

Effectiveness of a knee exercise intervention on knee osteoarthritis pain and severity in Buddhist monks receiving platelet-rich plasma injections: A quasi-experimental study

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ABSTRACT

Knee osteoarthritis (KOA) is a prevalent condition affecting individuals across all age groups, resulting in pain, diminished physical functioning, and disability. This study aimed to determine the effects of the knee exercise intervention on reducing KOA symptoms and enhancing the physical functioning of a vulnerable group (Buddhist monks) who receive platelet-rich plasma injections. We hypothesized that the knee exercise intervention would help alleviate symptoms of KOA and improve the monks' physical function. A two-group, pretest-posttest design quasi-experimental study was conducted. Sixty Buddhist monks were purposively selected from one hospital's outpatient orthopedic department in Thailand. Eligible participants were randomly assigned to an experimental group ($n = 30$) and a control group ($n = 30$). The experimental group received the Knee Exercise Program as an intervention, while the control group underwent the usual outpatient care. Data were collected from August 2022 to November 2022. Osteoarthritis severity and pain intensity were measured at baseline and program completion (12-week post-test). Data analysis included descriptive statistics and dependent and independent sample t -tests. The results showed that the average age of the 60 participants was 65 years (range: 50–83 years). No significant group differences were found in any outcome measures at baseline. At program completion, the experimental group reported significantly decreased pain intensity ($t = 5.66, p < .001$), stiffness ($t = 0.68, p < .001$), improved physical functioning ($t = 7.99, p < .001$), and less severity in KOA than the control group ($t = 4.19, p < .001$). Therefore, the Knee Exercise Program is effective in alleviating KOA symptoms, reducing KOA severity, and improving physical functioning in patients with KOA receiving platelet-rich plasma injections. A large-scale randomized controlled trial with long-term follow-up is warranted.

Keywords:

Buddhism, exercises, knee osteoarthritis, monks, platelet-rich plasma

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INTRODUCTION

Osteoarthritis (OA) is an arthritic condition found in all age groups, especially among adults and older adults. It is a major cause of years lived with disability in people over 70. Due to the increasing number of aging and obese people, one-fifth of the global population will suffer from knee osteoarthritis (KOA) by 2031¹. The aging population of Thailand in 2021 constituted almost 20% of the population and will increase to 21.7% by 2025.² This demographic shift will be associated with an increase in degenerative diseases, including OA.³ OA is caused by articular cartilage degeneration in both shape and structure. It leads to changes in the bone function of the joints and nearby areas. The irreversible changes may contribute to more severe deterioration.⁴ There are various types of KOA treatments, including medication-based and non-medication approaches, such as behavior modification, weight loss, knee exercises, and rehabilitation.⁵ Gaining 0.5 kilograms of body weight increases the force exerted on the knee joint by 1–1.5 kilograms. Non-medication treatment approaches would focus on behavior modification and weight loss. For medication-based or medical treatment, concentrated platelet therapy may be recommended for patients with KOA.⁶ In response to an injury, platelets naturally gather at the damaged site, preventing excessive blood loss. Platelet-rich plasma (PRP) can alleviate joint pain and muscle and tendon injuries by harnessing the natural healing processes of the human body.⁷ PRP is a blood component that contains platelets concentrated three to five times more than normal blood and is rich in human growth factors. Platelets stimulate tissue repair in the human body to relieve injuries associated with KOA, including tendon injuries, bone ligaments, and soft tissues.

Because platelets stimulate cells in the body to initiate tissue repair around injured areas associated with KOA, PRP can accelerate tissue repair without the need for surgery.

Buddhist monks in Thailand are known to have a high prevalence of several non-communicable diseases, including knee osteoarthritis,⁸ and obesity is a major risk factor for KOA and its clinical/functional consequences.⁹ Early symptoms of KOA include intermittent knee pain, a rustling sound in the joints, tension in the knee and calf when moving and bending, painful sensations when pressing on the knee, an inability to fully stretch the knee, knee stiffness, and difficulty moving in the morning.^{10,11} Medical intervention may require prolonged treatment through medication, injections, or surgery. The symptoms may persist, leading to chronic pain with the use of different types of analgesics or knee replacement surgery, which may give rise to complications that affect monks' health and result in associated treatment costs.¹²

Monks might rest or convalesce at temples without family support, especially during the three-month Buddhist Lent season (known as Phao Phansa or Vassa). During this time when they retreat to a temple, study the Dhamma (Buddhist principles and teachings), pay respect to the Buddha image, meditate, and chant mantras using frequent knee-bending positions, such as squatting, lotus sitting (cross-legged), side-knee bending, and kneeling.^{13,14,15} The activities and positions may worsen KOA and pain severity when performing these important ecclesiastical ceremonies and spiritual rituals.

KOA is known to be prevalent among Thai Buddhist monks,¹⁶ and its frequency is higher for monks than in the general Thai population.¹⁵ A family history of KOA, knee trauma, obesity, and being older are factors reported to be associated with KOA among Thai Buddhist monks.^{15,16}

Catastrophizing pain while performing their sacred rituals and activities of daily living (ADL) has been positively associated with symptoms of depression¹⁷.

Knowledge of self-care activities may be significantly important for Buddhist monks with KOA. Standard nursing care and medical treatment for people with KOA involve rehabilitation and follow-up care receiving PRP injections, which is often unavailable for Buddhist monks in Thailand and for others with KOA. The treatment goal for this disease is to help those with KOA understand their condition, follow treatment guidelines, comprehend complications and preventive measures, manage pain with analgesics, delay disease progression, and optimize knee function. Medical treatment may include receiving concentrated platelet therapy and palliative care.

Orem's self-care theory¹⁸ is relevant to people with KOA in its focus on enhancing self-care activities that improve health outcomes.^{19,20} The theory has two phases: Phase 1 involves decision-making, emphasizing the need for knowledge of practical and effective actions. This leads to Phase 2, the action phase, where goal setting is key to implementing and practicing self-care. The Knee Exercise Program, designed for this study, aimed to improve the self-care ability of Buddhist monks with KOA, reducing pain and severity and improving their quality of life while allowing them to perform religious duties. This research investigated the program's effectiveness in monks with KOA who received PRP injections. It was hypothesized that the experimental group would report lower pain and severity scores compared to the control group 12 weeks after baseline.

METHODS

Research Design

This was a two-group, pretest-posttest design quasi-experimental study. The experimental group received the Knee

Exercise Program, while the control group received the usual standard care at a hospital's orthopedic outpatient department in Thailand. The outcomes were analyzed 12 weeks after the baseline assessment, at the completion of the program, and after receiving PRP.

Population and Setting

The target population was Buddhist monks with KOA at the Priest Hospital in Bangkok, Thailand. The unique hospital offers healthcare services specifically for Buddhist monks. Between 2020 and 2022, the number of orthopedic outpatient visits by monks with OA increased from 2,500 to over 3,100, with an annual average of 2,837 visits. KOA ranks among the top five diseases for those receiving services at the hospital's outpatient orthopedic department, and it is one of the hospital's 10 most costly diseases.²¹

Sample

The inclusion criteria for eligible participants were: (a) Buddhist monks over 18 years of age; (b) diagnosed with KOA that could be treated medically and physically and receiving PRP; (c) were scheduled for follow-up appointments up to three months; (d) had no prior knee injuries resulting from accidents; (e) possessed normal perception, without hearing or vision problems; (f) could access and use the smartphone application, LINE (<https://line.me>); and (g) were able to communicate and understand the Thai language. Exclusion criteria included: (a) individuals with mild-level knee pain, arthritis, swelling, redness, and heat; (b) had undergone knee replacement surgery; (c) had documented cognitive impairment; and (d) could not consistently participate in the study.

The sample size was determined using the effect size formula with the G*Power program. The average effect size was based on a study with similar characteristics, with a magnitude of

influence = 0.46.²² The sample size was calculated to be 49 people based on the alpha set at .05 and power at 0.80. To account for potential sample loss during the program, the sample size was increased by 20%.²³ Of the 60 adult Buddhist monks approached, all volunteered to participate in the study, with 30 randomly assigned to the experimental group and 30 to the control group.

Intervention

All participants completed a pre-test (baseline) and a 12-week post-test. The experimental group received the Knee Exercise Program, while the control group received the usual care. The program was delivered face-to-face during clinic visits and was based on isometric techniques, the therapeutic application of a sandbag²⁴, and the nursing theoretical concepts proposed by Orem et al.¹⁸ The Knee Exercise Program for Buddhist monks receiving PRP injections began with relationship building, followed by identifying barriers and gathering information to supplement their previous knowledge and experiences. The program paid attention to the past experiences of the monks to set a plan, implement it, and provide tailored advice. Emphasis was placed on encouraging the monks with KOA to actively participate in knee exercise activities and express their perspectives.

The program was reviewed by experts in surgery and orthopedics, who assessed the content, language, activity format, and timing. Key components of the Knee Exercise Program included:

1. *A 20-Minute Health Education Session.* In groups of 4–5, the participants received education on KOA, including symptoms, risk factors, treatment, and care with PRP. The session emphasized exercise, rehabilitation, and daily care, with time for questions.

2. *A 10-Minute Health Education of a Flexible Knee Model.* Participants used a flexible knee model to understand knee function and learned to use an innovative sandbag.

3. *An Innovative Sandbag and an Hour Demonstration.* After the knee model session, participants practiced knee joint exercises using a 1 kg sandbag, with guided demonstrations.

4. *A 7-Minute Video Clip of Knee Joint Exercises.* The participants viewed a 7-minute video clip demonstrating knee joint exercises designed to alleviate KOA and then gave a return demonstration guided by the researchers. Each exercise session involved isometric contractions of the quadriceps, supine straight-leg lifts, leg lifts in the prone position, resistance knee extension, resistance knee flexion, active knee flexion, passive knee extension, and shifting the center of gravity (left and right/before and after). These exercises strengthen thigh muscles and ligaments around the knee.

5. *A Handbook of Health Knowledge and Exercise Guide:* Each participant received an informational handbook titled “Health Knowledge and Exercise Guide for KOA with PRP.

6. *Communication-messaging Application for Health Education.* Health education, exercise reinforcement, and group discussions were facilitated through the LINE app, with infographics and messages from the researchers.

During the three-month period after the education sessions, the researchers frequently phoned the Buddhist monks to provide them with any required counseling services related to KOA self-care. The participants could also phone the researchers to receive further education or answer questions.

The control group

The participants in the control group received standard care, including a

20-minute Health Education Session and a 10-minute presentation on the Health Education of a Flexible Knee Model. This included various health-related educational sessions provided by nurses in the orthopedic outpatient department and receiving PRP. The session topics for these Buddhist monks covered general health information and treatment details. Only the intervention group received the elements of the Knee Exercise Program.

Instruments

1. Demographic and Clinical Data Form. The form collected the participants' age, weight, height, underlying diseases, history of knee injection with PRP, and knee injection location with PRP. Medical history and latest vital signs were obtained from the medical record.

2. Numerical Rating Scale (NRS) for Pain. Originally developed by Jensen et al.²⁵, the single-item scale is a numerical pain assessment tool to determine the intensity of pain using a sliding scale with numbers from 0 to 10, where 0 represents "no pain" and 10 represents "the worst pain possible." The NRS scores are categorized as no pain (0), mild pain (1–3), moderate pain (4–6), and severe pain (7–10).

3. Western Ontario and McMaster Universities Arthritis Index (WOMAC). The scale measures KOA severity, encompassing pain intensity, joint stiffness, and physical function. Originally developed by Bellamy et al.²⁶, it was translated into Thai by Aksanukroh²⁷ and used for this study with permission. The 24-item WOMAC has three subscales, with 5 items on pain, 2 items on knee stiffness, and 17 items on the degree of difficulty in accomplishing daily life activities. The score for each subscale is calculated separately, with a total possible score of 240. Higher scores indicated greater pain, stiffness, and severity of KOA. Score categorization and interpretation are 0–60 for mild severity, 61–120 for less severe, 121–180 for moderately severe, and 181–240 for very severe. A pilot test with 30

Buddhist monks with KOA demonstrated the WOMAC's internal reliability with Cronbach's alpha of 0.93.

The aforementioned expert panel concluded that the length, readability, and clarity of the NRS pain assessment and WOMAC osteoarthritis severity assessment tools were satisfactory. The questionnaires had a good layout and were clearly organized. The Content Validity Index for the NRS and WOMAC was 1.00 and 0.92, respectively.

Data collection

Data collection took place from August 2022 to November 2022. The researchers approached the nurse leader of the orthopedic department to explain the study's objectives. At baseline (pre-test), the participants in the experimental and control groups completed the demographic questionnaires, pain assessment forms, and assessments of osteoarthritis severity. At 12 weeks, participants in both groups again completed the instruments assessing their KOA severity and pain after receiving PRP injections.

Data analysis

The means, standard deviations, frequencies, and percentages were calculated to summarize demographic data and NRS/WOMAC scores using IBM SPSS (version 21). Assumptions of normality and homogeneity of variance were met. Two-tailed dependent and independent t-tests were used to compare mean scores, with a significance level of .05.

RESULTS

Demographic and clinical characteristics

The mean age of participants in the intervention group was 65.0 years (SD=8.02, range 52–83 years). Their mean weight was 75.1 kg, height 167.1 cm, and BMI 26.9. Nearly half (46.7%) had no underlying disease, 30% had high blood

pressure, 20% had diabetes, and 13.3% had dyslipidemia. Seventy percent of the participants received PRP injections in the left knee and 30% in the right knee.

The mean age of participants in the control group was 65.4 years (SD=7.86, range 50–82 years). Their mean weight was 70.3 kg, height 162.3 cm, and BMI 26.6. A fifth (20%) had no underlying disease, nearly half (43.3%) had high blood pressure, 36.7% had diabetes, and over a fourth (26.7%) had dyslipidemia. Approximately 36.7% received PRP injections on the left knee, while 63.3% received injections on the right side.

Knee pain and osteoarthritis severity

At baseline, the experimental and control group participants reported severe knee pain; there was no statistical difference ($p = .29$) between their NRS pain scores (Table 1). At the 12-week post-test, the experimental group reported a significant decrease in pain ($p < .001$) compared to the control group. Although the control group reported a decrease in pain at the 12-week post-test from severe to moderate pain, it was not statistically significant ($p = .15$) from baseline (Table 2). The improvement in pain for the experimental group from baseline to the 12-week post-test was a significant decrease ($p < .001$) from severe to mild pain.

Table 1. Comparison of Pain Scores Using the Numerical Rating Scale Between Two Time Points (n=60)

Time periods	Between Group Pain Scores				t ^a	p-value
	Control group		Experimental group			
	Mean	SD	Mean	SD		
Baseline (pre-test)	7.13	2.74	7.56	3.85	1.06	0.29
12-week post-test	6.59	2.15	3.39	2.65	2.86	< .001

^aIndependent sample t-test, two-tailed

Table 2. Comparison of Within Group Numerical Rating Scale Pain Scores at Two Time Periods (n=60)

Participants	Within Group Pain Scores				t ^a	p-value
	Baseline (pre-test)		12-week post-test			
	Mean	SD	Mean	SD		
Control group (n=30)	7.13	2.74	6.59	2.15	3.28	.15
Experimental group (n=30)	7.56	3.85	3.39	2.65	3.09	< .001

^aDependent sample t-test, two-tailed

At baseline, the WOMAC total knee osteoarthritis severity scores showed moderate severity for participants in both groups. There was no statistical difference ($p = .380$) in reported mean total severity scores between the two groups at baseline (Table 3). Although the control group reported a change in severity from

moderate to less severe at the 12-week post-test, it was not statistically significant ($p = .095$). However, participants in the experimental group reported a significant improvement in change ($p < .001$), with a reduction from moderate to mild severity (Table 4).

Table 3. Comparison of the Average Scores for Total Arthritis Severity Using the Western Ontario and McMaster Universities Arthritis Index Between Two Times Points (n=60)

Time periods	Control group (n=30)		Experimental group (n=30)		t ^a	p-value
	Mean	SD	Mean	SD		
Baseline (pre-test)	122.38	7.41	123.95	8.69	1.09	.380
12-week post-test	110.15	6.52	59.15	6.37	4.19	< .001

^aIndependent sample t-test, two-tailed**Table 4.** Comparison of Within Group Mean Total Severity Scores on the Western Ontario and McMaster Universities Arthritis Index at Two Time Periods (n=60)

Participants	Baseline (pre-test)		12 th week post-test		t ^a	p-value
	Mean	SD	Mean	SD		
Control group (n=30)	122.38	7.41	110.15	6.52	4.56	.095
Experimental group (n=30)	123.95	8.69	59.15	6.37	4.25	< .001

^aDependent sample t-test, two-tailed**Effect of the Knee Exercise Program on knee osteoarthritis**

At baseline, there were no significant differences between the control and experimental groups for WOMAC mean pain severity scores, stiffness, and

physical function. However, at the 12-week post-test, the experimental group reported lower pain, less stiffness, and improved physical function than the control group (Table 5).

Table 5. A Comparison of Between Group Mean Scores of the Western Ontario and McMaster Universities Arthritis Index (WOMAC) for Pain, Stiffness, and Physical Function at Two Time Points (n=60)

WOMAC severity measures	n	Between group severity of knee osteoarthritis				t ^a	p-value
		Control group		Experimental group			
		Mean	SD	Mean	SD		
Pain (0–50)							
Baseline (pre-test)	30	24.15	4.16	25.44	4.44	0.45	.51
12-week post-test	30	22.89	4.05	13.61	3.81	5.66	< .001
Stiffness (0–20)							
Baseline (pre-test)	30	9.20	0.79	9.25	1.25	0.63	.94
12-week post-test	30	8.88	0.73	5.50	0.78	0.68	< .001
Physical function (0–170)							
Baseline (pre-test)	30	80.96	2.57	82.07	2.72	0.15	.88
12-week post-test	30	79.73	2.55	55.97	1.40	7.99	< .001

^aIndependent sample t-test, two-tailed

DISCUSSION

We hypothesized that the Buddhist monks completing the Knee Exercise Program would report lower KOA pain and improved severity scores compared to the control group. The results demonstrate the effectiveness of the Knee Exercise Program, thus supporting the hypothesis. The monks were older adults and overweight with KOA. The improvement they reported may be attributed to the Knee Exercise Program's focus on enhancing the strength of anterior thigh muscles and improving the coordination among muscles in the anterior and posterior legs, buttocks, and calves. Strengthening the knee joint through exercises may contribute to delaying disease progression by minimizing pressure on the joint during activities such as standing up and walking. The efficacy of knee exercise is contingent on individual physical conditions, KOA severity, and thigh muscle strength, ensuring benefits without adverse effects from exercising. The results are congruent with research showing that isometric quadriceps exercise can alleviate pain in people with cartilage osteoarthritis, which induces structural changes in the joints.²⁴ Isometric quadriceps exercises are a recommended treatment for reducing disease severity in patients with knee joint pain.

The exercises in the Knee Exercise Program are similar to those found in Iyengar Yoga and Ruesi Dadton. Iyengar Yoga is characterized by slow knee flexion and extension body movements that stretch muscles in stationary positions with gradual and continuous muscle movements around knee joints and joint ligaments. The tissues around the knee and ligaments are strengthened and become more flexible. A study incorporating Iyengar Yoga in 60-minute sessions three times a week over 12 weeks reported that older adults had lower

mean scores of KOA severity than those who participated in usual exercises.²⁸ Ruesi Dadton, or traditional Thai yoga, is a set of exercises that combine mind-body movements like yoga and tai chi. The body's movements trigger mechanisms to increase capillary blood flow to muscles, increasing oxygen conductivity, protein volume, and muscle fiber size. The strengthened muscles contribute to a reduction in the severity and pain associated with KOA. They have been shown to improve balance and the quality of life in middle-aged women with early-stage knee osteoarthritis.²⁹

We found that the Knee Exercise Program empowers Buddhist monks to take proactive care of their knees. Applying Orem's self-care theory¹⁸ to older adults with KOA suggests that they can effectively care for themselves by actively participating in the Knee Exercise Program when provided with relevant and applicable knowledge. Self-care is pivotal in stimulating individuals to engage in activities that benefit their lives, health, and well-being. Setting specific tailored objectives motivates and engages people with KOA in self-care activities aimed at improving health outcomes, leading to a reduced reliance on long-term medication, such as analgesics.

Self-relief programs can alleviate knee pain in older adults with OA.³⁰ Emphasizing self-care, self-relief programs are an alternative care approach that focuses on behavior modification. OA is influenced by two main types of risk factors: non-modifiable and modifiable.³¹ Nonmodifiable factors, like age, are hereditary and cannot be changed. Modifiable factors, which can be altered, are linked to behaviors related to obesity, dyslipidemia, and hypertension, which are diseases reported to be associated with the lifestyles of Buddhist monks.¹⁶ Because the monks were overweight and suffered from

KOA, modifying behavior by focusing on weight loss in conjunction with participation in a Knee Exercise Program is essential in alleviating symptoms and enhancing the quality of life.

A health behavior modification model emphasizes initiating changes at the individual level and subsequently using group processes to establish common health goals.³² Behavioral health modification can extend to a community where Buddhist monks reside. Incorporating the Buddhist monks in small groups for the Knee Exercise Program aligns with this concept. As the behavior modification and Knee Exercise Program continue, positive outcomes are anticipated for the nutrition and health of monks with KOA, who are considered as a vulnerable group and others with similar health problems.

Buddhist monks with KOA should be educated and encouraged to engage in regular knee exercises as part of their self-care routine facilitated by health promotion volunteer monks at the temple, known as “Phra kilanupataka,” who play a key public health role in Buddhism in Thailand³³. Nurses can provide essential information about KOA, covering clinical manifestations, diagnosis, treatment, risk factors, and daily care. They should emphasize the benefits of exercise and rehabilitation for managing KOA and provide guidance on incorporating knee exercises into the daily routine. Nurses are responsible for monitoring adherence to a prescribed knee exercise regimen and assessing its impact on relieving knee pain and severity during follow-up visits. They should openly discuss the challenges or barriers encountered by those during the program.

Buddhist monks might have specific lifestyle factors that affect KOA outcomes, such as their dietary habits, level of physical activity, and meditation practices. If these lifestyles are not accounted for, it may be unclear whether

improvements in pain and severity are due to the knee exercise intervention or influenced by other factors, such as their lifestyle habits.

Buddhist monks' cultural and religious context in Thailand might influence how KOA symptoms are perceived, reported, and interpreted. For instance, monks might downplay their symptoms, be more accustomed to coping with discomfort, or accept their afflictions and suffering due to their spiritual practices. This could lead to underreporting of KOA symptoms, as their pain tolerance and severity might be different from that of non-monastic individuals. To address these potential biases, the current study involved randomization, using a standardized intervention, blinding assessors, and controlling for confounding variables like lifestyle factors and adherence to the intervention. Further studies, including a diverse sample of participants, could help improve the generalizability of the findings.

CONCLUSION

Buddhist monks with KOA exhibit self-care deficits that include a lack of knowledge about the signs and symptoms of KOA. A structured Knee Exercise Program provides monks with KOA-related requisite knowledge and understanding of the principles and methods of knee exercises and encourages their active participation. The Knee Exercise Program reduces pain and improves the severity of KOA. Healthcare professionals and nurses can encourage Buddhist monks to participate in this program while receiving PRP injections. Future research might explore the Knee Exercise Program's application or modification for people with KOA undergoing knee arthroplasty replacement.

RECOMMENDATIONS

The sample was restricted to a purposive sample of male Buddhist monks in Thailand with similar lifestyles and physical activities. Comparing results with other populations and settings will be essential to validate the robustness of the Knee Exercise Program's procedures, especially for women who disproportionately suffer from osteoarthritis. Measuring outcomes at six months or a year would demonstrate the program's sustained effectiveness. A large-scale randomized controlled trial with long-term follow-up is warranted.

AUTHOR CONTRIBUTIONS

P.V.: Conceptualization, Methodology, Formal analysis. W.L.: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing. R.K.: Methodology, Writing - original draft.

ETHICAL CONSIDERATION

The study protocol was approved by the Priest hospital human research ethics committee (approval PRH 7/2022) on September 5, 2022, and conformed to the Helsinki Declaration. All participants received information about the study's objectives, were informed that their participation was voluntary, and could withdraw from the study at any time without treatment consequences. After giving written consent, they received a verbal explanation of the study tools. All identifiable information about individuals was removed from all data forms to ensure confidentiality.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

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