-to-treat and per protocol analyses.* (Note: SE = standard error).

	Intention-to-Treat	Per Protocol
	Estimate (SE)	Estimate (SE)
Mean intercept	.94 (.19)	.73 (.18)
Mean slope	1.22 (.41)	1.29 (.38)
Exp grp → intercept	-.24 (.22)	-13. (.25)
Age → intercept	.02 (.14)	-.08 (.15)
Gender → intercept	.12 (.21)	.39 (.25)
BMI → intercept	-.12 (.13)	-.03 (.11)
Symptoms → intercept	.01 (.14)	.10 (.13)
Pain → intercept	-.34 (.29)	-.13 (.24)
Function → intercept	-.18 (.19)	-.36 (.19)
Exp grp → slope	.92 (.44)	1.06 (.45)
Age → slope	-.42 (.16)	-.35 (.17)
Gender → slope	-.62 (.38)	-.69 (.41)
BMI → slope	.20 (.19)	.17 (.20)
Symptoms → slope	-.33 (.22)	-.32 (.23)
Pain → slope	.32 (.42)	.28 (.41)
Function → slope	-.07 (.37)	-.01 (.39)
Intercept ↔ slope	-1.35 (1.20)	-1.12 (1.07)
Age ↔ gender	-.01 (.03)	-.02 (.03)
Age ↔ BMI	.10 (.05)	.08 (.06)
Age ↔ symptoms	-.08 (.05)	-.03 (.06)
Age ↔ pain	-.17 (.06)	-.18 (.07)
Age ↔ function	-.21 (.06)	-.21 (.06)
Gender ↔ BMI	.00 (.03)	-.02 (.03)
Gender ↔ symptoms	.03 (.03)	.02 (.03)
Gender ↔ pain	.03 (.03)	.03 (.03)
Gender ↔ function	.00 (.03)	.00 (.03)
BMI ↔ symptoms	-.10 (.05)	-.06 (.06)
BMI ↔ pain	-.14 (.06)	-.06 (.07)
BMI ↔ function	-.10 (.06)	-.03 (.06)
Symptoms ↔ pain	.62 (.09)	.61 (.09)
Symptoms ↔ function	.56 (.09)	.55 (.09)
Pain ↔ function	.85 (.10)	.86 (.11)

Figure S1. The action and coping planning intervention.

Many people with knee pain find they intend to complete exercises to help with their condition but then forget or "never get around to it." Research has shown that that if you form a definite plan of exactly when, where, and how you will exercise you are more likely to complete exercises as planned and less likely to forget or not get around to exercise.

Please take a moment to PLAN WHEN, WHERE, and HOW you will exercise over the next 2 weeks. For each form of rehabilitative exercise, please also identify the most likely obstacle that will prevent you from engaging in that exercise (e.g., phone rings) and identify a strategy to deal with the obstacle (e.g., allow it to ring out for voicemail).

Form of rehab exercise:	
Day and time:	
Location:	
Obstacle and coping strategy:	

Figure S2. Schematic overview of hypothesized theoretical model (Note: the intercept captures participants' rehabilitation exercise behavior at time 1, whereas the slope represents the difference score in completed rehabilitation exercises between times 1 and 2).