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Content

Editorial

Original Articles

Notes from the Editor-in-Chief

I am pleased to introduce the first issue of the ASEAN Rehab Med Journal for 2025. This issue includes three randomized controlled trials exploring new interventions for neurological and musculoskeletal conditions, alongside three descriptive research studies that contribute to our understanding of rehabilitation:

Aramrussameekul et al. conducted a single-blind, randomized controlled trial comparing the efficacy of focused extracorporeal shockwave therapy (fESWT) and steroid injection for moderate carpal tunnel syndrome. Both treatments resulted in significant reductions in pain, paresthesia, and disability scores, with no notable differences between the two groups.

Brady et al. conducted a pilot study comparing mindful movement therapy and general exercise therapy in university athletes with chronic patellofemoral pain. Both treatments were effective in reducing pain intensity and improving physical and psychological well-being, despite the athletes' engagement in other physical activities during the study.

Tayati et al. performed a prospective, comparative cluster-randomized study to assess the effects of the five-point hands-free (FPHF) exercise program versus standard eye exercises on computer vision syndrome (CVS) and vestibulo-ocular symptoms among staff at Trang Hospital. After three weeks, the FPHF program showed promising benefits in alleviating CVS and vestibulo-ocular symptoms, though further research is needed to confirm its long-term effectiveness.

Phongdara et al. studied the prevalence of depression among caregivers of children with cerebral palsy at Siriraj Hospital, finding a 20.7% prevalence rate, with communication difficulties being a significant contributing factor.

Supasirimontri et al. investigated the alignment between the clinical competency needs of Thai physiatrists and the topics validated by the Board of Training and Examination in Rehabilitation Medicine. The study highlighted that low back pain, knee osteoarthritis, stroke, spondylosis/spondylolisthesis, and radiculopathy were among the most frequently encountered conditions.

Poosiri conducted a retrospective study examining the correlation between the 6-minute walk distance (6MWD) and severity of airflow limitation and the modified Medical Research Council (mMRC) dyspnea score in COPD patients. The results revealed a significant weak correlation, suggesting the importance of routinely evaluating 6MWT and mMRC scores in monitoring clinical changes in COPD patients.

I extend my heartfelt thanks to all readers, authors, reviewers, and the editorial board for your hard work and dedication. I look forward to your continued support for future issues.

Warm regards,

Assoc. Prof. Kingkaew Pajareya
Editor-In-Chief
The ASEAN Journal of Rehabilitation Medicine

Original Article

Efficacy of Single-Session Focused Extracorporeal Shockwave Therapy in Patients with Moderate-Degree Carpal Tunnel Syndrome Versus Steroid Injection Therapy: A Single-Blind Randomized Controlled Trial

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ABSTRACT

Objectives: To compare the efficacy of single-session focused extracorporeal shockwave therapy (fESWT) and steroid injection in moderate-degree carpal tunnel syndrome

Study design: A single-blind, randomized controlled trial

Setting: Her Royal Highness Princess Maha Chakri Sirindhorn Medical Center, Nakhon Nayok, Thailand

Subjects: Patients with electrophysiological evidence of moderate-degree carpal tunnel syndrome.

Methods: Thirty-three patients with a combined total of 36 affected hands were enrolled. The mean age was 56.9 (10.68) years. Among the affected hands, 25 were right hands and 11 were left hands. Equal numbers of the thirty-six affected hands were randomly assigned to the experimental group, which received single-session fESWT with energy flux density ranging from 0.03 to 0.10 mJ/mm², 2,000 shocks per session at a frequency 6-8 Hz and the comparative group which received an injection of 10 milligrams of triamcinolone acetonide in 1 milliliter of solution. Outcomes were assessed using the following questionnaires: 1. Visual Analog Scale (VAS) for pain, 2. VAS for paresthesia, 3. Quick Disabilities of the Arm, Shoulder, and Hand (Quick DASH) scores, and 4. Total Boston Carpal Tunnel Questionnaire (BCTQ). Scores were recorded both before the interventions and at follow-up weeks 4, 8, and 12.

Results: There were no significant differences in demographic characteristics between the groups. After treatment, both groups showed reductions in VAS for pain, VAS for paresthesia, QDASH scores, and total BCTQ scores between baseline and weeks 4 and 12 follow-ups, with no statistically significant differences between the groups.

Conclusions: There was no evidence indicating a difference in clinical efficacy between single-session fESWT and steroid injection therapy in patients with moderate-degree carpal tunnel syndrome over a 12-week period. Therefore, noninvasive fESWT could be considered an option to which can avoid possible side effects of steroid injection.

Keywords: carpal tunnel syndrome, focused extracorporeal shockwave therapy, steroid injection

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Introduction

Carpal tunnel syndrome (CTS) is the most common peripheral nerve entrapment neuropathy in the upper extremity. It results from compression of the median nerve as it passes through the flexor retinaculum at the wrist. Common symptoms often include numbness or tingling in the palm areas supplied by the median nerve, specifically the tips of the thumb, index finger, and middle finger, and weakness during movement or while gripping objects.[1,2] This condition is found in approximately 2.7% to 5.8% of the general population, with a reported incidence of 276:100,000 annually.[1] The pathophysiology of CTS involves a combination of mechanical trauma, increased pressure, and ischemic damage to the median nerve within the carpal tunnel.[3]

The treatment options were categorized into non-surgical and surgical treatments, with the choice of modality based on the condition's severity. Non-surgical treatment was particularly effective for cases with mild symptoms, a duration of less than one year, and no muscle atrophy. Non-surgical treatments are well-supported by credible evidence for their efficacy including splinting and steroid injections. Both of these options are recommended as first-line treatments.[4,5] The exact mechanism of symptom relief is unknown, but the effects are believed to relate to the anti-inflammatory effects of steroids and to slightly decrease the risk of surgery during the first year; however, they might not continue to decrease the rate of surgery when follow-up continues for years.[6] Complications after administering steroid injections can include pain during injection, skin discoloration, muscle atrophy, infection or inflammation, finger ischemia, torn or damaged

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tendons, and median nerve injury. These complications can be temporary or permanent.[7,8]

Focused extracorporeal shockwave therapy (fESWT) is a relatively new method that has been used to treat a variety of musculoskeletal diseases.[9] fESWT is a noninvasive treatment that applies shockwaves to injured tissue to reduce pain and promote the healing process in tendinopathies and in bone and skin pathologies. Studies have confirmed its success in treating chronic plantar fasciitis, epicondylitis, and rotator cuff tendinitis. The working principle of fESWT involves repairing and stimulating the healing of tissues, nerves, and muscles at the molecular level. It triggers the release of local analgesia, which helps reduce pain symptoms.[10,11] Prior studies of ESWT have been conducted in CTS patients. For example, a study by Paoloni M. et al. comparing treatments for CTS between ultrasound therapy administered five times a week for three weeks and extracorporeal shockwave therapy administered once a week for three weeks found the group treated with shockwave therapy showed more significant improvement. In that study, outcomes were assessed using the Visual Analog Scale (VAS) score for numbness symptoms and found that the benefits of the shockwave therapy lasted up to three months.[12] A study by Seok et al. using one session of ESWT for CTS demonstrated improvements in pain scores and functional status comparable to local steroid injections. Additionally, in contrast to steroid injection, ESWT has the added benefit of being noninvasive.[13] Ke et al. suggested that ESWT is a valuable method for treating CTS and that results are more detectable in moderate degree than in mild degree CTS.[14] Currently, the treatment of CTS with ESWT does not yet have clearly defined standards, and studies in patients with moderate degree CTS are still limited. A previous study highlighted the potential benefits of fESWT over other treatments and showed that a single-dose radial ESWT was appropriate for treating mild to moderate CTS and that it provided longer-lasting benefits (24 months) in Thais.[15] If the results of the present study are confirmed by additional research, ESWT could be more widely applied to this group and could provide an alternative for those concerned about the side effects of steroid injections or who are apprehensive about injections, thus potentially improving their quality of life and expanding healthcare options.

Methods

Study design

This study was a single-blind, randomized controlled trial conducted at the Department of Rehabilitation Medicine, HRH Maha Chakri Sirindhorn Medical Center, Nakhon Nayok, Thailand. The Human Research Ethical Committee of Srinakharinwirot University approved it for human research (ethical approval number SWUEC/F-445/2020), and it was registered in the Thai Clinical Trials Registry on July 1, 2024 (Number TCTR20240704004).

Participants

Participants in this study were patients with clinical and electrodiagnostic evidence of a moderate-degree of carpal tunnel syndrome. Inclusion criteria were: 1) symptoms including numbness or pain in the palm, along with positive findings on the following tests: Phalen's test, Tinel's test, and the median compression test; 2) patients diagnosed with moderate carpal tunnel syndrome by electrodiagnosis who showed abnormal prolonged (relative or absolute) sensory or mixed-nerve action potential distal latency (orthodromic, antidromic, or palmar) Sensory nerve action potential (SNAP) amplitude below the lower limit of normal, and (relative or absolute) prolongation of median motor distal latency;[16] 3) age 18 years and over; 4) new patients who had not been treated with a steroid injection or other treatments, such as ultrasound, were excluded. Exclusion criteria included: 1) A history of physical therapy treatment in the previous six months, 2) Contraindications for fESWT, such as pacemaker implantation, and 3) Refusal to participate in the study. The number of participants included in this study was determined based on studies by Seok H. et al.[13] The sample size was calculated using Frison and Pocock's method and STATA version 14.0. The required sample size was determined to be 18 participants per group, a total of 36, which is sufficient to detect a clinically meaningful difference with 80% power at a 5% significance level and to account for a potential combined dropout rate of 20% due to loss to follow-up, non-compliance, and attrition. All participants provided written informed consent.

Randomization

Eligible patients who consented to participate in the research were randomly assigned to one of two groups using block randomization, which was generated in blocks of four using a random number generator from a free program at www.randomization.com

This study was a single-blind trial, with two research physicians involved in evaluating the treatment's effectiveness. The first research physician, who was not blinded, administered the treatment and assessed any treatment-related side effects. This physician provided treatment to both volunteer groups. The second research physician, who was blinded, was responsible for recording and documenting the assessment results of both groups.

Intervention

One group received treatment via an injection of 10 milli grams of triamcinolone acetonide (TA) in 1 milliliter of solution, administered at a 45-degree angle to the medial side of the flexor retinaculum using a 25-gauge needle. The other group received a single session focused on extracorporeal shockwave therapy using an electromagnetic cylindrical coil (Storz Medical AG, Tägerwilen, Switzerland). This device has an energy flux density ranging from 0.03 to 0.10 mJ/mm², a 6-8 Hz frequency, and delivers 2,000 pulses per session.

The shockwave probe was placed around the medial side of the flexor retinaculum area, and the energy intensity was adjusted to a level tolerable for the patient and was continued at that level until the treatment was completed. During the 12-week data collection period following this intervention, additional treatments such as CTS splints, physical therapy, or other medication were not allowed.

Outcome measurement

The primary outcome measures were the VAS for pain, the VAS for paresthesia, the Thai version of Quick DASH (QDASH) scores[17], and the Thai version of the Boston Carpal Tunnel Questionnaire (BCTQ) scores [18], along with the assessment of any adverse events at weeks 4, 8, and 12 after the treatment.

Statistical methods

This study analyzed the demographic characteristics of both groups using the mean (standard deviation). Demographic data were analyzed using Fisher's exact test for categorical variables, the Mann-Whitney U test for non-normally distributed continuous variables, and the independent t-test for normally distributed continuous variables. Generalized estimating equation (GEE) statistics was used to compare the primary outcome at baseline and at weeks 4, 8, and 12 after treatment of VAS score for pain including VAS score for paresthesia, QDASH scores, and total BCTQ scores reported with the mean difference and a 95% confidence interval. Statistical significance was set at $p < 0.05$. The characteristics of adverse events were recorded.

Results

Thirty-three patients, comprising 32 females and one male, with a total of 36 affected hands, participated in the study. Their ages ranged from 40 to 77 years, with a mean age of 56.94 (10.68). Three individuals had symptoms in both hands, while 30 had symptoms in only one hand. Symptoms were found in 25 right hands and 11 left hands. Of those, 25 hands were on the dominant side, and 11 were on the non-dominant side. There were no significant differences in demographic data between the groups ($p > 0.05$), as shown in Table 1.

The participants' data were compared at baseline and at weeks 4, 8, and 12 after treatment, as shown in Tables 2-5. It was found that there was a reduction in VAS for pain, VAS for paresthesia, QDASH scores, and total BCTQ scores at the week four follow-up in both groups. Nonetheless, no statistically significant differences were found between the groups ($p = 0.987, 0.254, 0.230, 0.194$). At the week eight follow-up, there was a decrease in VAS for paresthesia, QDASH scores, and total BCTQ scores compared to baseline, but there was an increase in those values compared to the week four follow-up in both groups. Only the VAS for pain in the fESWT group increased compared to baseline. Comparison between the two groups found no statistically significant differences ($p = 0.482, 0.261, 0.959, 0.390$, respectively). At the week twelve follow-up, it was found that there was a reduction in VAS for pain, VAS for paresthesia, QDASH scores, and total BCTQ scores in both groups. Nonetheless, when comparing the groups, the differences were found to be not statistically significant ($p = 0.300, 0.945, 0.645, 0.396$). Overall, there was a reduction in VAS for pain, VAS for paresthesia, QDASH, scores and total BCTQ scores in both groups. Comparison between the groups found no statistically significant differences ($p = 0.107, 0.073, 0.720$, and $p < 0.001$)

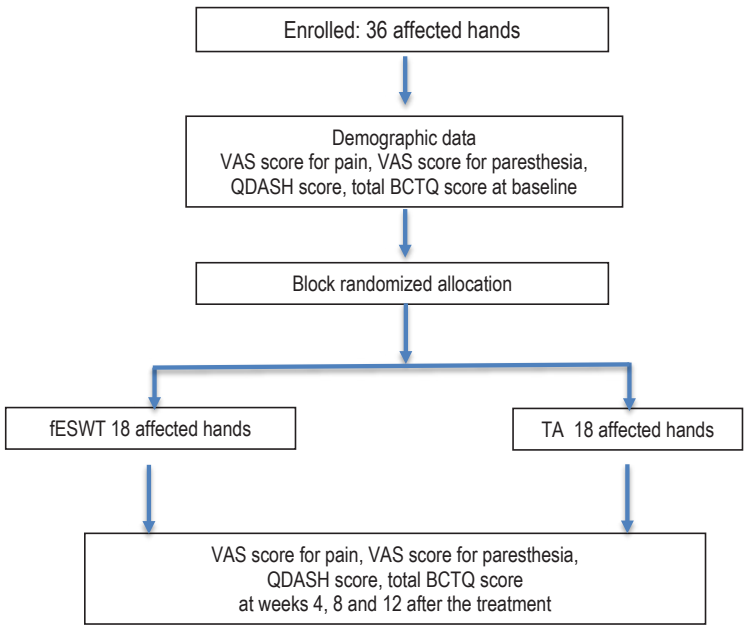

Figure 1. Flow diagram of the participants. fESWT, focused extracorporeal shockwave therapy; TA, triamcinolone acetonide

Table 1. A comparison of patient demographic data and baseline characteristics of the groups

Patient characteristic	fESWT group	TA group	*p-value
Gender (female/male)[1]	17/0	15/1	0.486
Age (year)[2]	55.67 (8.76)	58.22 (10.24)	0.426
Affected hand (left/right)[1]	5/13	6/12	1.000
Dominant hand (left/right)[1]	5/13	6/12	1.000
The nature of their occupation (light/heavy)[1]	12/6	6/12	0.094
Experienced nighttime symptoms (yes/no)[1]	5/13	9/9	0.305
Baseline time of CTS (month)[2]	9.83 (1.38)	9.11 (2.30)	0.350
Baseline VAS for pain[2]	2.57 (2.38)	2.55 (2.97)	0.977
Baseline VAS for paresthesia[2]	5.15 (1.79)	5.21 (2.60)	0.934
Baseline QDASH[2]	19.00 (12.06)	20.57 (15.68)	0.738
Baseline total BCTQ[2]	32.39 (8.21)	31.39 (8.82)	0.727

[1] Number, [2]Mean (SD), *$p < 0.05$ indicates statistical significance,
fESWT, focused extracorporeal shockwave therapy; TA, triamcinolone acetonide; CTS, Carpal tunnel syndrome; VAS, Visual analog scale; QDASH, quick disabilities of the arm, shoulder and hand; BCTQ, Boston Carpal Tunnel Questionnaire

Table 2. Comparison of visual analogue scale for pain at baseline and at weeks 4, 8, and 12 after treatment

Follow-up session	fESWT group Mean (SD)	TA group Mean (SD)	MD	(95% CI)	*p-value
Baseline	2.57 (2.38)	2.55 (2.97)	0.03	(-1.80-1.85)	0.977
Week 4	1.97 (2.39)	1.95 (2.42)	0.01	(-1.62-1.65)	0.987
Week 8	3.66 (6.95)	2.41 (2.73)	1.25	(-2.33-4.83)	0.482
Week 12	1.43 (1.93)	2.35 (3.15)	-0.92	(-2.69-0.85)	0.300
Overall	-	-	-0.06	(-1.4-0.01)	0.107

Generalized estimating equation (GEE) statistics, Mean (SD), *$p < 0.05$ indicates statistical significance
MD, mean difference; CI, confidence interval
fESWT, focused extracorporeal shockwave therapy; TA, triamcinolone acetonide

Table 3. Comparison of the visual analogue scale for paresthesia at baseline and at weeks 4, 8, and 12 after treatment

Follow-up session	fESWT group Mean (SD)	TA group Mean (SD)	MD	(95% CI)	*p-value
Baseline	5.15 (1.79)	5.21 (2.60)	- 0.06	(-1.58-1.45)	0.934
Week 4	2.60 (2.44)	3.60 (2.73)	-1.00	(-2.76-0.75)	0.254
Week 8	2.98 (2.68)	4.13 (3.35)	-1.16	(-3.21-0.90)	0.261
Week 12	2.98(3.13)	2.91 (3.00)	0.07	(-2.01-2.05)	0.945
Overall	-	-	-0.06	(-0.13-0.01)	0.073

Generalized estimating equation (GEE) statistics, Mean (SD), *$p < 0.05$ indicates statistical significance
MD, mean difference; CI, confidence interval
fESWT, focused extracorporeal shockwave therapy; TA, triamcinolone acetonide

Table 4. Comparison of the Thai version of the questionnaire assessing QDASH scores at baseline and at weeks 4, 8, and 12 after treatment

Follow-up session	fESWT group Mean (SD)	TA group Mean (SD)	MD	(95% CI)	*p-value
Baseline	19.00 (12.06)	20.57 (15.68)	-1.04	(-10.66-8.58)	0.827
Week 4	11.97 (11.63)	12.75 (12.67)	-1.50	(-9.74-6.74)	0.714
Week 8	18.76 (18.05)	17.88 (16.87)	-0.29	(-12.04-11.45)	0.959
Week 12	14.49 (14.84)	15.73 (20.83)	-2.74	(-14.70-9.22)	0.645
Overall	-	-	1.39	(-9.01-6.23)	0.720

Generalized estimating equation (GEE) statistics, Mean (SD), *$p < 0.05$ indicates statistical significance
MD, mean difference; CI, confidence interval
fESWT, focused extracorporeal shockwave therapy; TA, triamcinolone acetonide; QDASH, quick disabilities of the arm, shoulder and hand

Table 5. Comparison of the Thai version total BCTQ scores at the week before treatment and at weeks 4, 8, and 12 after treatment

Follow-up session	fESWT group Mean (SD)	TA group Mean (SD)	MD	(95% CI)	*p-value
Baseline	32.39 (8.21)	31.39 (8.82)	0.70	(-5.17-6.57)	0.809
Week 4	26.61 (10.43)	27.89 (9.24)	-2.09	(-8.61-4.42)	0.518
Week 8	28.89 (10.78)	31.28 (10.70)	-3.10	(-10.33-4.14)	0.390
Week 12	27.61 (8.68)	29.72 (12.21)	-2.96	(-9.99-4.05)	0.396
Overall	-	-	1.40	(1.21-1.60)	<0.001

Generalized estimating equation (GEE) statistics, Mean (SD), $^{*}p < 0.05$ indicates statistical significance
MD, mean difference; CI, confidence interval
fESWT, focused extracorporeal shockwave therapy; TA, triamcinolone acetonide; BCTQ, Boston Carpal Tunnel Questionnaire

Discussion

Our study showed a decrease in all parameters, but no statistically significant difference between the two treatment groups. The participants' outcomes were assessed at baseline and weeks 4, 8, and 12 after treatment, with the results shown in Tables 2-5. At the 4-week follow-up, both groups exhibited a reduction in VAS for pain, VAS for paresthesia, QDASH scores, and total BCTQ scores. However, the comparison between groups did not reveal any statistically significant differences (p = 0.987, 0.254, 0.230, 0.194). These findings suggest that while the treatments effectively reduced symptoms within each group, the improvement was comparable across groups. At the 8-week follow-up, there was a continued decrease in VAS for paresthesia, QDASH scores, and total BCTQ scores compared to baseline, except for VAS for pain in the fESWT group. Intriguingly, compared to the week 4 follow-up, an increase in these scores was observed, suggesting a potential fluctuation or plateau in symptomatic relief over time. However, comparisons between the groups showed no statistically significant differences (p = 0.482, 0.261, 0.959, 0.390), indicating that both groups experienced similar trends in symptom changes. By the 12-week follow-up, both groups had a notable reduction in VAS for pain, VAS for paresthesia, QDASH scores, and total BCTQ scores. Despite these improvements within each group, no statistically significant differences were identified between the groups (p = 0.300, 0.945, 0.645, 0.396). This consistent pattern of similar outcomes across both groups reinforces earlier findings that the treatment effects are equivalent throughout the study duration.

Overall, the data demonstrated a reduction in VAS for pain, VAS for paresthesia, QDASH scores, and total BCTQ scores from baseline to the 12-week follow-up in both groups. Although both groups benefited from the treatment, the lack of statistically significant differences between the groups (p = 0.107, 0.073, 0.720, < 0.001) indicates neither treatment regimen was superior. These findings suggest that the interventions provided comparable efficacy in managing symptoms in the study population. These results are consistent with Li et al.'s meta-analysis findings regarding pain relief and function improvement that the effects of ESWT and local corticosteroid injection for treating CTS are not significantly different.[19] The results are also consistent with the study by Vongvachvasin et al., which reported that fESWT combined with conservative treatment effectively improved symptoms and hand function in patients with moderate-to-severe carpal tunnel syndrome compared to conservative treatment alone.[20]

Seok et al. studied the effects of one session of ESWT for CTS and reported improvements in pain scores and functional status comparable to those achieved with local steroid injections.[13] Seok's study used ultrasonography to guide steroid injections and fESWT, yet the results were similar to those of the present study which did not utilize ultrasound guidance, a method not commonly used in Thailand. Additionally, a study by Gesslbauer suggested that fESWT is an effective and noninvasive treatment method for mild to moderate CTS.[21]

In our study, no side effects or serious complications occurred in the group treated with a single session of fESWT. However, one case of a side effect was reported after the steroid injection at the 4-week follow-up. This intervention involved a minor occurrence of nerve discomfort characterized by tingling and mild pain in the tip of the thumb. These symptoms resolved after appropriate treatment with medication.

Suggestions for future research projects include monitoring the duration of paresthesia symptoms returning after both treatments to assess treatment efficacy. Additionally, a cost-effectiveness comparison between the two treatments could be conducted to evaluate their relative value. This treatment employed single-session focused shockwave therapy which has shown lasting effects on patients for up to 12 weeks. However, further studies are needed to compare the effectiveness of single-session treatment versus weekly sessions to determine which approach yields superior outcomes.

Limitations of this research include the small number of participants which may be attributed to the limited diversity among research participants and the small sample size.

Conclusions

There is no evidence indicating a difference in clinical efficacy between single-session fESWT and steroid injection therapy in patients with moderate-degree carpal tunnel syndrome over a 12-week period. Therefore, noninvasive

fESWT can be considered an option to avoid possible side effects of steroid injection.

Acknowledgments

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Original Article

The Effect of Mindful Movement on Pain Intensity, Leg Muscle Fitness and Psychological Features in University Athletes with Chronic Patellofemoral Pain - A Randomized Controlled Trial Pilot Study

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ABSTRACT

Objectives: To evaluate and compare the effects of mindful movement therapy and general exercise therapy on pain intensity, leg muscle fitness, and psychological features in university athletes with chronic patellofemoral pain

Study design: Randomized controlled trial, a pilot study

Setting: Sport laboratory room, Department of Health and Sport Science, Mahasarakham University

Subjects: Thirteen athletes with chronic patellofemoral pain

Methods: The participants were males and females aged 19 to 25 years old who had had anterior knee pain for over three months. The self-report questionnaire and clinical tests diagnosed patellofemoral pain. The thirteen people were divided into two groups by block randomized allocation: the mindful movement group (n=7) and the general exercise therapy group (n=6). They were assessed for pain intensity, leg muscle fitness, and psychological features before and after the eight-week study. Both groups visited the physiotherapist to train three times a week for eight weeks.

Results: After the 8-week intervention, both groups showed significant improvement in pain intensity, pain catastrophizing scale, fear-avoidance beliefs questionnaire, and strength, endurance, and power tests of the legs over baseline ($p < 0.05$), but the acceptance scores of the mindful movement group ($p = 0.286$) and all levels of mindfulness of the general exercise therapy group showed no statistically significant difference ($p = 0.904$). The differences in average outcomes between the two groups at baseline were not statistically significant with the exception of leg power ($p = 0.008$). Moreover, there was no significant difference in the change in all outcomes between the two groups after the 8-week intervention ($p > 0.05$).

Conclusions: Both interventions can reduce pain intensity and improve physical and psychological features, even though the athletes had continued to perform other physical activities in daily life while participating in the program. Future studies with a larger sample size and a determination of retention time are needed.

Keywords: mindful movement, pain intensity, leg muscle fitness, psychological features, chronic patellofemoral pain

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Introduction

Chronic patellofemoral pain (chronic PFP) is a local pain around the anterior aspect of a knee which has had knee pathology for more than three months. It has been found to be highly prevalent in physically active adolescents, young adults, elite athletes, and the military.[1] Additionally, previous studies have shown that the prevalence of PFP among young Thai athletes (12-18 years) was 6% (19 of 310)[2] and 6.14% (42 of 683) in Thai university athletes.[3] Pain is a common symptom of PFP, and the long-term prognosis for most patients with PFP is poor.[4] Pain is also recognized in the brain, leading to chronic pain and poor long-outcomes, which may impact occupational tasks and sports negatively. Twenty-five percent of recreational athletes with PFP quit participating in sports because of knee pain.[5,6] In fact, 70-90 percent of individuals with PFP still have recurrent or chronic pain.[7] Interestingly, psychological features play a role in chronic PFP that may limit the potential for improvement with rehabilitation or which may act as barriers to recovery. Those psychological features include pain catastrophizing, which refers to a detrimental cognitive and emotional reaction towards expected or real pain, and kinesiophobia, which is an excessive and irrational fear of movement or physical activity due to the belief that it will result in pain or re-injury. A recent study reported that pain catastrophizing and kinesiophobia may be elevated in patients with PFP and that they are both correlated with pain and reduced physical function.[8] Past studies have found

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greater kinesiophobia, pain catastrophizing, and poorer objective function in individuals with PFP than pain-free controls. Catastrophizing and kinesiophobia can predict current pain and disability in anterior knee pain patients.[9,10] In addition, fear-avoidance beliefs (FABs), which refers to the cognitive and emotional factors that contribute to the avoidance of activities or movements due to fear of pain or injury, were the strongest predictor of functional outcome of the PFP patients.[11] The PFP patients with elevated FABs also presented with lower limb weakness.[12] Previous studies have reported that patients in the United Kingdom with chronic PFP had pain-related fear avoidance and damaged beliefs.[13] A study of long-lasting pain showed that the pain catastrophizing is associated with FABs that determine pain in the future, mental problems, and functional disability.[14] Previous studies have found that the Philadelphia mindfulness scale, the pain catastrophizing scale (PCS), and the Fear Avoidance Beliefs Questionnaire were significantly correlated with the visual analog scale, so the researchers suggested that the biopsychosocial targeted interventions should be explored in future research.[3] Exercise programming combined with other therapies including stretching and strength training of the lower extremity, hip, and trunk muscles was the most effective treatment for patients with PFP. The current consensus is that best-evidence treatments consisting of hip and knee strengthening may not address the fear and beliefs identified in the study.[13] However, the optimal clinical approach to treating PFP is not yet clear, as studies have found that 40%-57% of people treated with an evidence-based treatment program did not see long-term improvement.[15] Previous studies have also shown that a physical therapy program, including strengthening, stretching, and patellar taping, reduced pain and improved function significantly, but that FABs were changed only insignificantly.[16] The missing link in current treatment plans may relate to non-physical, psychological factors that affect perceived musculoskeletal pain.[8] Previous studies have found a significant negative correlation between pain intensity and mindfulness, and that the relationship of mindfulness is highly inversely related with pain catastrophizing and has a medium inverse correlation with the fear-avoidance model of musculoskeletal chronic pain.[17] The treatment aims to reverse these changes in the central nervous system, which can be categorized as a top-down approach, e.g., exercise, education, and/or relaxation training such as mindfulness.[18] Previous studies of mindfulness intervention have been associated with reduced pain and increased physical function as well as better emotional control and quality of life in patients with chronic pain such as cancer, low back pain, and shoulder or upper limb pain.[19,20] Those studies included both genders, but nearly all participants were middle age or older. Interestingly, the mindful movement technique focuses awareness on the state of the movement at all times. It may disconnect attention from the pain, and repeated training can lead to increased concentration and relearning in the brain, which can lead to changes in attitudes and acceptance of pain. Current studies in sports psychology have also reported that mindfulness enhances general well-being and athletic performance in the pediatric, adolescent, and young adult populations. However, there has been no attention specifically on chronic pain. It may be useful to focus on rehabilitation exercises to ensure correct movement performance and to gain maximum benefits from physical interventions.[21] Mindfulness-based interventions (MBIs) can improve athletic performance, mindfulness levels, and mindfulness-related psychological components in athletes. Research findings also indicate that more high-quality studies utilizing a rigorous empirical design (e.g., RCT) will be necessary in the future, especially in athletes' mental health domains.[22]

To date, no studies have investigated the efficacy of mindful movement therapy in athletes with chronic patellofemoral pain. Therefore, this study was designed to evaluate and compare the effects of mindful movement therapy and general exercise therapy on various outcomes in university athletes with chronic patellofemoral pain. Outcomes evaluated include pain intensity, strength, endurance, power of leg muscles, mindfulness level, pain catastrophizing, and fear-avoidance beliefs in university athletes with chronic patellofemoral pain based on assessment before and following an eight-week intervention.

Methods

Participants and design

The study was a randomized comparative trial. The sample size was calculated following the formula for sample size calculation and using a power of 0.80, the standard deviation from the previous study, which was 1.4[23] and a clinically meaningful improvement of 2 cm on a 10 cm visual analog scale (VAS)[24] and an alpha level of 5%, with at least eight individuals with PFP in each group. To account for a possible 15% withdrawal, there were 10 participants per group. The participants were divided by block randomized allocation with block size 4, 6, and 8, and stratification factors male and female with assignment to either mindful movement or general exercise therapy groups.

Study procedures

The Khon Kaen University Ethics Committee for Human Research approved the study based on the declaration of Helsinki and the ICH good clinical practice guidelines (HE 622192; No.4.2.02:30/2019). The research assistant explained the details of the study to the participants before they signed the consent forms. The participants ranged in age from 19 to 25 years and were university athletes at Thailand National Sports University (Mahasarakham Campus), Mahasarakham University, or Rajabhat Mahasarakham University. The inclusion criteria were fluent Thai speakers with retro patellar pain for more than three months without traumatic onset and elevated pain during three of the following four tasks: walking

up or down stairs, jumping, running, and squatting. PFP was diagnosed by the self-report questionnaire, the Thai version of the Survey Instrument for Natural History, Aetiology and Prevalence of Patellofemoral Pain Studies (SNAPPS).[25] Participants with a total score of 6 or more were considered to have PFP. They were also clinically diagnosed with PFP by a physiotherapist using tests including vastus medialis coordination, patellar apprehension, eccentric step, and single leg squat. The diagnosis was considered to be confirmed if at least two tests were positive. Participants had a moderate intensity of usual pain assessed using the VAS with scores ranging from 4 to 6 out of 10 in unilateral symptomatic PFP, medium mindfulness level measured by a total score of 50 to 80 on the Philadelphia Mindfulness Scale (PHLM), kinesiophobia indicated by scores greater than 15 on the Fear Avoidance Beliefs Questionnaire-Physical Activity (FABQ-PA) and low to medium level of leg strength measured by a leg dynamometer. Results were associated with gender and age. The exclusion criteria were knee swelling from any disease, a history of dislocation of the patella or knee surgery, and any use of non-steroidal anti-inflammatory or corticosteroids. Data was then collected before and after the eight weeks of exercise programs, including VASs, PHLM, PCS, and FABQ-PA, which are self-report questionnaires. The final tests assessed leg muscle fitness, including the leg dynamometer test, single leg wall sit test, and vertical jump test. All assessments were conducted in the same order and by the same research assistant.

Mindful movement intervention and General Exercise Program

Five experts approved the programs for appropriateness. The participants of both groups visited a physiotherapist to train three times a week for 8 weeks. The physiotherapist was responsible for administering the rehabilitation protocol and demonstrating all exercises to each patient. Both groups performed the same 7 exercises, but in the mindful movement group, participants also had the addition of mindful focus on the movement during exercise led by the instructor using physical cues to direct the participants' attention to how their bodies felt and moved and discouraging comparison to other participants. The participants were encouraged to take a nonjudgmental view of their progress. The instructor questioned the participants often to help ensure they were still focused on the program.

They were also reminded to focus by the bell of the mindfulness application which rang 3 times after every 5 minutes. Initially, a physiotherapist demonstrated and taught the correct breathing technique to the participants, putting one hand on the stomach while the other was on the chest and breathing in slowly through the nose. This caused the belly to expand and the lungs to fill with air, after which the belly relaxed and the individual breathed slowly through the nose or pursed lips. Practicing this technique continued until the participants could breathe in and out without the chest moving and felt relaxed and comfortable. Before and at the end of the exercise program, participants were instructed to perform static stretching of the quadriceps, hip flexor, hamstrings, tensor fascia latae, iliotibial band, and gastrocnemius muscles, with each position held for 20 seconds, for 1 set of 3 repetitions.

The first two weeks of the program started with non-weight, partial weight, and weight-bearing muscle stabilization and strengthening exercises focused on activating the core, hip, and leg musculature. There were seven positions, including an abdominal draw-in exercise (hold 10 seconds, repeat 10 times, 3 sets), static quadriceps muscle contractions (hold 10 seconds, repeat 10 times, 3 sets), supine with straight leg raises (12 times/side, 3 sets), supine arm/leg extensions (12 times/side, 3 sets), hip adduction side-lying (12 times/side, 3 sets), side-lying clamshells with an elastic band (12 times/side, 3 sets) and side-lying straight leg raises with elastic band with each position held for 15 seconds of rest/set (Figure 1).

The first two weeks of the program begin with no non-weight and weight bearing (open-closed chain exercise) of muscle stabilization and strengthening exercise that focus on stimulating core, hip and leg muscles. Exercise positions of 3-5 weeks progressed to partial weight and weight bearing but still focused on muscle stabilization and strengthening of the core, hip, and leg. There were seven positions, including a 90/90 breathing position (hold 10 seconds, 10 times, 3 sets, bridging (20 times/side, 3 sets), single leg bridging (12 times/side, 3 sets), prone plank (hold 30 seconds, 5 times, 2 sets) and quadruped arm/leg extensions (12 times/side, 3 sets), with each position followed by 15 seconds/set of rest. For the side plank (hold 10 seconds,10 times, 2 sets) and the isometric hip abduction against the wall while standing (hold

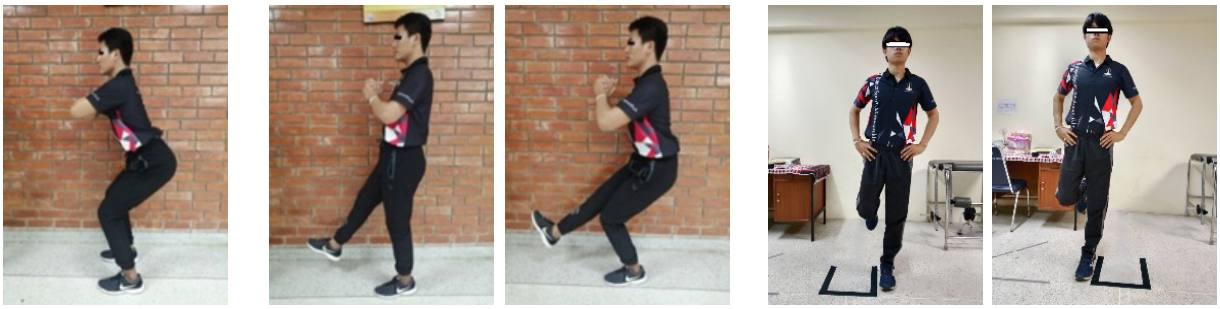
Static quadriceps muscle contractions

Side-lying clamshells with elastic band

Figure 1. Example of weeks 1-2 of the exercise program

Single leg bridging | Prone plank | Isometric hip abduction against the wall while standing

Figure 2. Example of weeks 3-5 of the exercise program



Mini squat | Single leg mini squat | Side-hop

Figure 3. Example of weeks 6-8 of the exercise program

10 seconds, 10 times, 2 sets), each position was followed by 30 seconds/set of rest (Figure 2).

The program's final three weeks focused on functional movement and weight bearing. There were seven positions, including the mini squat (hold 10 seconds, 10 times, 3 sets), mini lunge (hold 10 second,10 times, 3 sets), lateral lunge (hold 10 seconds, 10 times, 3 sets), single leg mini squat (10 times, 3 sets), step-ups and down (10 times, 3 sets), step-ups and down, lateral (10 times, 3 sets), and side-hop (6 times/side, 3 sets), with each position including a minute of rest between each set (Figure 3). Moreover, all positions were performed while breathing smoothly and continuously. If a participant felt pain with some movement or position, they were allowed to adapt or change the angle of movement to be more comfortable.

Instruments

VASs were used to assess pain intensity of patellofemoral pain, including usual pain (VAS-U), worst pain (VAS-W), and pain during activities such as ascending (VAS-AS) and descending stairs (VAS-DS), jumping (VAS-J), running (VAS-R) and squatting (VAS-SQ). Participants had to mark their VASs on 10 cm. lines of a visual analog scale (0 cm, no pain-10 cm, extremely intensive pain). The reliability of VASs was 0.89-0.94.[26]

The Thai version of the PHLM) was designed to assess mindfulness. It consists of two subscales, awareness and acceptance, which use a 5-point Likert scaleS (1=never, 5=very often).[27] There are twenty questions, with a maximum score of 100. Participants indicated their degree of mindfulness level. A high total score meant high mindfulness. In this study, the reliability of PHLMS_TH was 0.97.

The Thai version of the PCS was used[28] which includes thirteen statements describing different thoughts and feelings that may be associated with pain. Participants indicated the degree to which they had these thoughts and feelings when experiencing pain. For each statement, participants chose from a scale of 0 to 4. Possible scores of PCS were 0 to 52. Higher scores mean more negative thoughts and feelings about pain. In this study, the reliability of PCS_TH was 0.95.

The Thai version of the FABQ-PA was used.[29] Four statements describe how much physical activity would affect knee pain. Participants chose from a scale of 0 to 6 for each statement. Possible scores of FABQ-PA ranged from 0 to 24. Higher scores mean greater pain-related fear. In this study, the reliability of FABQ-PA_TH was 0.86.

Leg strength used a dynamometer to measure the maximal isometric force of the legs. The participants stood upright on the dynamometer, facing the handle with feet spread apart on the plate. They gripped the handle with an overhand grip, straight arms, straight back, and bent knees, then gradually applied maximal force upwards while avoiding jerking the handle. The position of the back should be forward or vertical. The neck should be reasonably relaxed and neutrally positioned. The test was repeated after a 15-second break, and the higher scores were recorded in kilograms/body weight. In this study, the reliability was 0.93, demonstrating good reliability (Figure 4).

Leg endurance using the single-leg wall sit tests the strength and endurance of the quadriceps. The participants stood with their backs against a wall, then slid down it, shuffling their feet forward until their knee and hip angles reached 90 degrees. The participants lifted the pain-free leg 5 cm off the ground and then started recording their time. They balanced

Leg dynamometer test

Wall squat test

Vertical jump test

Figure 4. Tests of leg muscle fitness

and held the position for as long as possible, then stopped recording when they put their foot down again, repeating the test after a 15-second break, then recorded the higher score in seconds. In this study, the reliability was 0.92, demonstrating good reliability (Figure 4).

Leg power using the vertical jump measures the power of the legs using the Marathon digital jump equipment, which was developed in Thailand. The participants stood with feet shoulder-width apart on a jump mat with hands on hips. They were instructed to bend at the hips and knees and then do a counter-movement vertical jump to the maximum height possible. They jumped with both feet and landed on both feet while keeping their hands on their hips. This exercise was repeated for 3 jumps with 15-second breaks between jumps, and the mean height was recorded in centimeters. In this study, the reliability was 0.91, demonstrating good reliability (Figure 4).

Statistical analyses

The participants were of both genders, including individuals with either left or right sides affected, and participating in a variety of sports. Age, weight, and height are presented as mean and standard deviation. The visual analog scale, Philadelphia mindfulness scale, PCS, fear-avoidance beliefs questionnaire, physical activity, strength, endurance, and power tests of the leg muscles are also expressed as mean and standard deviation. Prior to statistical analysis, all variables were assessed for distribution based on the Shapiro-Wilk test. For those with a normal distribution, paired t-tests and independent t-tests were performed to compare within the group and between groups. The Wilcoxon sign rank test analyzed variables that were not normally distributed, and Mann-Whitney U. Group comparisons were adjusted for confounding variables using an analysis of covariance (ANCOVA) model when pre-assessment results were different across groups. All of the statistical analyses used SPSS.

Results

Forty-two university athletes with chronic knee pain were willing to complete all the self-report questionnaires, clinical tests, and physical performance tests. Nineteen university athletes fulfilled the eligibility criteria and signed consent forms to participate in the exercise program. They were randomized into two groups. Six participants dropped out of the study before the 8th week. Thirteen participants completed the eight weeks of the program, of whom seven participants were in the mindful movement and six were in the general exercise therapy group (Figure 5). The power of analysis was 0.76.

Assessment of baseline comparability showed no significant difference between participants in the mindful movement and the general exercise therapy groups for gender, affected side, sports, age, weight, height, experience of playing the sport, sport training duration, or frequency of sport training ($p > 0.05$) (Table 1). The baseline of the study outcome measures did not differ between groups with the exception of leg power which was significantly different ($p = 0.008$) (Table 2).

After the 8-week intervention, the mindful movement group showed that visual analog scales, the Philadelphia mindfulness scale, total scores, awareness subscale, PCS, fear-avoidance beliefs questionnaire, and strength, endurance, and power tests of the legs improved significantly compared with baseline. The acceptance subscale of PHLM_TH was improved, but the difference was not statistically significant. Similarly, the general exercise therapy group demonstrated no significant difference in total scores on the Philadelphia mindfulness scale or any of the subscales. However, other outcomes in the general exercise therapy group showed significant improvement compared to the baseline. There was no difference in change in all outcomes ($p > 0.05$) between the two groups. However, the mindful movement group tended to improve the mindfulness level and physical fitness of leg muscles more than the general exercise therapy group (Table 2).

Discussion

We determined the effect of mindful movement on pain intensity, physical performance, and psychological features in university athletes with chronic patellofemoral pain. The study was specific regarding diagnosis and other inclusion criteria, so obtaining a large sample size was challenging. 19 participants met the inclusion criteria, which resulted in unequal group sizes. This research was conducted from August 2023 through March 2024. Some participants in the

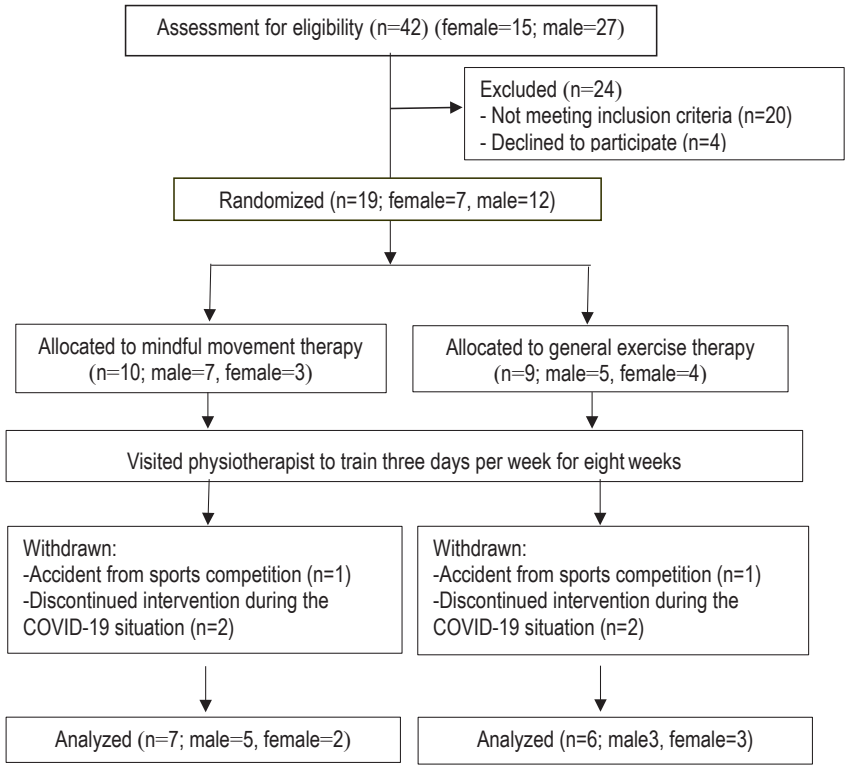


Figure 5. Flow chart describing the progression of participants

Table 1. Basic characteristics of participants

Characteristics	Mindful movement (n=7)	General exercise therapy (n=6)	*p*-value
Gender[1]			0.429
Male	5	3	
Female	2	3	
Affected side 1[1]			0.391
Right	4	2	
Left	3	4	
Affected side 2[1]			0.797
Dominant leg	3	3	
Non-dominant leg	4	3	
Sports[1]			0.639
Ballroom dance	2	2	
Futsal	0	1	
Volleyball	2	1	
Sepak takraw	1	0	
Rugby	1	0	
Athletics	1	1	
Swimming	0	1	
SNAPPS[2]	8.85 (0.69)	8.66 (0.81)	0.657
Age (years)[2]	21.57 (1.61)	20.83 (2.31)	0.514
Weight (Kg)[2]	73.85 (16.17)	69 (14.58)	0.636
Height (cm)[2]	174.00 (11.60)	174.66 (7.20)	0.905
Experience of playing the sport (months)[2]	63.85 (31.68)	71.16 (39.79)	0.719
Sport training duration (hours/day)[2]	3.28 (1.11)	3.33 (0.81)	0.933
Frequency of sport training (days/week)[2]	5.42 (0.78)	4.83 (0.98)	0.215

[1]number, [2]Mean (SD)

The survey instrument for natural history, aetiology, and prevalence of patellofemoral pain studies (SNAPPS), kilogram (kg), centimeter (cm), $p < 0.05$, significant at 0.05

Table 2. Comparative effects on pain intensity, leg muscle fitness and psychological features within and between groups

Outcomes	Mindful movement (n=7)		*p*-value within group	General exercise therapy (n=6)		*p*-value within group	*p*-value Pre-assessments	*p*-value Between groups
	Pre-test Mean (SD)	Post-test Mean (SD)		Pre-test Mean (SD)	Post-test Mean (SD)			
Pain intensity								
VAS-U (cm)	6.35 (1.01)	1.61 (1.03)	<0.001*	5.13 (1.27)	1.61 (1.74)	0.002*	0.081	0.998
VAS-W (cm)	7.58 (0.74)	3.30 (2.45)	0.004*	7.90 (1.43)	2.96 (2.01)	0.001*	0.622	0.796
VAS-AS (cm)	4.84 (1.55)	1.02 (0.66)	<0.001*	4.30 (2.70)	1.40 (1.04)	0.032*	0.659	0.453
VAS-DS (cm)	5.24 (2.03)	1.27 (1.17)	0.006*	4.41 (2.69)	1.38 (0.79)	0.026*	0.542	0.848
VAS-J (cm)	6.71 (2.20)	1.48 (1.15)	0.001*	6.86 (2.68)	2.43 (1.52)	0.002*	0.912	0.230
VAS-R (cm)	6.45 (1.54)	1.35 (0.79)	0.001*	6.50 (2.39)	1.46 (0.56)	0.007*	0.970	0.785
VAS-SQ (cm)	6.85 (1.67)	2.28 (1.64)	0.001*	5.78 (1.34)	2.1 (1.49)	0.001*	0.234	0.880
Leg muscles fitness								
Leg strength (kg/BW)	1.76 (0.41)	2.61 (0.44)	0.018*	1.36 (0.34)	2.09 (0.71)	0.039*	0.090	0.141
Leg endurance (sec)	3.11 (3.25)	16.97 (6.38)	0.018c*	5.38 (4.67)	14.84 (5.40)	<0.001*	0.317[a]	0.533
Leg power (cm)	32.69 (4.88)	38.14 (7.06)	0.008*	24.72 (3.82)	29.32 (5.04)	0.020*	0.008*	0.880[b]
Psychological features								
PHLM_TH	65.57 (8.56)	71.42 (9.94)	0.045*	65.50 (7.66)	65.83 (6.04)	0.904	0.988	0.256
Awareness	32.71 (5.12)	36.00 (6.55)	0.048 c*	33.28 (5.70)	33.00 (6.57)	0.859	0.942[a]	0.429
Acceptance	33.28 (5.70)	35.42 (3.77)	0.286	32.16 (5.70)	32.83 (3.43)	0.709	0.731	0.225
PCS_TH	27.28 (9.10)	14.42 (7.11)	0.012*	23.66 (6.68)	11.33 (7.81)	0.011*	0.439	0.470
FABQ-PA_TH	18.14 (1.95)	11.50 (4.72)	0.005*	16.83 (1.32)	11.16 (2.71)	0.002c*	0.175[a]	0.884

Usual pain (VAS-U), worst pain VAS-W, ascending (VAS-AS), and descending stairs (VAS-DS), jumping (VAS-J), VAS-SQ, running (VAS-R) and squatting; PHLMS_TH The Thai version of the Philadelphia Mindfulness Scale; PCS; The Thai version of Pain Catastrophizing Scale; FABQ-PA, The Thai version of Fear Avoidance Beliefs Questionnaire-physical activity; Sec, second; kg/BW; kilogram/body weight, centimeter (cm)

[a], using an analysis of Mann-Whitney U; [b], using an analysis of covariance (ANCOVA) model; [c], using an analysis of the Wilcoxon sign rank test,

*$p < 0.05$, significant at 0.05.

local area joined the program during the COVID-19 situation, where the university had to be closed and locked down for one month during December and January 2024. Four participants dropped out, and two participants had an accident in a sports competition. Finally, 13 participants completed the programs. We analyzed per protocol before the experiment, and this study was assessor-blinded. The general exercise group was an active control group in which participants performed 7 exercises without a mindful focus on the movement during exercise using only physical cues by the instructor and the bell of the mindfulness application.

The results of both groups showed that all of the visual analog scales, PCS, fear-avoidance beliefs questionnaire, and strength, endurance, and power tests improved significantly after participating for eight weeks. Almost all variables of both groups improved, possibly due to the appropriate exercise posture design, suitable exercise dosage, adherence of the participants, and other factors. Exercise postures were designed to include muscles related to the pathomechanics of PFP. The program gradually progressed from easy positions to a more difficult ones, such as wide to narrow base support, high to low center of gravity, and increasing load on body weight. In the first two weeks of the program, the participants started with non-weight, partial weight, and weight-bearing muscle stabilization and strengthening exercises that focused on activating the core, hip, and leg musculatures with low central gravity and wide base support. Exercise positions over the next three weeks progressed to more weight-bearing. The last three weeks of the program focused on close-chain exercise and functional movement. Previous studies have shown strong evidence that exercise therapy is the only intervention that has received such a high recommendation for patients with PFP.[5] Exercise reduced pain and improved function in the short-medium and long term, which is strongly recommended for treatment of PFP because of its influence on the biomechanics of these muscles, and on femur alignment as well as the potential effect of exercise in improving altered biomechanics of the knee and that it is better than no treatment. Moreover, regular exercise can promote pain relief, by increasing opioids and serotonin levels in central inhibitory pathways, including the periaqueductal gray (PAG) and the rostral ventromedial medulla (RVM). Exercise uses endogenous inhibitory systems to reduce pain.[30] Strengthening exercises of the hip external rotators, the abductor muscles, and the trunk provided more pain relief than strengthening exercises of the quadriceps in patients with PFPS.[31] According to Ferber et al.[32], the hip, core, and knee rehabilitation protocols improved the function of movement and strength over six weeks. Also, the hip and core strengthening protocol could decrease pain and increase strength better than the knee-focused protocol. At the beginning of the knee treatment group, non-weight-bearing exercises, including quadriceps strengthening, were performed, then the program progressed to weight-bearing

quadriceps-strengthening exercises. In addition, the proximal stability program focused on neuromuscular control of the hip and core musculature showed that an 8-week rehabilitation program improved the hip and core muscle strength and reduced knee abduction moment, which is associated with developing PFP. Then, dynamic exercises were added at the beginning of the program. Participants had to control and correct lower extremity alignment, such as maintaining the knee over the second toe, maintaining a level pelvis during exercise, and not letting the knee move medially to the foot during a single-legged stance. The end of the program was a more complex functional task, and the maintenance of position and alignment became automatic.[33] The rehabilitation program should begin with performing open kinetic chain exercises in deeper ranges of knee flexion, e.g., 50°-90°, and closed kinetic chain exercises in lower ranges, e.g., 0°-45° because of the lower patellofemoral contact force.[34]

Exercise dosage is also an essential factor that affects changes in variables, e.g., intensity, frequency, and adherence to exercise programs. The present study used 10-12 repetitions per exercise and three sessions per week for 8 weeks. Current research on PFP rehabilitation often follows the exercise dosage described by the American College of Sports Medicine.[35] The most intense exercise programs for PFP include ten repetitions per exercise session conducted two to four times per week for a total of six weeks 6 for reducing pain and improving muscle function properties. However, kinesiophobia typically requires more than three to eight weeks of rehabilitation intervention. Thus, patients would need to continue an exercise program for the long term, i.e., more than six months to achieve these treatment goals.[36] Runners with PFP performed a home exercise program and education component three times a week for eight weeks. The symptom and functional outcomes significantly improved mean scores at four weeks, eight weeks, and 20 weeks compared with baseline, but only the exercise group increased knee extension strength.[37] A systematic review of three trials that explored 8-12 weeks of hip and knee strengthening to provide strength measures found that the results were significantly higher.[38] However, exercise dosage should be deter-mined and prescribed based on an individual's deficits or specific assessments. In addition, adherence to participation in the program is also essential. In this study, all subjects had greater than 80% adherence to the program. A pilot study reported that adolescents (12-16 years) with PFP had poor adherence to the exercise program, so self-reported outcomes were only slightly improved. There were no significant changes in knee strength after three months of intervention.[39] With other strategies, the participants were encouraged to perform exercises and functional movement without pain, and if they felt pain with some movement or position, they were allowed to adapt or change the angle of movement to make it more comfortable. It is essential to gradually increase the intensity and frequency of training while providing adequate rest periods between sessions. This method helps to reduce the risk of suffering severe pain or injury.

Only the mindful movement group showed significantly improved Philadelphia Mindfulness Scale, total scores and awareness subscale compared with baseline. This study used a questionnaire to determine mindfulness indirectly. It could be explained by based on theories and previous studies that determined brain activity when participants did mindfulness therapy or meditation. The aim of mindfulness in the treatment of chronic pain is to cultivate a quality of openness and experiential acceptance of pain rather than rejecting or avoiding the pain.[40] Neuropsychological research has found that individuals with greater trait mindfulness have higher prefrontal cortical activation during affect labeling, that trait mindfulness is also associated with reduced bilateral amygdala activation when responding to fear, and that high mindfulness is indicative of an inverse relationship between the prefrontal cortex and right amygdala responses. Thus, mindful individuals may better regulate emotional responses via the prefrontal cortex and inhibition of the amygdala.[41] Additionally, Marie et al.[42] have reported that alleviation of pain is associated with increased neuronal connectivity between the anterior insular cortex and the dorsal anterior mid-cingulate cortex, so long-term mindfulness practice may affect cortical thickness in pain-related brain areas and result in changes in pain sensitivity. Additionally, mindfulness techniques can modulate neural brain processes; for example, less activity in the amygdala has been associated with less fear of pain and increased activity in the anterior insular and anterior cingulate, two areas involved in the emotional regulation of pain processing. Mindfulness decreases basal sympathetic tone, leading to reduced chronic pain and increased blood flow in the frontal-lobe region, which plays a role in reframing the contextual evaluation of an event. This suggests that increasing blood flow is related to the re-evaluation and awareness of changes in emotional state.

In addition, mindful movement may help to concentrate the participants' focus to ensure the correct movement, performance and control of muscles to gain maximum benefits from the physical intervention. The mindful movement technique focuses on sensory information from movement of the body and breathing. It tends to go slowly, along with mental training that involves the sense of muscles and movement, rhythmic diaphragmatic breathing, and meditation. All of these trainings involve light to moderate intensity physical activities and are useful for symptomatic management in many musculoskeletal diseases, for example, knee osteoarthritis, fibromyalgia, and chronic lower back pain. Systematic reviews have reported that mindfulness exercises may help reduce pain and increase physical function in adults with knee osteoarthritis; however, sample sizes were small.[43,44] Mills et al.[45] reported that the mindfulness of movement intervention also involves developing a moment-to-moment awareness of the quality of postures, including whether the posture is

aligned or misaligned; breathing, including whether breathing is inhale or exhale and movement; and whether movements are integrated with mental preparation or whether there is a sense of mind-body disconnection. In addition, mindfulness training, movement therapy, and relaxation strategies may be effective for improving physical function, pain, and low mood for adults with fibromyalgia compared to usual care controls. However, the quality of the evidence could have been higher because the sample size was small and the use of outcome measures was not consistent in analysis-restricted studies.[46]

Moreover, the mindful movement used the bell of mindfulness application, and the researcher gave physical cues to direct participants' attention to how their bodies felt and moved and discouraged comparison with others. Participants were encouraged to take a nonjudgmental view of their progress. The instructor had to ask participants often to check that they were focused on the program, and to remind them to focus their movement, a bell rang 3 times every five minutes. A previous study reported that sound healing had been used for religious and spiritual ceremonies, including bells, singing bowls, and gongs, and that sound healing was beneficial to emotional healing, psychological and psychosocial factors which have been used in psychotherapy in addition to breathing, relaxation and meditation.[47] Previous studies have demonstrated the potential effect of sound healing on pain perception, decreasing blood pressure and heart rate more than silence alone.[48] According to Goldby et al.[49], a singing bowl meditation significantly improved mood, reduced tension, anxiety, physical pain, and increased spiritual well-being. Even though the reasons for the beneficial effect of sound healing are not clear, theories have suggested that different sound beats or frequencies drive into the brain and propel brainwave states such as beta, alpha, theta, and delta waves, which indicate an ordinary waking consciousness, relaxing, meditation and deep, dreamless sleep. There is a need for further study to reveal brain wave states during mindful movement training combined with the bell of mindfulness.

This study also found no difference in improvement in all outcomes between the two groups. However, the mindful movement group tended to improve mindfulness levels more than the exercise therapy group. Possible reasons for these results include that the sample size was small, the mindful movement intervention period was not long enough to change all outcomes compared to an active control group in patients with chronic PFP, and that both groups included relaxation techniques such as breathing techniques during movement. Participants could still do other activities in daily life while participating in the program, in which each person had different activities and stresses, which may have been confounding. Systematic review and meta-analysis research on the effectiveness of mindfulness-based interventions for chronic pain has revealed that most effects were not significant when compared with controls, and that the effect of mindfulness was generally found to be equivalent to the active comparator. Mindfulness improved significantly in only two of the four studies, in the intervention group compared to the control group. Limitations of those studies include small sample sizes, recruitment methods, and participation rates, all of which may have resulted in a self-selected sample. Additionally, and the frequency of practice may have affected outcomes.[50] The mindful movement intervention was as effective at reducing chronic neck pain as an equivalent duration of exercise intervention.[51]

In contrast, mindful exercises for chronic lower back pain have shown significantly reduced pain intensity and disability compared to the control group. Mindful exercises have also shown significantly reduced pain intensity compared with active control alone, including conventional exercises, core training, and physical therapy programs.[44] Pathological musculoskeletal-related muscle impairments can cause this chronic pain, but exercise therapy can improve symptoms of muscle impairment. However, prolonged pain may cause abnormal neural networks (neuro matrix) and disturb several areas of the brain related to emotional and cognitive performance, factors that can change a person's behavior and physiological responses to pain. Treatment plans may include non-physical treatment as well. Longer pain duration is a poor and inconsistent prognostic indicator. A duration of more than two months was significantly associated with poor reduction of pain severity at 3-12 months, so sports medicine practitioners should try to increase efficacy in reducing PFP and should promote early intervention.[4] In addition, some participants in the present study explained in their diary that after eight weeks of mindful movement, that they experienced not only decreased pain and improved physical function in daily life, but that they also felt relaxed, calmed down, less anxiety and fearfulness, and could control their emotions better. Both programs can be performed even if the individual has to participated in other physical activities such as playing sports, exercising, and studying in physical classes. However, this study has some limitations, including a small sample size, no control group, varied types of athletes in each group, and data collection during the coronavirus disease (COVID-19) situation.

Conclusions

Both groups had similar results: decreased pain intensity as well as improved psychological features and leg muscle fitness. However, only the mindful movement group improved mindfulness levels significantly compared with baseline after eight weeks and they tended to improve in terms of decreased pain intensity more than the general exercise therapy group. Future studies are needed with large sample sizes and similar types of sports. Sports training schedules should be planned that are compatible with the program as well. Athletes with chronic PFP may need more extended periods of treatment, and it should consider stress and anxiety in their lives.

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Conflicts of Interest

The authors declare that they have no competing interests.

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Original Article

Comparison of Effects of the Five Points Hands Free Program Versus Standard Eye Exercises in Office Workers with Computer Vision Syndrome in Trang Hospital

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ABSTRACT

Objectives: To compare the effects of the five-point hands free (FPHF) exercise program and standard eye exercises on computer vision syndrome (CVS) and vestibulo-ocular symptoms among Trang Hospital staff.

Study design: A prospective, comparative, cluster-randomized study

Setting: Trang Hospital, Trang, Thailand

Subjects: Sixty-two office workers with CVS symptoms

Methods: Participants were divided into a standard exercise group (n=31) and a FPHF group (n=31). CVS symptoms were assessed using the CVS questionnaire. Vestibular ocular motor function was evaluated using the Vestibular/Ocular Motor Screening (VOMS) tool before and after a 3-week intervention.

Results: After three weeks, both the FPHF and the standard group improved CVS and VOMS scores. The FPHF group had a reduction in almost all symptoms, similar to the standard group. The FPHF group significantly reduced headaches, dizziness, and fogginess during VOMS ($p < 0.05$). However, between-group differences in CVS and VOMS cumulative scores were not statistically significant.

Conclusions: The FPHF program demonstrated potential benefits in reducing CVS and vestibulo-ocular symptoms, suggesting that it may be a viable alternative intervention for managing CVS. However, further research is needed to establish its long-term effectiveness compared to standard exercises.

Keywords: dizziness, occupational health, exercise therapy, computers

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Introduction

In today's digital era, electronic devices such as computers, tablets, and smartphones have become essential for work and communication.[1] Healthcare personnel rely heavily on computers for continuous patient data recording and service provision.[2] Digital technology is crucial in the modern healthcare system, enabling provision of efficient, high-quality services and increasing access to care via digital platforms.[3] Despite the benefits of digital technology in healthcare, its extensive use comes with potential drawbacks. Specifically, these technologies may adversely affect the users' health, e.g., computer vision syndrome (CVS), a condition resulting from prolonged digital device use.[4]

CVS is especially prevalent among healthcare workers who regularly use these tools.[5,6] It is characterized by a complex of eye and vision-related symptoms, including eyestrain, headaches, blurred vision, dry eyes, and neck and shoulder pain.[7] These symptoms result from individual visual problems, poor workplace conditions, and improper work habits.[8] Previous studies have identified increased risks to long-term computer users,[9] which may lead to reduced work productivity, increased error rates, and poor job satisfaction.[10]

While the prevalence of CVS is well-documented, its complex pathophysiology involves multiple mechanisms. Prolonged close work and sustained inappropriate accommodation can lead to ciliary muscle fatigue and reduced accommodative amplitude.[11] Infrequent blinking and increased tear evaporation during computer use disrupt the tear film, causing ocular surface dryness and irritation.[12] The use of electronic screens also exposes the eyes to high-energy visible light, which may cause retinal damage and increase the risk of age-related macular degeneration.[13]

Additionally, CVS can cause dizziness. While current studies have not established a direct link between CVS and neuro-ophthalmology, there is a recognized association between ocular and vestibular dysfunctions.[14] Symptoms of CVS, including vertigo/dizziness, can be exacerbated by visually induced aggravation, known as visual vertigo (VV).[15,16] This suggests a potential overlap of these symptoms. Given the multifaceted nature of CVS, comprehensive rehabilitation approaches remain limited.[17] Prevention methods include

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addressing factors such as lighting, screen settings, posture, using eye drops, taking visual breaks, and performing eye exercises.[4] Standard eye exercises, such as eye-rolling, focusing, and palming, aim to reduce eye strain by relaxing eye muscles and improving blood circulation.[18] While effective for alleviating some CVS symptoms, these exercises primarily focus on ocular health and may not address the broader neuro-ophthalmic and vestibular aspects of CVS.

Trang Hospital established a Vertigo Clinic in 2007 to provide vestibular rehabilitation for patients with dizziness. Experienced physical therapists assess visual stability and provide eye exercises to reduce visual disturbances after canalith repositioning procedures (CRP).[19,20] The clinic has also developed a Five Points Hand Free (FPHF) program for patients with benign paroxysmal positional vertigo (BPPV) post-CRP, which has shown promising results.[21] The FPHF program, which is based on vestibular rehabilitation, targets both visual and vestibular systems with coordinated head and eye movements, improving gaze stability and balance. The program can be implemented without specialized equipment.

Recognizing the potential overlap between CVS and vestibular symptoms, this study aimed to explore a new avenue for managing CVS. The researcher hypothesized that CVS symptoms may share similarities with post-CRP symptoms in BPPV patients. The FPHF program offers a new approach to managing CVS, especially with increased digital technology use at work. Its advantages over standard eye exercises include a comprehensive approach, improved gaze stability, enhanced vestibular-ocular reflex, ease of implementation, and potential long-term benefits by targeting vestibular function more effectively than eye exercises alone.

This study aimed to compare the effects of the FPHF program and standard eye exercises on CVS symptoms and vestibulo-ocular symptoms among Trang Hospital staff. The findings may guide the development of eye health interventions and strategies for effectively working with digital technologies in the future.

Methods

The participants were comprised of staff from various departments at Trang Hospital. Participation was voluntary and recruitment was conducted through announcements and posters. Eligible participants were assigned to groups using the cluster random sampling method. Based on the 2020 research by Gupta et al. on ocular exercises for CVS, the initial sample size was 16 participants per group. To account for potential dropouts, an additional 20% was added, resulting in a target of 40 participants. However, all 62 eligible volunteers were included in the study to mitigate dropout risks and enhance statistical power. This study was approved by the Trang Hospital Human Research Ethics Committee (ID006/02-2566)

The inclusion criteria were as follows: age between 20 and 60 years, working with computers for at least 2 hours per day and having at least one symptom of CVS. The exclusion criteria included a history of eye injuries or surgery, severe dry eyes or other ocular surface disorders, binocular vision disorders, and neurological or vestibular disorders. The data collection was conducted from February to March 2024.

Intervention included standard eye exercises[18] and FPHF exercises[21] as follows:

Standard eye exercises:

1. Distant gazing: Look at a distant object for 10-15 seconds, then focus on a near object for 10-15 seconds. Repeat 10 times.
2. Eye rolling with eyes closed: Slowly roll your eyes in a circular motion clockwise and counterclockwise, performing five rotations in each direction.
3. Finger focusing at eye level: Hold a finger at arm's length, focus on it with both eyes for 10-15 seconds, then focus on a distant object for 10-15 seconds. Repeat 10 times.

Participants were instructed to perform these exercises 2 times daily, each lasting approximately 5-7 minutes.

Five Points Hand Free Exercises:

1. Using an exercise chart with five numbered points arranged in a cross pattern: a) Face forward and gaze at each of the different numbered points alternately 20 times per set. b) Lock gaze on number 1 (center point), then move the head left-right and up-down 20 times while maintaining focus.
2. Perform 3 sets of these exercises, with a 30-second rest between sets.
3. Total exercise duration: approximately 10 minutes per session, to be performed twice daily.

Participants in the study were single-blinded and received interventions administered by experienced physical therapists. They were divided into two groups: standard exercise (n=31) and FPHF (n=31). Exercises were designed and supervised by two physical therapists with over 15 years of experience and were conducted daily from Monday to Friday. Participants were instructed to practice at home daily for 3 weeks.[18] Adherence was monitored through weekly interviews, daily logs, and reverse demonstrations to ensure compliance. Interviews included questions on exercise frequency, duration, and any modifications made.

Outcome measurements

Participants completed a general information questionnaire, the CVS questionnaire[22] and underwent the Vestibular Ocular Motor Screening (VOMS)[23] assessment before and after the 3-week intervention. The CVS questionnaire evaluates the frequency and intensity of 16 symptoms, including ocular (e.g., eyestrain, eye pain, dry eyes, tearing), visual (e.g., blurred vision, double vision), and musculoskeletal (neck, shoulder, or back pain) symptoms, on a scale of 0-3. The total score ranges from 0 to 48, with higher scores indicating greater severity.

The VOMS is a validated screening tool for identifying vestibular and ocular motor impairments. It consists of brief assessments of smooth pursuits, saccades, near point of

convergence (NPC), horizontal and vertical vestibulo-ocular reflex (VOR), and visual motion sensitivity (VMS). Participants rate their headache, dizziness, nausea, and fogginess on a scale of 0-10 after each assessment. Higher scores indicate greater symptom provocation. Moreover, VOMS is an assessment tool commonly used in vestibular rehabilitation clinics, providing physical therapists with a reliable method for evaluating outcomes.

The outcome assessors, experienced physical therapists, were blinded to the participants' group allocations and were not involved in the intervention administration. To ensure the reliability of variable assessments, the assessors underwent specific training. Participants were instructed not to disclose their group assignment or discuss their exercises. The trained assessors conducted the VOMS and consistently administered the CVS questionnaire across all evaluations to maintain uniformity in assessment.

Data analysis

Participants' baseline data were analyzed using descriptive statistics. Proportions were compared using the Chi-square test. A nonparametric analysis of CVS symptoms and VOMS scores was performed. The Friedman test was conducted to examine differences across multiple conditions, and the Bonferroni correction was applied to adjust for type I errors. If significant results were found, post-hoc analyses were performed using the Wilcoxon Signed-Rank Test for within-group comparisons or the Mann-Whitney U Test for between-group comparisons. Statistical significance was set at $p < 0.05$ in all cases.

Results

Out of 139 registered participants, only 62 met the inclusion criteria and provided informed consent. Table 1 shows the baseline demographic characteristics of the 62 participants, divided into the standard exercise group (n=31) and the FPHF exercise group (n=31). There were no statistically significant between-group differences in any baseline characteristics ($p > 0.05$), indicating effective randomization and a reduced likelihood of confounding effects on treatment outcomes.

Table 2 presents a statistical analysis comparing CVS symptom severity scores between the standard and FPHF exercise groups. At pre-intervention, there were no significant differences in CVS scores between groups ($p > 0.05$). Post-intervention, both groups had significantly reduced total CVS scores ($p < 0.05$). The FPHF group showed significant reductions in headache, eye pain, photophobia, blurred vision, and double vision ($p < 0.05$), while the standard group had significant decreases in headache, eye pain, burning eyes, photophobia, and blurred vision ($p < 0.05$). However, as shown in Table 3, the cumulative CVS scores showed statistically significant differences only within groups when analyzed using the Friedman test with Bonferroni correction.

This study evaluated the impact of eye movements on symptom severity using the VOMS tool (Table 4). Both groups exhibited low baseline severity for headache, dizziness, nausea, and fogginess (median score = 0) and showed no significant post-test changes in almost all domains ($p > 0.05$), except NPC distances. However, the cumulative VOMS scores demonstrated improvement in both groups, with significant improvements observed in the standard group, specifically in horizontal saccades and convergence (Table 5). Furthermore, NPC was analyzed but our study found no improvement after treatment in either group.

Discussion

This study aimed to compare the effects of the FPHF program and standard eye exercises on CVS symptoms and vestibulo-ocular symptoms among Trang Hospital staff. Based on total CVS and VOMS scores, the FPHF group did not differ significantly from the standard group in overall outcomes. However, both interventions demonstrated effectiveness in reducing CVS symptoms and improving vestibulo-ocular function.

Although both interventions had similar effects, their mechanisms of action differ. Standard exercises, based on the concept of visual fatigue from prolonged screen focusing and frequent lens adjustment, aim to relieve eye muscle tension and promote ocular blood flow through near-far focusing[24] while the FPHF program is based on vestibular rehabilitation principles, focusing on improving gaze stability and visual-vestibular integration through coordinated head and eye movements.

The FPHF program is based on vestibular rehabilitation principles, emphasizing stimulation and balance of the inner ear vestibular system, which works closely with the visual system.[25] The vestibular system maintains eye stability and prevents visual images from 'slipping' on the retina's surface as the head position changes. Vestibular dysfunction can manifest as dizziness, motion sensitivity, and impaired gaze stability, which may exacerbate CVS symptoms.[26] The FPHF program also includes coordinating visual input, vestibular input, and proprioception through simultaneous head and eye movements in various planes to stimulate the vestibulo-ocular reflex (VOR). This mechanism promotes gaze stabilization, reduces visual motion sensitivity, and improves postural control.[20]

The effectiveness of vestibular rehabilitation in improving dizziness and balance function has been well-established in the literature. Cochrane Review found that vestibular rehabilitation significantly improved dizziness symptoms and balance function in patients with various vestibular disorders.[20] These findings support the potential benefits of the FPHF program, which incorporates vestibular rehabilitation principles, in managing CVS symptoms. The VOR is a crucial reflex that stabilizes vision during head movements by generating compensatory eye movements in the opposite direction.[27,35]

Table 1. Baseline demographic characteristics of the participants (n=62)

Characteristics	Standard exercise group (n=31) n (%)	FPHF exercise group (n=31) n (%)	Total	*p*-value
Gender				0.86[a]
Male	5 (16.10)	1 (3.20)	6	
Female	26 (83.90)	30 (96.80)	56	
Age				0.86[a]
20-30 years	1 (3.20)	2 (6.50)	3	
31-40 years	8 (25.80)	7 (22.60)	15	
41-50 years	14 (45.20)	12 (38.70)	26	
51-60 years	8 (25.80)	10 (32.30)	18	
Education				0.25[a]
Below diploma	2 (6.50)	1 (3.20)	3	
Diploma	2 (6.50)	4 (12.90)	6	
Bachelor's	24 (77.40)	26 (83.90)	50	
Above bachelor's	3 (9.70)	0 (0.00)	3	
Dominant hand				0.72[a]
Left	4 (12.90)	5 (16.10)	9	
Right	27 (87.10)	26 (83.90)	53	
Vision problems				0.49[a]
No problem	12 (38.70)	12 (38.70)	24	
Myopia	7 (22.60)	7 (22.60)	14	
Hyperopia	9 (29.00)	12 (38.70)	21	
Astigmatism	2 (6.50)	0 (0.00)	2	
Color blindness	1 (3.20)	0 (0.00)	1	
Wearing glasses				0.73[b]
No	17 (54.80)	17 (54.80)	34	
Wearing contact lenses				1.00[b]
Yes	29 (93.50)	29 (93.50)	58	
Daily computer use				1.00[b]
≤ 4 hours/day	4 (12.90)	1 (3.20)	5	
> 4 hours/day	27 (87.10)	30 (96.80)	57	
Musculoskeletal disorders				0.41[a]
No	20 (64.50)	23 (74.20)	43	
Daily sleep duration				0.37[a]
< 4 hours/day	1 (3.20)	0 (0.00)	1	
46 hours/day	6 (19.40)	7 (22.60)	13	
68 hours/day	24 (77.40)	22 (71.00)	46	
> 8 hours/day	0 (0.00)	2 (6.00)	2	
Exercise frequency				0.48[a]
None	3 (9.70)	6 (19.40)	9	
12 times/week	13 (41.90)	15 (48.40)	28	
34 times/week	12 (38.70)	7 (22.60)	19	
> 4 times/week	3 (9.70)	3 (9.70)	6	
Regular medication use				0.78[b]
No	23 (74.20)	21 (67.70)	44	
Underlying diseases				0.80[b]
No	20 (64.50)	18 (58.00)	38	
Eye diseases				1.00[b]
No	30 (96.80)	30 (96.80)	60	
Occupational health training				0.41[b]
No	11 (35.50)	20 (64.50)	31	
Occupational health assessment				0.11[b]
No	16 (51.60)	23 (74.20)	39	

[a], Chi-Square; [b], Fisher's exact test; * *p*-value < 0.05

Impairments in VOR gain or phase can cause retinal slip and oscillopsia, leading to visual disturbances and dizziness.[28] The FPHF exercises aim to enhance VOR adaptation and improve visual-vestibular interaction, which may be disrupted in individuals with CVS.[29] Furthermore, the FPHF program incorporates smooth pursuit and saccadic eye movements, which are essential for tracking moving objects and quickly shifting gaze between targets, respectively.[30] Deficits in these eye movements can impair reading ability, visual search, and attention, contributing to visual fatigue and discomfort.[31] The

Table 2. Comparison of computer vision syndrome (CVS) symptom severity scores between the standard and the five points hand free (FPHF) exercise groups

CVS symptoms	Standard exercise group (n=31)			FPHF exercise group (n=31)		
	Pre Median (IQR)	Post Median (IQR)	Wilcoxon Signed Ranks Test (within group)	Pre Median (IQR)	Post Median (IQR)	Wilcoxon Signed Ranks Test (within group)
1. Headache	1 (0.00-1.00)	0 (0.00-1.00)	$p = 0.00^*$	1 (1.00-1.00)	1 (0.00-1.00)	$p = 0.00^*$
2. Eye pain	1 (1.00-1.00)	0 (0.00-1.00)	$p = 0.00^*$	1 (1.00-2.00)	1 (0.00-1.00)	$p = 0.00^*$
3. Burning eyes	1 (1.00-2.00)	1 (0.00-1.00)	$p = 0.01^*$	1 (1.00-2.00)	1 (0.00-1.00)	$p = 0.14$
4. Eye irritation	1 (0.00-1.00)	0 (0.00-1.00)	$p = 0.10$	1 (0.00-1.00)	1 (0.00-1.00)	$p = 0.10$
5. Dry eyes	1 (0.00-1.00)	0 (0.00-1.00)	$p = 0.32$	1 (0.00-2.00)	1 (0.00-1.00)	$p = 0.40$
6. Tearing	1 (0.00-1.00)	0 (0.00-1.00)	$p = 0.10$	1 (0.00-1.00)	0 (0.00-1.00)	$p = 0.09$
7. Photophobia	1 (0.00-1.00)	0 (0.00-1.00)	$p = 0.00^*$	1 (0.00-1.00)	0 (0.00-1.00)	$p = 0.00^*$
8. Blurred vision	1 (0.00-1.00)	0 (0.00-1.00)	$p = 0.01^*$	1 (0.00-2.00)	1 (0.00-1.00)	$p = 0.00^*$
9. Poor visual acuity	1 (0.00-1.00)	0 (0.00-1.00)	$p = 0.01^*$	1 (1.00-2.00)	1 (0.00-1.00)	$p = 0.02^*$
10. Double vision	0 (0.00-1.00)	0 (0.00-0.00)	$p = 0.10$	1 (0.00-1.00)	0 (0.00-1.00)	$p = 0.02^*$
Total score	9 (4.00-11.00)	3 (1.00-10.00)	$p = 0.00^*$	10 (7.00-13.00)	6 (3.00-9.00)	$p = 0.00^*$

$^*p$-value < 0.05; IQR, inter-quartile range

Table 3. Comparison of cumulative score of the computer vision syndrome (CVS) symptoms between the standard and the five points hand free (FPHF) exercise groups

CVS symptom Cumulative score (0-40) Condition	Median (IQR 1-3)	Mean rank	Friedman test χ^2	*p*-value Post hoc with Bonferroni		
				Asymp. Sig.	Within group	Between group
Pre standard exercise	9.00 (4.00-11.00)	2.77	19.77	< 0.01	0.02*	NS
Post standard exercise	3.00 (1.00-10.00)	1.82				
Pre FPHF exercise	10.00 (7.00-13.00)	3.13			0.05	
Post FPHF exercise	6.00 (3.00-9.00)	2.27				

$^*p$-value < 0.05; CVS; IQR, inter-quartile range; Asmp. Sig., Asymptotic Significance (*p*-value)

FPHF exercises provide a structured approach to train these eye movements and improve visual efficiency.

While traditional eye exercises have primarily focused on alleviating eye muscle strain[4,32], CVS encompasses a range of symptoms both related and unrelated to eye muscle function. These symptoms include headaches, blurred vision, neck pain, fatigue, dry eyes, and dizziness, suggesting that a more comprehensive approach is necessary to address the full spectrum of CVS manifestations. Studies have found that these exercises help alleviate eye strain and CVS to some extent but are limited to the eyes only.[24] These techniques have not been previously studied for their neurological effects associated with CVS.

The lack of significant between-group differences in VOMS scores may be due to several factors. First, the study participants had relatively mild CVS symptoms at baseline, which may have led to a floor effect in the VOMS assessment. Second, the intervention duration of 3 weeks may have been too short to produce substantial changes in vestibular ocular motor function. Third, the VOMS, although a validated screening tool, may need to be more sensitive to detect subtle changes in CVS. Future studies should consider using more comprehensive vestibular and oculomotor assessments, such as videonystagmography, dynamic visual acuity, and gaze stabilization tests.[33]

This study found similar effectiveness between FPHF and standard exercises. While standard exercises effectively reduce specific CVS symptoms, they may not address vestibular aspects. Future research should explore these interventions comprehensively, combining approaches to optimize CVS management in various populations and workplace settings. Limitations of this study include the homogeneity of the sample, mild CVS symptoms, and the short intervention period. Future studies should involve more diverse participants, have extended follow-up periods, and include individuals with pronounced vestibular ocular motor symptoms to better assess long-term efficacy and comprehensive impact.

Table 4. Comparison of vestibular ocular motor screening (VOMS) scores between the standard and the five points hand free (FPHF) exercise groups

Test/symptoms	Standard exercise group (n=31)			FPHF exercise group (n=31)		
	Pre Median (IQR)	Post Median (IQR)	Wilcoxon Signed Ranks Test	Pre Median (IQR)	Post Median (IQR)	Wilcoxon Signed Ranks Test
1. Baseline (pre-VOMS) symptoms						
Headache (0-10)	0 (0.00-3.00)	0 (0.00-0.00)	*p*=0.17	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.38
Dizziness (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.21	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.23
Nausea (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.32	0 (0.00-0.00)	0 (0.00-0.00)	*p*=1.00
Fogginess (0-10)	1 (0.00-4.00)	0 (0.00-1.00)	*p*=0.01*	0 (0.00-6.00)	0 (0.00-4.00)	*p*=0.08
2. Smooth pursuits						
Headache (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.79	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.71
Dizziness (0-10)	0 (0.00-3.00)	0 (0.00-0.00)	*p*=0.01*	0 (0.00-3.00)	0 (0.00-0.00)	*p*=0.02*
Nausea (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.18	0 (0.00-0.00)	0 (0.00-0.00)	*p*=1.00
Fogginess (0-10)	1 (0.00-1.00)	0 (0.00-0.00)	*p*=0.33	0 (0.00-2.00)	0 (0.00-0.00)	*p*=0.02*
3. Saccades – horizontal						
Headache (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.20	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.04*
Dizziness (0-10)	0 (0.00-0.20)	0 (0.00-0.00)	*p*=0.01*	0 (0.00-0.20)	0 (0.00-0.00)	*p*=0.68
Nausea (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.32	0 (0.00-0.00)	0 (0.00-0.00)	*p*=1.00
Fogginess (0-10)	1 (0.00-2.00)	0 (0.00-0.00)	*p*=0.06	0 (0.00-2.00)	0 (0.00-0.00)	*p*=0.02*
4. Saccades – vertical						
Headache (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.07	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.07
Dizziness (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.04*	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.29
Nausea (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.32	0 (0.00-0.00)	0 (0.00-0.00)	*p*=1.00
Fogginess (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.11	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.14
5. VOR – horizontal						
Headache (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.71	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.11
Dizziness (0-10)	0 (0.00-3.00)	0 (0.00-0.00)	*p*=0.01*	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.07
Nausea (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.66	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.32
Fogginess (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.44	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.21
6. VOR – vertical						
Headache (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.11	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.59
Dizziness (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.13	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.10
Nausea (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.32	0 (0.00-0.00)	0 (0.00-0.00)	*p*=1.00
Fogginess (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.55	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.26
7. VMS test						
Headache (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.07	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.32
Dizziness (0-10)	0 (0.00-2.00)	0 (0.00-0.00)	*p*=0.01*	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.21
Nausea (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.18	0 (0.00-0.00)	0 (0.00-0.00)	*p*=1.00
Fogginess (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.21	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.02*
8. Convergence						
Near point (CM.)	15 (7.00-22.50)	17.5 (15.00-22.50)	*p*=0.35	15 (9.00-17.50)	15 (10.00-21.50)	*p*=0.03*
Headache (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.18	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.10
Dizziness (0-10)	0 (0.00-3.00)	0 (0.00-0.00)	*p*=0.01*	0 (0.00-3.00)	0 (0.00-3.00)	*p*=0.72
Nausea (0-10)	0 (0.00-0.00)	0 (0.00-0.00)	*p*=0.18	0 (0.00-0.00)	0 (0.00-0.00)	*p*=1.00
Fogginess (0-10)	0 (0.00-1.00)	0 (0.00-0.00)	*p*=0.01*	0 (0.00-1.00)	0 (0.00-1.00)	*p*=0.03*

*p-value < 0.05; VOR, vestibular ocular reflex; VMS, visual motor sensitivity; IQR, inter-quartile range

Conclusions

The FPHF program demonstrated potential benefits in reducing CVS and vestibulo-ocular symptoms comparable to standard eye exercises. By targeting both visual and vestibular systems, it offers a promising approach for CVS treatment. However, this study found no statistically significant differences in effectiveness between FPHF and standard exercises. Both interventions improved CVS symptoms, suggesting that FPHF could be an effective alternative or complementary approach. Further research, including larger-scale randomized controlled trials with diverse populations and more extended follow-up periods, is needed to establish the long-term effectiveness and generalizability of FPHF. As digital device use continues to rise, exploring innovative interventions like FPHF presents new opportunities for managing CVS in the modern workplace.

Table 5. Comparison of cumulative score of the vestibular ocular motor screening (VOMS) between standard and the five points hand free (FPHF) exercise groups

VOMS Cumulative score (0-40)	Pre standard exercise	Post standard exercise	*p*-value	Pre FPHF exercise	Post FPHF exercise	*p*-value	*p*-value Post hoc with Bonferroni		
	Wilcoxon Signed Ranks Test			Wilcoxon Signed Ranks Test			Within Group SD	Within Group FH	Between group
1. Baseline VOMS[1]	4 (0.00-6.00)	0 (0.00-3.00)	0.02*	2 (0.00-9.00)	0 (0.00-5.00)	0.16	NS	NS	NS
2. Smooth Pursuits[1]	0 (0.00-5.00)	0 (0.00-0.00)	0.02*	0 (0.00-4.00)	0 (0.00-4.00)	0.02*	NS	NS	
3. Saccades-Horizontal[1]	0 (0.00-5.00)	0 (0.00-0.00)	0.00*	0 (0.00-4.00)	0 (0.00-0.00)	0.01*	0.01*	NS	
4. Saccades-Vertical[1]	0 (0.00-3.00)	0 (0.00-0.00)	0.06	0 (0.00-3.00)	0 (0.00-0.00)	0.02*	NS	NS	
5. VOR-Horizontal[1]	0 (0.00-5.00)	0 (0.00-0.00)	0.04*	0 (0.00-2.00)	0 (0.00-0.00)	0.03*	NS	NS	
6. VOR-Vertical[1]	0 (0.00-3.00)	0 (0.00-0.00)	0.07	0 (0.00-3.00)	0 (0.00-0.00)	0.03*	NS	NS	
7. VMS Test[1]	0 (0.00-5.00)	0 (0.00-0.00)	0.01*	0 (0.00-4.00)	0 (0.00-0.00)	0.04*	NS	NS	
8. Convergence	0 (0.00-5.00)	0 (0.00-0.00)	0.01*	0 (0.00-0.00)	0 (0.00-0.00)	0.14	0.01*	NS	
Near point mean (SD)	15.34 (7.68)	16.29 (5.88)	0.44	14.37 (6.61)	16.75 (7.53)	0.03*	-	-	

[1]Data presented in median (inter-quartile range, IQR) **p*-value < 0.05, VOR, vestibular ocular reflex; VMS, Visual Motor Sensitivity;

Disclosure

The authors declare no conflicts of interest related to this study.

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Original Article

Prevalence of and Factors Associated with Depression in Caregivers of Children with Cerebral Palsy

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ABSTRACT

Objectives: To investigate the prevalence of depression in caregivers of children with cerebral palsy including the quality of life of caregivers and factors associated with depression

Study design: Cross-sectional study

Setting: Department of Rehabilitation Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University

Subjects: Ninety-two caregivers of children with cerebral palsy

Methods: Caregivers of children with cerebral palsy were recruited and asked to complete a three-section questionnaire: demographic and personal information of both caregivers and the children they care for, The Patient Health Questionnaire-9 (PHQ-9) Thai version, and The World Health Organization Quality of Life Brief Thai version (WHOQOL-BREF-THAI).

Results: Sixty-three percent of the participants were female, with a median age of 39 and an interquartile range (IQR) of 32-44. The children with cerebral palsy had a median age of 8 years (IQR: 4-11). The prevalence of depression in the primary caregivers of children with cerebral palsy was 20.7%, with statistically significant findings indicating that caregivers of children with cerebral palsy who were non-verbal were more likely to experience depression at a rate 3.4 times higher than caregivers of children who could communicate using language ($p < 0.05$). Overall, the quality of life of the primary caregivers of children with cerebral palsy was moderate (65.5%). Caregivers with depression had significantly lower quality of life scores in all domains with the exception of social relationships.

Conclusions: The prevalence of depression among primary caregivers of children with cerebral palsy at Siriraj Hospital was 20.7%, with lack of language communication of their children with cerebral palsy a significant factor

Keywords: prevalence, cerebral palsy, caregivers, depression, quality of life

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Notice of Correction:
This article has been corrected for duplicated data in Table 1.
See: https://url.in.th/aTXny
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Introduction

Cerebral palsy (CP) is one of the most common neurological disorders in children. According to the Centers for Disease Control and Prevention (CDC), cerebral palsy affects 1 to 4 individuals per 1,000 births, representing 0.1-0.4% of all births.[1] The condition results from abnormalities in brain development during childhood, either during pregnancy or in the early years of life during brain development. Causes include oxygen deprivation, head injuries, meningitis, and near drowning. Cerebral palsy tends to be a persistent and non-progressive condition which can lead to motor control problems, muscle weakness, spasms, and intellectual disability resulting from its impact on brain development during childhood.

Primary caregivers of children with cerebral palsy bear a significant caregiving burden beginning from the birth of the child and involving endless assistance with daily activities and medical care. A study by Basaran in 2013[2] indicated that the quality of life and mental health of primary caregivers of children with cerebral palsy are worse than those of caregivers for typically developing children. Additionally, Srinuan's study,[3] which used the Zarit Burden Interview questionnaire, concluded that 45% of primary caregivers of children with cerebral palsy felt burdened by their responsibilities.

Beyond the challenges of caregiving, studies in many countries have suggest that there is a high prevalence of depression among primary caregivers of children with cerebral palsy. For example, a survey by Farajzadeh[4] found a prevalence of depression of 45%, a study by Sonune[5] reported a prevalence of 82.8%, and a study conducted in Thailand by Hongrapipat[6] found a prevalence of 71.4%. Moreover, these studies stated that depression could negatively impact the caregiver's health, emotions, relationships, and work capabilities and, in severe cases, might even lead to suicidal tendencies.

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Irwin's review[7] found that behavioral family intervention significantly reduced depression in caregivers of individuals with cerebral palsy and that early awareness, prevention, and management of depression in these caregivers is beneficial.

The existing studies of caregiver depression were conducted in many countries where the social, economic, and healthcare system contexts were different from those in Thailand. The study in Thailand by Hongrapipat in 2014[6] included only 28 participants at Surin Hospital, a small sample size, and did not indicate the relationship between the caregiver and the patient. Our study aimed to investigate the prevalence of depression in primary caregivers of children with cerebral palsy in Thailand and to analyze factors associated with caregiver depression, potentially enabling early detection and treatment.

Objectives

Primary outcome

- To investigate the prevalence of depression in primary caregivers of children with cerebral palsy in Siriraj Hospital, Thailand

Secondary outcome

- To identify factors associated with depression in primary caregivers of children with cerebral palsy in Siriraj Hospital, Thailand

- To investigate the levels of quality of life and their association with depression in caregivers of children with cerebral palsy in Siriraj Hospital, Thailand

Methods

Participants and study design

This cross-sectional study was conducted at the Rehabilitation Medicine Outpatient Department Unit of Siriraj Hospital. Primary caregivers of children with cerebral palsy who came to the Rehabilitation Medicine Outpatient Department Unit were invited to participate in the study. They signed an informed consent form prior to beginning the questionnaires. The research assistant provided information about the questionnaires and separated the participants from the children with cerebral palsy while the participants filled out the questionnaires. The inclusion criteria for the participants were: relative and primary caregiver of children with cerebral palsy, age 18-75 years, able to read and understand the Thai language, having cared for children aged 2-18 years old who had had cerebral palsy for more than six months. Caregivers who were diagnosed with a psychiatric disorder (with the exception of a major depressive disorder) were excluded from the study.

The sample size of n=93 was calculated with a significance level of 5%, an allowable error of 0.1, and the reported prevalence of depression among primary caregivers of individuals with cerebral palsy from a previous study, which was 45.0%.[4] A sample size of 103 was required, with a 10% likelihood of being excluded.

The Siriraj Institutional Review Board (No. 450/2565 (IRB2)) approved this study.

Outcome measurements

1. From July 2022 to January 2024, demographic data and personal information of caregivers and children with cerebral palsy were obtained through questionnaires and medical records.

2. Patient Health Questionnaire-9 (PHQ-9) scores was obtained using The Patient Health Questionnaire-9 (PHQ-9) Thai version[8] which consists of 9 questions about symptoms in the previous two weeks and the frequency of each symptom. Each symptom was assigned a score of 0-3 points, where 0 points indicating no occurrence, 1 point for a few days but not often, 2 points for quite often, and 3 points for almost every day. Total scores ranged from 0-27 points. A score ≥ 9 indicates depression and a score < 9 indicates no depression.

3. The quality of life (QOL) level was obtained using the World Health Organization Quality of Life Brief Thai version (WHOQOL-BREF-THAI).[9] The questionnaire consisted of 26 questions covering four aspects of QOL as follows: Physical Health (questions 2, 3, 4, 10, 11, 12, 24), Mental Health (questions 5, 6, 7, 8, 9, 23), Social Relationships (questions 13, 14, 25), and Environmental health (questions 15, 16, 17, 18, 19, 20, 21, 22). Questions 1 and 26 also served as a measure of overall QOL. For questions with negative connotations (2, 9, 11), the scoring was as follows: 1 (highest), 2 (high), 3 (moderate), 4 (low), 5 (not at all). For the remaining positively worded questions, the scoring was 1 (not at all), 2 (low), 3 (moderate), 4 (high), 5 (highest). The overall QOL score, ranging from 26 to 130 points, can be interpreted as follows: 26-60 points (poor QOL), 61-95 points (moderate QOL), and 96-130 points (good QOL).

Statistical methods

The demographic data of caregivers and cerebral palsy patients were described using descriptive statistics and are presented as frequency, percentage, mean, standard deviation (SD), median and interquartile range (IQR). The prevalence of depression obtained by the questionnaire is presented as a percentage. Factors associated with the PHQ-9 depression (cut-off value ≥ 9 for depression) were evaluated using logistic regression analysis. We compared the means of the WHOQOL-BREF scores between caregivers in the with and without depression groups using the independent sample T-test. A *p*-value less than 0.05 was considered statistically significant. Statistical analyses were performed using IBM SPSS Statistics version 28.0 for Windows, IBM Corporation, Armonk, NY, USA.

Results

Characteristics

Participants included 92 caregivers of children aged between 2 and 18 with cerebral palsy. The demographic data

Table 1. Demographic data of the children with cerebral palsy

Characteristics of the children (n=92)	Median (IQR) or number (%)
Age in years[1]	8 (4, 11)
Gender[2]	
Male	51 (55.4)
Epilepsy[2]	
Yes	19 (20.7)
Communication[2]	
Non-verbal	53 (57.6)
Verbal	39 (42.4)
Participated in school[2]	
No	50 (54.3)
Route of feeding[2]	
Oral	78 (84.8)
Tube feeding	14 (15.2)
CP type[2]	
Spastic diplegia	38 (41.3)
Spastic hemiplegia	18 (19.6)
Spastic quadriplegia	35 (41.3)
Other	1 (1.1)
GMFCS level[2]	
I	9 (9.8)
II	18 (19.6)
III	16 (17.4)
IV	22 (23.9)
V	27 (29.3)

[1]Median (interquartile rage, IQR); [2]mumber (%); CP, cerebral palsy; GMFCS, Gross Motor Function Classification System

Table 2. Demographic data of caregivers of children with cerebral palsy

Caregivers' characteristics	Median (IQR) or number (%)
Age in years[1]	39.0 (32.0, 44.0)
Gender[2]	
Female	82 (89.1)
Relationship to the children	
Father	8 (8.7)
Mother	69 (75)
Others	15 (16.3)
Marital status[2]	
Married	67 (72.8)
Divorced/single	25 (27.2)
Education[2]	
Below bachelor's degree	56 (60.9)
At least a bachelor's degree	36 (39.1)
Employment[2]	
Employed	51 (55.4)
Unemployed	41 (44.6)
Income[2]	
0-20,000 baht/month	61 (66.3)
More than 20,000 baht/month	31 (33.7)
Health problems[2]	
Yes	22 (23.9)
Another dependent family member requiring care	
Yes	27 (29.3)

[1]Median (IQR, interquartile rage); [2]mumber (%)

of the children with cerebral palsy are shown in Table 1. The median age of the children was 8 years (IQR: 4, 11). Fifty-three of the children with cerebral palsy (57.6%) were unable to communicate verbally. Most of the children with cerebral palsy could eat through their mouths (84.8%), while the remaining 15.2% relied on tube feeding. Ten percent (n=9) of the participating children were diagnosed at the Gross Motor Function Classification System (GMFCS) level I, 19.6% (n=18) at level II, 17.4% (n=16) at level III, 23.9% (n=22) at level IV, and 29.3% (n=27) at level V.

The median age of caregivers was 39 years (IQR: 32.0, 44.0). Among the 92 caregivers, 89.1% were female, 72.8% were married, 55.4% were employed, 39.1% had at least a bachelor's degree, 33.7% had an income of more than 20,000 baht per month, and 76.1% had no health problems.

Prevalence of depression

The 92 participants' PHQ-9 scores ranged from 0 to 14 points, with a median of 5 points (IQR: 3 to 8). Utilizing a cut-off value of ≥ 9 for depression, the prevalence of depression was 20.7% (n = 19) (Table 3).

Quality of life

Table 3 shows the quality of life of caregivers of children with cerebral palsy. The study found that most of the sample group had a moderate overall quality of life (65.2%), followed by a good quality of life (34.8%). Considering the quality of life across all four domains, it was found that most participants had a moderate quality of life in terms of physical health, mental health, social relationships, and environmental domains (62.0%, 50.0%, 63.0%, 66.3% respectively).

Association between demographic characteristics and depression

The characteristics of caregivers and the children with cerebral palsy are presented in Tables 4 and 5 according to the presence of depression in the caregivers. The majority of caregivers experiencing depression were found among those who cared for children with cerebral palsy who were unable to communicate verbally and who were classified as GMFCS level IV-V (78.9% and 68.4%, respectively). All caregivers in the depression group were female. The majority of caregivers experiencing depression were mothers of the patient, married, had an education below a bachelor's degree, and reported no health problems (89.5%, 73.7%, 63.2%, and 73.7%, respectively).

The degree of association between demographic characteristics of children with cerebral palsy and depression in caregivers was analyzed using binary logistic regression (Table 4). The odds of depression among caregivers of non-verbally communicating cerebral palsy children was 3.4 times higher than among caregivers of verbally communicating cerebral palsy children (*p*-value = 0.042, OR = 3.4, 95% CI: 1.05-11.41). However, other demographic characteristics of

Table 3. Demographic data of caregivers of children with cerebral palsy

Health status and quality of life	Characteristics	Number (%)
Depression	No (PHQ-9 score 0-8)	73 (79.3)
	Yes (PHQ-9 score ≥ 9)	19 (20.7)
WHO-QOL brief Thai domain		
Physical health	Poor	2 (2.2)
	Moderate	57 (62.0)
	Good	33 (35.9)
Mental health	Poor	0 (0.0)
	Moderate	46 (50.0)
	Good	46 (50.0)
Social relationships	Poor	5 (5.4)
	Moderate	58 (63.0)
	Good	29 (31.5)
Environmental Health	Poor	2 (2.2)
	Moderate	61 (66.3)
	Good	29 (31.5)
Overall quality of life	Poor	0 (0.0)
	Moderate	60 (65.2)
	Good	32 (34.8)

Median (interquartile rage, IQR); PHQ-9, The Patient Health Questionnaire-9; WHOQOL, he World Health Organization Quality of Life

children with cerebral palsy were not statistically significantly associated with depression in caregivers.

The degree of association between demographic characteristics of caregivers and caregiver depression was analyzed by binary logistic regression (Table 5). All caregivers with depression were female; the lack of a control group of male caregivers limits the ability to make definitive conclusions. There was no significant association between the various variables and depression in caregivers.

The association between WHOQOL-BREF domains and PHQ-9 scores is shown in Table 6. Caregivers without depression (PHQ-9 score ≤ 9) had a statistically significantly higher overall quality of life score than the caregivers with depression (PHQ-9 score > 9). The mean WHOQOL-BREF scores of each domain were statistically significantly lower for caregivers with depression, except for the social relationships domain.

Discussion

This study found a 20.7% incidence of depression among caregivers of children with cerebral palsy. Caregivers of non-verbal or minimally verbal children were three times more likely to experience depression compared to those caring for verbally communicative children, a statistically significant

Table 4. Characteristics of children associated with depression of caregivers (n=92)

Characteristics of children	Number of caregivers (%)		OR (95%CI)	*p*-value
	Without depression (n=73)	With depression (n=19)		
Age				0.704
2 to 6 years	30 (41.7)	10 (52.6)	1.27	
6 to 10 years	23 (31.9)	4 (21.1)	0.66	
More than 10 years	19 (26.4)	5 (26.3)	1	
Gender				0.429
Female	31 (42.5)	10 (52.6)	1.50 (0.55-4.15)	
Epilepsy				0.748
Yes	15 (20.5)	4 (21.1)	1.03 (0.30-3.57)	
Communication				0.042
Non-verbal	38 (52.1)	15 (78.9)	3.45 (1.05-11.41)	
Participated in school				0.728
No	39 (53.4)	11 (57.9)	1	
Route of feeding				0.430
Oral	63 (86.3)	15 (78.9)	1	
Tube feeding	10 (13.7)	4 (21.1)	1.68 (0.46-6.10)	
CP type				N/A
Spastic diplegia	30 (41.1)	8 (42.1)	1.33 (0.31-5.77)	
Spastic hemiplegia	15 (20.5)	3 (15.8)	1	
Spastic quadriplegia	27 (37.0)	8 (42.1)	1.48 (0.34-6.44)	
Other	1 (1.4)	0 (0.0)	N/A	
GMFCS level				0.143
I-III	37 (50.7)	6 (31.6)	1	
IV-V	36 (49.3)	13 (68.4)	2.23 (0.76-6.50)	

OR, odd ratio; CI, confident interval; CP, cerebral palsy; GMFCS, Gross Motor Function Classification System

Table 5. Characteristics of children associated with depression of caregivers (n=92)

Caregiver characteristics	Number of caregivers (%)		OR (95%CI)	*p*-value
	Without depression (n=73)	With depression (n=19)		
Age				0.417
Under 25 years	4 (5.5)	3 (15.8)	3.00 (0.21-42.62)	
26 to 60 years	65 (89.0)	15 (78.9)	0.92 (0.10-8.86)	
> 60 years	4 (5.5)	1 (5.3)	1	
Gender				N/A
Female	63 (86.3)	19 (100.0)	N/A	
Relationship to the children				0.119
Mother	52 (71.2)	17 (89.5)	3.43 (0.73-16.18)	
Father/Other relative	21 (28.8)	2 (10.5)	1	
Marital status				0.925
Divorced/Single	20 (27.4)	5 (26.3)	0.95 (0.30-2.97)	
Education				0.819
Below bachelor's degree	44 (60.3)	12 (63.2)	1.13 (0.40-3.21)	
At least a bachelor's degree	29 (39.7)	7 (36.8)	1	
Employment				0.809
Unemployed	33 (45.2)	8 (42.1)	0.88 (0.32-2.45)	
Income				0.386
0-20,000 baht/month	50 (68.5)	11 (57.9)	0.63 (0.22-1.78)	
More than 20,000 baht/month	23 (31.5)	8 (42.1)	1	
Health problems				0.783
Yes	17 (23.3)	5 (26.3)	1.18 (0.37-3.74)	
Having another dependent family member requiring care				0.156
Yes	24 (32.9)	3 (15.8)	0.38 (0.10-1.44)	

OR, odd ratio; CI, confident interval; N/A, not applicable

Table 6. Demographic data of caregivers of children with cerebral palsy

WHO-QOL brief Thai domain	No depression (n=73) (PHQ-9 ≤ 9) Mean (SD)	Depression (n=19) PHQ-9 > 9 Mean (SD)	*p*-value
Physical health	26.08 (3.64)	22.42 (4.11)	<0.001
Mental health	23.25 (2.97)	19.63 (2.73)	<0.001
Social relationships	10.81 (1.96)	10.11 (1.79)	0.161
Environmental health	27.78 (4.13)	25.47 (4.20)	0.033
Overall quality of life	94.97 (11.55)	84.21 (12.26)	0.001

Median (IQR, interquartile rage); PHQ-9, The Patient Health Questionnaire-9; WHOQOL, The World Health Organization Quality of Life

finding. The study also suggests that the prevalence of depression tends to be higher among female caregivers, particularly mothers, though this was not statistically significant. Depression prevalence was 26.5% among caregivers of children at GMFCS levels IV and V, compared to 14.0% for children at GMFCS levels I, II, and III, but this difference was not statistically significant. Additionally, caregivers with depression had significantly lower WHOQOL-BREF scores in all domains except social relationships. Most caregivers reported a moderate overall quality of life.

Our study found a notably lower prevalence of depression compared to the 71.4% reported by Hongrapipat in 2018[6] which involved a small sample of 28 participants. This substantial difference may be due to methodological variations, including sample size. The smaller sample in the previous study might have biased the findings and overstated depression rates. Also, the Hongrapipat study involved primarily children with severe impairments (GMFCS levels IV-V) who are more likely to experience communication issues than those with less severe impairments (GMFCS I-III).[10] The differences in participant characteristics and the level of medical care – quaternary in our study versus tertiary in the previous study – may also help account for the differences in prevalence rates.

Caregivers of non-verbal or minimally verbal children with cerebral palsy are more likely to experience depression, as highlighted by Unsal-Delialioglu's 2009 study[11] which found that mothers' depression was significantly affected by their children's speech problems.

Hewawitharana et al.[12] (2023) found that the GMFCS level of children with cerebral palsy significantly predicts caregiver burden. Basaran (2013) also linked the severity of

functional limitations in these children to caregivers' mental health and quality of life.[2] Our study found that 26.5% of caregivers of children at GMFCS levels IV and V experienced depression, compared to 14.0% for those at levels I, II, and III. These results, consistent with Gugala's 2019 study[13], suggest that lower GMFCS levels are associated with increased likelihood of caregiver depression, though statistical significance was not reached.

Our study found that the mean WHOQOL-BREF scores for caregivers with depression were consistent with the previous findings of Arrieta.[14] The quality of life of caregivers of children with cerebral palsy impacts both the well-being of the care giver and the care provided to the children. Pandit's 2021 study[15] in Nepal found that most primary caregivers had a poor quality of life. Basaran's 2013 study[2] reported moderate overall quality of life levels among caregivers, which aligns with our results.

One strength of this study is that it was executed at a major tertiary and quaternary-care medical center, marking the first exploration of this topic at Siriraj Hospital. Our findings suggest that assessing a child's language ability may help identify caregiver depression, potentially guiding future prevention and treatment strategies.

It is essential, however, to also acknowledge the limitations of this study. Multiple factors can influence depression, adding an additional level of complexity to the analysis. The study was conducted at a single hospital center. Additionally, the majority of participants were female and had no health problems. Finally, differences in cultural attitudes toward disability and social support systems could affect caregiver depression. As a result, these results may not accurately reflect or generalize the condition of participants of all genders or represent the entire population of Thailand.

Furthermore, this was a cross-sectional study. Longitudinal, multicenter studies are needed to establish the factors associated with depression among caregivers of children with cerebral palsy.

Conclusions

The prevalence of depression among primary caregivers of children with cerebral palsy in Thailand is 20.7%. Factors related to depression among primary caregivers include the child's ability to use language for communication. The majority of caregivers of children with cerebral palsy reported a moderate overall quality of life. The group of primary caregivers experiencing depression tended to have lower average scores in all quality-of-life domains with the exception of the social relationships domain.

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Original Article

Clinical Competency Needs of Physiatrists in Thailand: A Cross-Sectional Study

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ABSTRACT

Objectives: To determine the degree to which the clinical competency needs of Thai practicing physiatrists in the current rehabilitation medicine residency curriculum align with topics validated by the Board of Training and Examination in Rehabilitation Medicine of Thailand

Study design: Cross-sectional study

Setting: Department of Rehabilitation Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand

Subjects: Total Thai physiatrists in 2020-2021

Methods: A total of 731 physiatrists in Thailand were surveyed using the questionnaire which was composed of two parts. The first part covered participants' characteristics. The second part included 96 rehabilitation medicine topics which had been validated by the Board of Training and Examination in Rehabilitation Medicine of Thailand. Participants rated each of the topics on a four-point (1-4) Likert scale for both "Frequency" and "Importance". Frequency refers to how often the participant applied each topic in their practice and importance refers to the significance of each topic in their clinical practice.

Results: The response rate was 15.3% (112/731). The five most frequently encountered conditions rated 4 were low back pain (N=86.6%), osteoarthritis of the knee (N=83.0%), stroke (N=79.5%), spondylosis/spondylolisthesis (N=78.6%), and radiculopathy (N=70.5%). The five most essential conditions rated 4 were stroke (N=87.5%), osteoarthritis of the knee (N=79.5%), low back pain (N=78.6%), chronic pain (N=75.9%), and radiculopathy (N=75.0%).

Conclusions: The survey provides essential information which the Royal College of Physiatrists of Thailand and could use to help improve the curriculum content for entrustable professional activities.

Keywords: physical and rehabilitation medicine, education, medical, graduate, professional practice, program evaluation

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Introduction

Medical education is a science characterized by continuous improvement. Competency-based medical education (CBME) is a paradigm that conceptualizes curriculum competencies and focuses on the development of learners.[1] The key components of an educational curriculum are objectives, learning, and evaluation. In CBME, the evaluation process is based on the concept of entrustment to ensure the professional competency of students and trainees. Entrustable professional activities (EPAs) are tasks or responsibilities that can be entrusted to a trainee once they have sufficient specific competence to allow unsupervised practice.[2] EPAs are now crucial for assessing competency in on-the-job or clinical undergraduate and postgraduate medical education activities.[3] The advantages of EPAs include integrating several competencies into one EPA, promoting patient safety by confirming that learners can complete an activity without supervision and enabling learners to compare their progress to standard milestones and EPAs.[4]

Rehabilitation medicine residency training is a postgraduate program that provides training in diagnosing and managing various conditions, including those affecting special populations and all age groups. In Thailand, the Royal College of Physiatrists of Thailand (RCPhysiatrT) has transitioned the curriculum to be a competency-based medical education which includes competencies in areas such as patient care, medical knowledge and practical skills, interpersonal and communication skills, practice-based learning and improvement, professionalism, and system-based practice. To develop residents into entrustable physiatrists for Thai society, EPAs have become essential for assessing residents' competencies during training. According to the development of curriculum and clinical practices, a previous study in the United States (U.S.) by the Association of Academic Physiatrists conducted a study which proposed the grouping typical clinical activities

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into nineteen EPAs carried out by residents in physical medicine and rehabilitation (PM&R) in their practices.[5] Additionally, a study in the U.S. supported the idea that electrodiagnostic EPAs in the curriculum demonstrated potential as tools for evaluating the observational abilities of PM&R residents in the outpatient context.[6] Additionally, the another previous study in the U.S. developed observable professional activities in the spinal cord injury EPAs for the PM&R residents to practice in a real-life setting.[7] According to another survey in the U.S., creating a rehabilitation global health curriculum that PM&R residents can access could offer chances for resident improvement, strengthen connections with foreign partners, and increase the accessibility of rehabilitation services to older adults.[8]

In the Thai context, the Board of Training and Examination in Rehabilitation Medicine (TERM) under the Royal College of Physiatrists of Thailand listed thirteen EPAs during curriculum development in 2018-2019. However, those epidemiological changes, social contexts, and technological revolutions have disrupted the current health system.[9] In response, a wide range of conditions have been included in the curriculum. To ensure the clinical practice content is relevant and meets societal needs, it is important to survey PM&R members in Thailand. However, the RCPhysiatrT had not previously conducted such a survey. The present study is the first of its kind in Thailand. It was conducted with the objective of determining the degree to which the clinical competency needs of Thai practicing physiatrists under the current rehabilitation medicine residency curriculum align with topics validated by the Board of Training and Examination in Rehabilitation Medicine.

Methods

Study design

This cross-sectional study was conducted at the Department of Rehabilitation Medicine, Siriraj Hospital, Thailand. The protocol for the study was approved by the Siriraj Institutional Review Board (SIRB), Faculty of Medicine Siriraj Hospital, Mahidol University (COA no. SI 789/2019).

Participants

All 731 members of the Royal College of Physiatrists of Thailand at the time of the study were invited to participate by filling out a Google Forms questionnaire via group email and the Line social media application between 2020-2021. The researcher sent the documents to the RCPhysiatrT for permission to distribute the online questionnaire to the members. Then the secretaries of the RCPhysiatrT sent the online questionnaire as an e-mail attachment to all members. The researchers and the secretaries also sent the online questionnaire to all current members of the Thai physiatrist group using the Line social media application. Responding to the confidential online surveys involved participants reading a general introduction page, selecting the "next" option, and indicating their consent to complete the surveys.

Outcome measurements

The questionnaire consisted of two parts. The first part focused on the participants' characteristics, and the second part included ninety-six rehabilitation medicine topics from the Thai curriculum of rehabilitation medicine residency training program curriculum. Adapted from a previous study[10], participants rated each topic on two aspects, "frequency" and "importance," using a four-category rating scale. Frequency refers to how often respondents applied each topic during their clinical practice as physiatrists. The frequency domain scores ranged from 1: "never or rarely used the knowledge"; 2: "used the knowledge in a few cases"; 3: "used the knowledge sometimes"; and 4: "used the knowledge very often". Importance refers to the respondent's estimation of the significance of each topic in their clinical practice as physiatrists. In the importance domain, the scores consisted of 1: "unimportant," 2: "somewhat important," 3: "moderately important," and 4: "very important."

Statistical methods

Descriptive statistics were used to analyze the data. The basic characteristics of the participants were reported as frequencies and percentages. Frequencies and percentages were also used for the frequency and importance of content. The internal consistency and reliability of the questionnaire was evaluated using Cronbach's alpha. Data analyses were performed using the Statistical Package for the Social Sciences (SPSS) for Windows 18.0. The statistical significance level was set at a $p < 0.05$.

Results

Basic characteristics of participants

The overall response rate was 15.3% (112/731). Female participants comprised 64.3% of the respondents, and most respondents were currently working in university hospitals (31.3%). Regarding years of experience post-graduation, the largest group had less than five years of experience (30.4%). Most participants had performed electrodiagnosis in their current work (81.3%). Other characteristics are shown in Table 1.

Frequency of application and importance of the topics

The frequency of application of each of the ninety-six topics during clinical practice by participating physiatrists rated with a score of 4 ranged from 0% to 86.6%. The Cronbach's alpha for the frequency domain of the questionnaire was 0.959.

The ten most frequently encountered medical conditions with a score of 4 were low back pain (N=86.6%), osteoarthritis of the knee (N=83.0%), stroke (N=79.5%), spondylosis/spondylolisthesis (N=78.6%), radiculopathy (N=70.5%), chronic pain

Table 1. Basic characteristics of participants

Characteristics	N (%)
Gender	
Male	40 (35.7)
Female	72 (64.3)
Age (years)	
30-35	36 (32.1)
36-40	31 (27.7)
40-65	45 (40.2)
Currently working in the rehabilitation field	
Yes	109 (97.3)
Hospital type	
University Hospital	35 (31.3)
Center hospital	29 (25.9)
Provincial hospital	13 (11.6)
District hospital	8 (7.1)
Private hospital	20 (17.9)
Others	7 (6.2)
Years since rehabilitation board graduation	
Less than 5 years	34 (30.4)
5-9 years	30 (26.8)
10-15 years	18 (16.1)
16-20 years	8 (7.1)
More than 20 years	22 (19.6)
Rehabilitation clinic practice (days/week)	
0-3	46 (41.1)
4-7	66 (58.9)
Have a rehabilitation ward in their current hospital	
Yes	32 (28.6)
No ward, but rehabilitation inpatients can be admitted to other wards	42 (37.5)
No	38 (33.9)
Inpatient care	
Yes	104 (92.9)
Perform electrodiagnosis in current work	
Yes	91 (81.3)

(N=66.1%), inpatient consultation (N=61.6%), tendinopathy (N=59.8%), medical certificate for disability (N=58.9%), and fracture (N=55.4%). The five least frequently encountered medical conditions with a score of 1 were doping (N=57.1%), osteogenesis imperfecta (N=54.5%), toe pressure index (N= 50.9%), arthrogryposis multiplex congenita (N=48.2%), and juvenile idiopathic arthritis (N=42.9%). Details are shown in Table 2.

The importance of the ninety-six topics rated with a score of 4 by participants based on their experience ranged from 8% to 87.5%. The Cronbach's alpha for the importance domain of the questionnaire was 0.98. The ten most important medical conditions with a rating score of 4 were stroke (N=87.5%), osteoarthritis of knee (N=79.5%), low back pain (N=78.6%), chronic pain (N=75.9%), radiculopathy (N=75.0%), swallowing (N=68.8%), spondylosis/spondylolisthesis (N=67.9%), inpatient consultation (N=67.0%), spinal cord injury (N=66.1%), and medical certificate for disability (N=64.3%). The five least important medical conditions with rated score 1 were angiogram (N=20.5%), doping, osteogenesis imperfecta (N= 19.6%), toe pressure index (N=18.8%), and arthrogryposis multiplex congenita (N=17.0%). Details are shown in Table 2.

Discussion

Thai physiatrists provided valuable insights based on their clinical practice experience. Overall, while almost all topics were deemed important for physiatrists, the frequency of actually encountering these topics varied according to their different clinical practice experiences.

This discussion addresses the issues included in the EPAs of RCPhysiatrT for the year 2021. The results of this study highlight the high frequency and importance of stroke rehabilitation, which align with the RCPhysiatrT's 2021 recom-

Table 2. Frequency and importance of rehabilitation topics

Topic	Frequency (number (%))				Importance (number (%))			
	Never or rarely used the knowledge	Used the knowledge in a few cases	Used the knowledge sometimes	Used the knowledge very often	Unimportant	Somewhat important	Moderately important	Very important
Stroke	1 (0.9)	2 (1.8)	20 (17.9)	89 (79.5)	1 (0.9)	1 (0.9)	12 (10.7)	98 (87.5)
Amputee								
Amputee-upper limb	17 (15.2)	78 (69.6)	10 (8.9)	7 (6.3)	10 (8.9)	27 (24.1)	51 (45.5)	24 (21.4)
Amputee-lower limb (partial foot)	12 (10.7)	63 (56.3)	29 (25.9)	8 (7.1)	7 (6.3)	38 (33.9)	44 (39.3)	23 (20.5)
Amputee-lower limb (transtibial)	7 (6.3)	30 (26.8)	44 (39.3)	31 (27.7)	4 (3.6)	13 (11.6)	45 (40.2)	50 (44.6)
Amputee-lower limb (transfemoral)	6 (5.4)	46 (41.1)	41 (36.6)	19 (17.0)	4 (3.6)	17 (15.2)	45 (40.2)	46 (41.1)
Musculoskeletal conditions								
Low back pain	0 (0.0)	2 (1.8)	13 (11.6)	97 (86.6)	0 (0.0)	1 (0.9)	23 (20.5)	88 (78.6)
Systemic lupus erythematosus	16 (14.3)	82 (73.2)	10 (8.9)	4 (3.6)	8 (7.1)	55 (49.1)	38 (33.9)	11 (9.8)
Tendinopathy	1 (0.9)	7 (6.3)	37 (33.0)	67 (59.8)	1 (0.9)	5 (4.5)	39 (34.8)	67 (59.8)
Other soft tissue injuries	1 (0.9)	16 (14.3)	45 (40.2)	50 (44.6)	1 (0.9)	12 (10.7)	47 (42.0)	52 (46.4)
Musculoskeletal ultrasound	27 (24.1)	47 (42.0)	25 (22.3)	13 (11.6)	6 (5.4)	30 (26.8)	55 (49.1)	21 (18.8)
Rheumatoid arthritis	3 (2.7)	68 (60.7)	36 (32.1)	5 (4.5)	2 (1.8)	24 (21.4)	67 (59.8)	19 (17.0)
Seronegative spondyloarthropathy	7 (6.3)	86 (76.8)	18 (16.1)	1 (0.9)	5 (4.5)	32 (28.6)	61 (54.5)	14 (12.5)
Osteoarthritis of hip	1 (0.9)	69 (61.6)	36 (32.1)	6 (5.4)	2 (1.8)	19 (17.0)	69 (61.6)	22 (19.6)
Osteoarthritis of knee	1 (0.9)	5 (4.5)	13 (11.6)	93 (83.0)	1 (0.9)	5 (4.5)	17 (15.2)	89 (79.5)
Calcium pyrophosphate deposition diseases	9 (8.0)	76 (67.9)	23 (20.5)	4 (3.6)	3 (2.7)	45 (40.2)	49 (43.8)	15 (13.4)
Other arthritis	6 (5.4)	55 (49.1)	40 (35.7)	11 (9.8)	4 (3.6)	41 (36.6)	46 (41.1)	21 (18.8)

Table 2. Frequency and importance of rehabilitation topics (continued)

Topic	Frequency (number (%))				Importance (number (%))			
	Never or rarely used the knowledge	Used the knowledge in a few cases	Used the knowledge sometimes	Used the knowledge very often	Unimportant	Somewhat important	Moderately important	Very important
Orthopedic conditions								
Fracture	2 (1.8)	16 (14.3)	32 (28.6)	62 (55.4)	1 (0.9)	10 (8.9)	33 (29.5)	68 (60.7)
Post arthroplasty	1 (0.9)	20 (17.9)	40 (35.7)	51 (45.5)	1 (0.9)	9 (8.0)	41 (36.6)	61 (54.5)
Post-muscle/nerve/tendon transfer	7 (6.3)	75 (67.0)	21 (18.8)	9 (8.0)	1 (0.9)	26 (23.2)	53 (47.3)	32 (28.6)
Spondylosis/Spondylolisthesis	0 (0.0)	5 (4.5)	19 (17.0)	88 (78.6)	0 (0.0)	6 (5.4)	30 (26.8)	76 (67.9)
Osteopenia/ Osteoporosis	1 (0.9)	24 (21.4)	51 (45.5)	36 (32.1)	1 (0.9)	8 (7.1)	50 (44.6)	53 (47.3)
Brain disorders								
Traumatic brain injury	1 (0.9)	34 (30.4)	50 (44.6)	27 (24.1)	1 (0.9)	7 (6.3)	40 (35.7)	64 (57.1)
Parkinson's disease	1 (0.9)	52 (46.4)	46 (41.1)	13 (11.6)	1 (0.9)	15 (13.4)	67 (59.8)	29 (25.9)
Dementia	5 (4.5)	48 (42.9)	45 (40.2)	14 (12.5)	1 (0.9)	26 (23.2)	59 (52.7)	26 (23.2)
Brain tumor	4 (3.6)	78 (69.6)	23 (20.5)	7 (6.3)	1 (0.9)	30 (26.8)	57 (50.9)	24 (21.4)
Spinal cord disorders								
Axial pain	3 (2.7)	34 (30.4)	47 (42.0)	28 (25.0)	2 (1.8)	18 (16.1)	60 (53.6)	32 (28.6)
Myelopathy	2 (1.8)	55 (49.1)	43 (38.4)	12 (10.7)	1 (0.9)	13 (11.6)	48 (42.9)	50 (44.6)
Neoplastic	7 (6.3)	67 (59.8)	28 (25.0)	10 (8.9)	5 (4.5)	33 (29.5)	53 (47.3)	21 (18.8)
Myelodysplasia	27 (24.1)	76 (67.9)	8 (7.1)	1 (0.9)	11 (9.8)	53 (47.3)	32 (28.6)	16 (14.3)
Post-traumatic syringomyelia	28 (25.0)	78 (69.6)	6 (5.4)	0 (0.0)	8 (7.1)	42 (37.5)	46 (41.1)	16 (14.3)
Spinal cord injury	2 (1.8)	44 (39.3)	44 (39.3)	22 (19.6)	1 (0.9)	7 (6.3)	30 (26.8)	74 (66.1)
Urodynamic test for spinal cord injury	28 (25.0)	52 (46.4)	23 (20.5)	9 (8.0)	5 (4.5)	24 (21.4)	56 (50.0)	27 (24.1)
Peripheral neurological disorders								
Radiculopathy	1 (0.9)	3 (2.7)	29 (25.9)	79 (70.5)	1 (0.9)	4 (3.6)	23 (20.5)	84 (75.0)
Plexopathy	1 (0.9)	50 (44.6)	35 (31.3)	26 (23.2)	1 (0.9)	10 (8.9)	51 (45.5)	50 (44.6)
Motor neuron disease	6 (5.4)	80 (71.4)	22 (19.6)	4 (3.6)	1 (0.9)	23 (20.5)	53 (47.3)	35 (31.3)
Neuromuscular junction disorder	3 (2.7)	83 (74.1)	23 (20.5)	3 (2.7)	1 (0.9)	33 (29.5)	50 (44.6)	28 (25.0)
Myopathy	3 (2.7)	68 (60.7)	38 (33.9)	3 (2.7)	1 (0.9)	25 (22.3)	53 (47.3)	33 (29.5)
Mononeuropathy	2 (1.8)	29 (25.9)	37 (33.0)	44 (39.3)	2 (1.8)	12 (10.7)	36 (32.1)	62 (55.4)
Polyneuropathy	1 (0.9)	16 (14.3)	54 (48.2)	41 (36.6)	1 (0.9)	10 (8.9)	49 (43.8)	52 (46.4)
Peripheral demyelinating disease (GBS, CIDP)	4 (3.6)	60 (53.6)	39 (34.8)	9 (8.0)	1 (0.9)	15 (13.4)	45 (40.2)	51 (45.5)
Peripheral vascular diseases								
Ankle-brachial index	14 (12.5)	60 (53.6)	30 (26.8)	8 (7.1)	5 (4.5)	27 (24.1)	57 (50.9)	23 (20.5)
Toe pressure index	57 (50.9)	49 (43.8)	4 (3.6)	2 (1.8)	21 (18.8)	53 (47.3)	25 (22.3)	13 (11.6)
Doppler ultrasound	40 (35.7)	50 (44.6)	20 (17.9)	2 (1.8)	18 (16.1)	46 (41.1)	35 (31.3)	13 (11.6)
Angiogram	42 (37.5)	54 (48.2)	14 (12.5)	2 (1.8)	23 (20.5)	49 (43.8)	27 (24.1)	13 (11.6)
Deep vein thrombosis	7 (6.3)	63 (56.3)	33 (29.5)	9 (8.0)	4 (3.6)	12 (10.7)	49 (43.8)	47 (42.0)
Peripheral arterial disease	6 (5.4)	64 (57.1)	30 (26.8)	12 (10.7)	3 (2.7)	15 (13.4)	60 (53.6)	34 (30.4)
Lymphatic disease	8 (7.1)	76 (67.9)	25 (22.3)	3 (2.7)	2 (1.8)	35 (31.3)	58 (51.8)	17 (15.2)
Pulmonary embolism	12 (10.7)	84 (75.0)	12 (10.7)	4 (3.6)	4 (3.6)	18 (16.1)	45 (40.2)	45 (40.2)
Sports medicine and rehabilitation								
Sport nutrition	38 (33.9)	49 (43.8)	20 (17.9)	5 (4.5)	10 (8.9)	42 (37.5)	38 (33.9)	22 (19.6)
Doping	64 (57.1)	44 (39.3)	3 (2.7)	1 (0.9)	22 (19.6)	60 (53.6)	21 (18.8)	9 (8.0)
Ergogenic aids	34 (30.4)	49 (43.8)	20 (17.9)	9 (8.0)	16 (14.3)	37 (33.0)	37 (33.0)	22 (19.6)
Sports for people or athletes with disabilities	40 (35.7)	53 (47.3)	16 (14.3)	3 (2.7)	12 (10.7)	44 (39.3)	30 (26.8)	26 (23.2)
Sport-related concussion	44 (39.3)	51 (45.5)	15 (13.4)	2 (1.8)	13 (11.6)	36 (32.1)	42 (37.5)	21 (18.8)
Cancer rehabilitation								
Paraneoplastic syndrome	18 (16.1)	68 (60.7)	22 (19.6)	4 (3.6)	6 (5.4)	38 (33.9)	52 (46.4)	16 (14.3)
Palliative care	5 (4.5)	42 (37.5)	41 (36.6)	24 (21.4)	3 (2.7)	24 (21.4)	45 (40.2)	40 (35.7)
Lymphedema	6 (5.4)	72 (64.3)	28 (25.0)	6 (5.4)	3 (2.7)	34 (30.4)	58 (51.8)	17 (15.2)
Pain in cancer patient	8 (7.1)	50 (44.6)	42 (37.5)	12 (10.7)	3 (2.7)	21 (18.8)	54 (48.2)	34 (30.4)
Geriatric rehabilitation								
Cognitive impairment	3 (2.7)	23 (20.5)	57 (50.9)	29 (25.9)	1 (0.9)	13 (11.6)	52 (46.4)	46 (41.1)
Depression, anxiety	2 (1.8)	31 (27.7)	57 (50.9)	22 (19.6)	1 (0.9)	17 (15.2)	58 (51.8)	36 (32.1)

Table 2. Frequency and importance of rehabilitation topics (continued)

Topic	Frequency (number (%))				Importance (number (%))			
	Never or rarely used the knowledge	Used the knowledge in a few cases	Used the knowledge sometimes	Used the knowledge very often	Unimportant	Somewhat important	Moderately important	Very important
Pediatric rehabilitation								
Cerebral palsy	6 (5.4)	66 (58.9)	32 (28.6)	8 (7.1)	2 (1.8)	20 (17.9)	60 (53.6)	30 (26.8)
Spida bifida and myelomeningocele	27 (24.1)	69 (61.6)	11 (9.8)	5 (4.5)	11 (9.8)	30 (26.8)	43 (38.4)	28 (25.0)
Spinal muscular atrophy	41 (36.6)	67 (59.8)	1 (0.9)	3 (2.7)	12 (10.7)	37 (33.0)	46 (41.1)	17 (15.2)
Duchenne and Becker muscular dystrophy	36 (32.1)	69 (61.6)	5 (4.5)	2 (1.8)	11 (9.8)	34 (30.4)	48 (42.9)	19 (17.0)
Poliomyelitis	19 (17.0)	87 (77.7)	5 (4.5)	1 (0.9)	9 (8.0)	37 (33.0)	48 (42.9)	18 (16.1)
Arthrogryposis multiplex congenital	54 (48.2)	50 (44.6)	7 (6.3)	1 (0.9)	19 (17.0)	42 (37.5)	36 (32.1)	15 (13.4)
Autism	26 (23.2)	51 (45.5)	29 (25.9)	6 (5.4)	8 (7.1)	37 (33.0)	46 (41.1)	21 (18.8)
Juvenile idiopathic arthritis	48 (42.9)	55 (49.1)	7 (6.3)	2 (1.8)	18 (16.1)	47 (42.0)	34 (30.4)	13 (11.6)
Congenital limb deficiencies	30 (26.8)	68 (60.7)	12 (10.7)	2 (1.8)	16 (14.3)	29 (25.9)	45 (40.2)	22 (19.6)
Idiopathic scoliosis	3 (2.7)	56 (50.0)	36 (32.1)	17 (15.2)	2 (1.8)	13 (11.6)	58 (51.8)	39 (34.8)
Developmental dysplasia of the hip	38 (33.9)	64 (57.1)	7 (6.3)	3 (2.7)	12 (10.7)	29 (25.9)	54 (48.2)	17 (15.2)
Osteogenesis imperfecta	61 (54.5)	48 (42.9)	2 (1.8)	1 (0.9)	22 (19.6)	44 (39.3)	37 (33.0)	9 (8.0)
Hemophilia	38 (33.9)	63 (56.3)	9 (8.0)	2 (1.8)	14 (12.5)	30 (26.8)	44 (39.3)	24 (21.4)
Down syndrome	22 (19.6)	60 (53.6)	27 (24.1)	3 (2.7)	9 (8.0)	39 (34.8)	54 (48.2)	10 (8.9)
Advanced technology								
Transcranial magnetic stimulation	38 (33.9)	48 (42.9)	16 (14.3)	10 (8.9)	12 (10.7)	36 (32.1)	43 (38.4)	21 (18.8)
Others								
Burn rehabilitation	9 (8.0)	72 (64.3)	26 (23.2)	5 (4.5)	4 (3.6)	12 (10.7)	55 (49.1)	41 (36.6)
Chemodenervation/Chemoneurolysis	26 (23.2)	46 (41.1)	32 (28.6)	8 (7.1)	9 (8.0)	24 (21.4)	46 (41.1)	33 (29.5)
Spasticity	1 (0.9)	7 (6.3)	57 (50.9)	47 (42.0)	1 (0.9)	2 (1.8)	45 (40.2)	64 (57.1)
Multiple sclerosis	10 (8.9)	87 (77.7)	12 (10.7)	3 (2.7)	6 (5.4)	24 (21.4)	58 (51.8)	24 (21.4)
Post-polio syndrome	25 (22.3)	76 (67.9)	9 (8.0)	2 (1.8)	6 (5.4)	44 (39.3)	44 (39.3)	18 (16.1)
Amyotrophic lateral sclerosis	13 (11.6)	75 (67.0)	23 (20.5)	1 (0.9)	2 (1.8)	29 (25.9)	55 (49.1)	26 (23.2)
Chronic pain	0 (0.0)	5 (4.5)	33 (29.5)	74 (66.1)	0 (0.0)	3 (2.7)	24 (21.4)	85 (75.9)
Prosthesis and orthoses	3 (2.7)	24 (21.4)	41 (36.6)	44 (39.3)	1 (0.9)	6 (5.4)	44 (39.3)	61 (54.5)
Swallowing	1 (0.9)	7 (6.3)	45 (40.2)	59 (52.7)	1 (0.9)	4 (3.6)	30 (26.8)	77 (68.8)
Pressure ulcer	2 (1.8)	17 (15.2)	49 (43.8)	44 (39.3)	1 (0.9)	11 (9.8)	38 (33.9)	62 (55.4)
Sexual rehabilitation	46 (41.1)	58 (51.8)	7 (6.3)	1 (0.9)	16 (14.3)	43 (38.4)	37 (33.0)	16 (14.3)
Kinesiology	21 (18.8)	53 (47.3)	25 (22.3)	13 (11.6)	12 (10.7)	26 (23.2)	52 (46.4)	22 (19.6)
Chronic obstructive pulmonary disease	3 (2.7)	38 (33.9)	46 (41.1)	25 (22.3)	3 (2.7)	11 (9.8)	54 (48.2)	44 (39.3)
Medical certificate for disability	5 (4.5)	14 (12.5)	27 (24.1)	66 (58.9)	1 (0.9)	8 (7.1)	31 (27.7)	72 (64.3)
Electrodiagnosis	6 (5.4)	15 (13.4)	42 (37.5)	49 (43.8)	1 (0.9)	5 (4.5)	41 (36.6)	65 (58.0)
Diabetic foot examination	8 (7.1)	22 (19.6)	45 (40.2)	37 (33.0)	3 (2.7)	5 (4.5)	42 (37.5)	62 (55.4)
Interdisciplinary team meeting	8 (7.1)	33 (29.5)	46 (41.1)	25 (22.3)	2 (1.8)	8 (7.1)	50 (44.6)	52 (46.4)
Ability to care for patients in a rehabilitation ward	5 (4.5)	11 (9.8)	48 (42.9)	48 (42.9)	2 (1.8)	4 (3.6)	37 (33.0)	69 (61.6)
Management of functional impairment and disability	3 (2.7)	10 (8.9)	49 (43.8)	50 (44.6)	1 (0.9)	6 (5.4)	38 (33.9)	67 (59.8)
Coordinating patient referrals between hospitals	4 (3.6)	30 (26.8)	44 (39.3)	34 (30.4)	1 (0.9)	10 (8.9)	47 (42.0)	54 (48.2)
Inpatient consultation	3 (2.7)	8 (7.1)	32 (28.6)	69 (61.6)	2 (1.8)	5 (4.5)	30 (26.8)	75 (67.0)
Improving quality and safety	2 (1.8)	18 (16.1)	42 (37.5)	50 (44.6)	1 (0.9)	8 (7.1)	36 (32.1)	67 (59.8)

mendations. The prevalence of stroke in Thailand further underscores the importance of this focus.[11] According to a previous study in the U.S., evaluating and managing the rehabilitation needs of patients following stroke is essential for residency training in physical medicine and rehabilitation.[5]

Among pain-related conditions, low back pain, tendinopathy, other soft tissue injuries, osteoarthritis of the knee, spondylosis/spondylolisthesis, radiculopathy, and chronic pain were identified as having both high frequency and high importance. These findings support the EPAs of RCPhysiatrT which require evaluation of musculoskeletal pain, neuropathic pain, and chronic pain, and include skills such as dry needling, trigger point injection, and intra-articular or soft tissue injection. These results are also consistent with a previous

study from the U.S. which found that evaluating and managing patients with musculoskeletal syndromes requires a residency curriculum.[5]

In this study, spinal cord injury (SCI) cases were deemed highly important but infrequent, while urodynamic tests for spinal cord injury were regarded as both low frequency and low importance. This difference may be due to the working environment of the responders, as the institutions of only 28.6% had a rehabilitation ward, and in some hospitals, urologists conducted the urodynamic test. This finding indicates a need for increased attention to SCI patient care to prevent complications. Therefore, skills for coordinating patient referrals to higher-level hospitals with more specialized equipment and personnel should be considered for inclusion in the curriculum.

Electrodiagnosis has been rated as a frequently needed and important skill for physiatrists. In the current study, most participants had performed electrodiagnosis. In response, RCPhysiatrT has developed an online course for electrodiagnosis for all residents in Thailand to address this skill gap. Additionally, radiculopathy has been rated as a frequent and important condition, where electrodiagnosis is a key tool for confirming a radiculopathy diagnosis. According to a previous study in the U.S.[6], EPAs for electrodiagnosis provide useful evaluations in outpatient departments. Introducing residents to competency assessment in electrodiagnosis can help set learning goals and enhance understanding of feedback concepts.

Geriatric rehabilitation has been identified as a common and important domain relevant to the global society.[12] Other conditions in the geriatric domain, including osteoarthritis of the knee[13], stroke[14], and swallowing problems[15], are also prevalent in older patients in Thailand. However, RCPhysiatrT does not currently include geriatric rehabilitation in the main domain of EPAs. The data on the present situation in Thailand indicate that geriatric rehabilitation should be considered for incorporation in the next revision of the EPAs.

Pediatric rehabilitation has been rated as a less common and less important domain. This rating may be due to the low prevalence of pediatric diseases and to the low fertility rate in Thailand.[16] Cases are usually referred to university hospitals for treatment. However, encountering pediatric disabilities can be challenging, so the curriculum should include skills for residents on appropriate treatment of these patients.[17] While sports rehabilitation was also rated as less common and less important, orthopedic doctors might typically treat patients with sports-related conditions. However, exercise and sports for individuals with disabilities are emerging trends in rehabilitation.[18] Integrating these topics into the curriculum would highlight their significance to learners. Interestingly, in this research doping was rated as the least frequent and least important topic. This rating may be due to the fact that Thai physiatrists are not directly responsible for controlling doping. In Thailand, the Doping Control Agency has both the authority and the duty to regulate athletes to preserve the competitive spirit and to safeguard their health.[19]

The respondents in the present study were from various hospital types and had diverse experiences in the rehabilitation field in Thailand, providing practical data for program development and evaluation in rehabilitation medicine. Nevertheless, using this data should proceed cautiously due to the differing contexts in health systems and technologies across countries. Additionally, a limitation of this survey was that only 15% of RCPhysiatrT members participated in the study. Due to the small number of responses, subgroup analysis was not performed. Furthermore, most respondents were physiatrists working in university hospitals or center hospitals. Only patients who could access these hospitals were seen by physiatrists. The “frequency” and “importance” of contents were used as an indirect measure of the clinical competency needs of physiatrists in Thailand. However, patients who need rehabilitation may be unable to travel to hospitals providing those services. Additionally, conditions mentioned by the Board of Training and Examination in Rehabilitation Medicine can also be treated by doctors who are not physiatrists; it is thus possible that patients who need rehabilitation may not be referred to and be seen by physiatrists and will have thus missed opportunities to receive rehabilitation services.

Conclusions

Low back pain, osteoarthritis of the knee, stroke, spondylosis/spondylolisthesis, and radiculopathy are the most frequent conditions, and stroke, osteoarthritis of the knee, low back pain, chronic pain, and radiculopathy are essential contents for rehabilitation medicine according to the views of Thai physiatrists. This study provides updated essential information to help RCPhysiatrT to improve the curriculum in the next revision.

Disclosure

There are no conflicts of interest to report.

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Original Article

Correlation Between 6-Minute Walk Distance, Severity of Airflow Limitation and Dyspnea Score in COPD Patients: A Retrospective Study

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ABSTRACT

Objectives: To determine the correlation between 6-minute walk distance (6MWD) and severity of airflow limitation as well as modified Medical Research Council (mMRC) dyspnea score in Chronic obstructive pulmonary disease (COPD) patients

Study design: Retrospective study

Setting: Outpatient Rehabilitation Clinic, Trang Hospital.

Subjects: Patients diagnosed with COPD who completed the 6-minute walk test (6MWT) between January 1, 2022 and December 31, 2023.

Methods: The patients' baseline characteristics were obtained from medical records. The Forced Expiratory Volume in one second (FEV_1), 6MWD, and mMRC dyspnea scores were collected and analyzed.

Results: One hundred and ninety-seven patients with COPD were recruited, of whom 91.9% were male. The average 6MWD was 403.4 meters (SD=78.4). Half the patients had moderate COPD. The majority of the patients had an mMRC dyspnea score of 1. There was a weak positive correlation between 6MWD and FEV_1 ($r = 0.299$, $p < 0.001$) and a weak negative correlation between 6MWD and mMRC dyspnea score ($r = -0.266$, $p < 0.001$). However, there was a strong negative correlation between 6MWD and the mMRC dyspnea score ($r = -0.727$, $p < 0.05$) in patients with very severe degree COPD.

Conclusions: The study showed a significant weak correlation between 6MWD and FEV_1 as well as 6MWD and mMRC dyspnea score. However, in patients with very severe COPD, the correlation between 6MWD and mMRC dyspnea score was stronger than in others. This suggests that 6MWT and mMRC dyspnea score should be routinely evaluated in patients with COPD to monitor clinical change.

Keywords: chronic obstructive pulmonary disease, 6-minute walk distance, dyspnea score, forced expiratory volume in one second

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Introduction

Chronic obstructive pulmonary disease (COPD) is one of the three leading causes of death worldwide, and 90% of these deaths occur in low- and middle-income countries. More than 3 million people died of COPD in 2012, accounting for 6% of all deaths globally.[1] According to Thailand's medical and public health data center, there were 473,214 COPD patients in 2023, with 13,522 new COPD cases, an increase from the 8,014 new cases in 2022. In 2023, a total of 20,888 patients died of COPD, a rate which continued to increase from 2021 and 2022.[2] For this reason, COPD, a significant public health challenge that is both preventable and treatable, has led to one of the service plans for health system development projects in the field of non-communicable diseases in 2017 which is aimed at reducing the incidence of acute exacerbations and establishing comprehensive and standardized COPD clinics.[3]

COPD is a heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, coughing, sputum production including exacerbation of those symptoms) due to abnormalities of the airways (bronchitis, bronchiolitis) or alveoli (emphysema) that cause persistent, often progressive, airflow obstruction. COPD is usually caused by significant exposure to noxious particles or gases.[1] From airway inflammation and abnormal inflammatory response in the lung, these pathological changes result in increased resistance to airflow in the small conducting airways, air trapping, and progressive airflow obstruction, which affects gas exchange, causing hypercapnia and hypoxemia, resulting in dyspnea.[4,5] COPD should be considered if the patient has difficulty breathing, chronic cough with or without sputum, and frequent lower respiratory tract infections with a history of exposure to risk factors. According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guideline, spirometry is the gold standard for diagnosing COPD. If the ratio of forced expiratory volume in one second (FEV_1) to forced vital capacity (FVC) is less than 70% after bronchodilator administration, the patient is diagnosed with COPD.[1]

COPD severity can be classified based on airflow limitation using the FEV_1. GOLD grade I (mild degree) is defined as a FEV_1 equal to or greater than 80% of the predicted value; GOLD grade II (moderate degree) as an FEV_1 between 50%

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and 79% of the predicted value; GOLD grade III (severe degree) as an FEV_1 between 30% and 49% of the predicted value; and GOLD grade IV (very severe degree) as an FEV_1 equal to or less than 30% of the predicted value.[1] Lower FEV_1 indicates greater severity of the disease. However, many studies have shown that FEV_1 correlates with disease severity less than other clinical parameters such as dyspnea, quality of life, and functional capacity.[6] That suggests FEV_1 should not be used alone to assess disease severity.

Dyspnea is the most common symptom of COPD. The modified Medical Research Council (mMRC) dyspnea score is used to assess dyspnea and is based on five stages of dyspnea ranging from 0 (No dyspnea) to exertion 4 (dyspnea at rest). The mMRC dyspnea score is closely related to other multidimensional health status measures and can be used to predict future mortality risk.[1]

The 6-minute walk distance (6MWD) is a field test used to assess the functional status of patients with COPD. It was introduced in 1976 as a 12-minute walk test to measure exercise capacity for patients with chronic lung disease and was later reduced to six minutes. The 6-minute walk test (6MWT) can be used as a clinical, functional capacity indicator. The purpose of the 6MWT is to evaluate exercise tolerance, monitor therapy, and predict prognosis in patients with chronic respiratory diseases like COPD, interstitial lung disease (ILD), pulmonary hypertension (PH), chronic heart failure, lung transplant and heart-lung surgery as well as to evaluate the functional capacity of the elderly.[7] The test measures walking distance in six minutes at maximal intensity, reflecting the patient's functional exercise capacity for daily physical activity. 6MWT is a reproducible, simple, and inexpensive test. Studies have also found that the 6MWD can be used to monitor clinical changes in COPD better than the FEV_1, which is a less sensitive parameter for detecting clinical changes, especially in the late stage of the disease.[8] A study by Pinto-Plata et al. [9] showed that the level of exercise capacity was a better predictor of mortality than FEV_1. However, other studies have found that many factors can affect exercise capacity in COPD patients. For example, there are pulmonary and non-pulmonary factors associated with a reduced 6MWT performance. Some non-pulmonary factors, such as mMRC dyspnea score and depression score, are more important to and more consistently associated with walking distance compared to the pulmonary parameters.[6,9]

Spirometry is a noninvasive test for diagnosing and assessing airflow limitation in COPD; however, it is not available in every hospital due to a lack of personnel and equipment. Moreover, it takes time to evaluate, making it less convenient for outpatient visits. In contrast, the 6MWT and assessment of dyspnea by mMRC dyspnea scores is easier to conduct and can be performed in all hospitals including those in rural areas. Studies of the correlation between the 6MWD and the severity of airflow limitation as indicated by FEV_1, as well as the mMRC dyspnea score, are still limited in Thailand. The present study aimed to explore these correlations in COPD patients classified by severity level and to use that information for planning future management.

Method

Study design

This research was a retrospective study. The protocol of the study was approved by the Trang Hospital Research Ethics Committee (Certificate No. ID 006/02-2567).

Participants

The study was carried out in Trang Hospital's Rehabilitation Medicine Department. Patients diagnosed with COPD (GOLD criteria) between January 1, 2022 and December 31, 2023, and who were referred for 6MWT by pulmonologists were included in the study. Pulmonologists performed spirometry on all patients within three months of referring them for the 6-minute walk test (6MWT). The 6MWT was completed following the ATS guidelines.[10] At the start of the test, the patient's vital signs were taken, including blood pressure, heart rate, and respiratory rate. The Borg rating of perceived exertion scale (Borg scale), mMRC dyspnea score, and oxygen saturation were also recorded. Patients were encouraged to walk along a flat hospital corridor as rapidly as possible for six minutes. At the end of the test, vital signs, the Borg scale, and oxygen saturation were re-recorded. The distance walked was measured in meters. The patients were observed for 15 minutes following the test to assess any problems. All data were recorded in the hospital's database system.

In this study, the researcher reviewed hospital electronic medical records. COPD patients aged 40 years or older who had completed 6MWT were eligible for the study. Patients were excluded if they were unable to finish the exam.

Variables for statistical analysis

The following data were retrieved from the patients' medical records: baseline characteristics including gender, age, weight and height (for calculating body mass index or BMI), underlying diseases, history of smoking (pack-years), FEV_1/FVC, FEV_1% predicted, modified Medical Research Council Scale for dyspnea (mMRC) and 6-minute walk distance (6MWD) results.

Statistical analysis

All data was analyzed using the R statistical program version 4.3.2. Descriptive statistics, including percentage, frequency, mean and standard deviation (SD), median, and quartile, were used to describe baseline characteristics. The Pearson correlation coefficient (r) was used to evaluate the correlation between 6MWD and FEV_1 and between 6MWD and mMRC dyspnea scores. A *p*-value of less than 0.05 was considered to be clinically significant.

Results

Among the 197 patients with COPD at Trang Hospital who met the inclusion criteria of the study, 181 were male (91.9%) and 16 were female (8.1%). The average age was 69.6 years, and the average FEV_1 was 61.7%. Of these patients, 50.3% had a moderate degree COPD, 26.4% had a severe degree COPD, and 19.3% had a mild degree COPD. The average 6MWD for all patients was 403.4 meters, classified by airflow limitation as mild degree COPD (448.1 meters), moderate degree COPD (396.3 meters), severe degree COPD (401.9 meters), and very severe degree COPD (288.8 meters). Most patients had an mMRC dyspnea score of 1 (Table 1).

Overall, there was a statistically significant positive correlation between 6MWD and FEV_1 ($p < 0.001$). When analyzed by the degree of airflow limitation, patients with moderate to very severe degree COPD showed a positive correlation between 6MWD and FEV_1. However, the correlation was statistically significant only for those with moderate degree COPD ($p < 0.005$) (Table 2).

Both patients with mild or very severe degrees COPD showed a significant correlation between 6MWD and the mMRC dyspnea score. The correlation was particularly strong in very severe degree patients ($r = -0.727$, $p < 0.05$) (Table 2).[11]

Table 1. Baseline characteristics

Variable	N = 197
Age (years)[1]	69.6 (8.7)
Gender[2]	
Male	181 (91.9)
Female	16 (8.1)
BMI, (kg/m^2) [1]	22.2 (3.7)
Smoking (pack-years)[3]	23 (12,40)
mMRC dyspnea score[2]	
0	28 (14.2)
1	143 (72.6)
2	22 (11.2)
3	4 (2.0)
GOLD classification[2]	
GOLD I (mild)	38 (19.3)
GOLD II (moderate)	99 (50.3)
GOLD III (severe)	52 (26.4)
GOLD IV (very severe)	8 (4.1)
FEV_1/FVC[3]	0.6 (0.5, 0.6)
FEV_1%predicted[1]	61.7 (20.1)
GOLD I (mild)	90.9(10.0)
GOLD II (moderate)	64.2 (8.6)
GOLD III (severe)	40.9 (6.3)
GOLD IV (very severe)	24.9 (4.1)
Underlying diseases[2]	
Diabetes mellitus	7 (3.6)
Hypertension	29 (14.7)
Dyslipidemia	17 (8.6)
Cardiovascular disease	8 (4.1)
Musculoskeletal	7 (3.6)
Others	9 (4.6)
6MWD (meters)[1]	403.4 (78.4)
GOLD I (mild)	448.1 (70.3)
GOLD II (moderate)	396.3 (72.2)
GOLD III (severe)	401.9 (65.8)
GOLD IV (very severe)	288.8 (121.8)

[1]Mean (SD), [2]Number (%), [3]Median (IQR)

BMI, body mass index; mMRC, modified Medical Research Council; GOLD, global initiative for chronic obstructive lung disease; FEV_1, forced expiratory volume in one second; FVC, forced vital capacity; 6MWD, 6-minute walk distance

Table 2. Correlation coefficient between 6MWD and both FEV_1 and mMRC dyspnea scores

6MWD	FEV_1		mMRC	
	r[1]	*p*-value	r[1]	*p*-value
All (N=197)	0.299	<0.001	-0.266	<0.001
GOLD classification				
I (N=38)	-0.301	0.066	-0.332	0.041
II (N=99)	0.232	0.020	-0.121	0.231
III (N=52)	0.139	0.324	-0.126	0.371
IV (N=8)	0.008	0.985	-0.727	0.040

[1]Pearson correlation coefficient, statistically significant at $p < 0.05$

Discussion

The study found that the average 6MWD was highest in mild degree patients and lowest in those with very severe degree COPD. This result is in line with a study by C. Casanova et al.[8] which explored changes in 6MWD in 294 COPD patients over five years. A significant decline in 6MWD was found in severe and very severe degree COPD patients. The reason is that in advanced COPD, there is often muscle atrophy, loss of fat-free mass, deconditioning, and peripheral muscle weakness leading to exercise intolerance. In addition, the 6MWD depends on multiple factors, not only on the severity of lung function, but also on extrapulmonary manifestations such as age, comorbidities, nutritional status, and psychological condition which can also affect the 6MWD.

Overall, there was a statistically significant positive correlation between FEV_1 and 6MWD, indicating that patients with higher FEV_1 likely also have higher 6MWD. However, these correlations showed only weak relationships. These results are consistent with the study by Agrawal MB et al.[12] which reported a weak positive correlation between 6MWD and FEV_1, a result similar to that of Pinto-Plata et al.[9] which noted a weak correlation between 6MWD and FEV_1. Examination of the data on COPD severity in this study found a significant correlation only in patients with moderate COPD. This finding suggests that 6MWD depends on multiple factors, as noted above. Thus, patients with the same FEV_1 may eventually have different 6MWD, which is consistent with the findings of Chauhan NK et al.[13] and Karanth MP et al.[14], which found no statistical correlation between 6MWD and FEV_1, and is similar to a study by C. Casanova et al.[8] which found that the decline in 6MWD increased with disease severity. In contrast, the decline in FEV_1 was smaller in patients with more severe degrees due to the low FEV_1 in advanced COPD.

The mMRC dyspnea score also has a statistically significant negative correlation with 6MWD ($p < 0.001$). This correlation is particularly strong in patients with very severe degree COPD ($p < 0.05$), similar to the findings of Zeng GH et al.[15] which noted a significant correlation between 6MWD and mMRC as well as Chen H et al.[16] which concluded that in cases of very severe degree COPD, 6MWD has a significant negative correlation with the dyspnea scale. The present study suggests that patients with a higher dyspnea score (higher mMRC) probably tend to walk shorter distances independent of changes in FEV_1.

Spirometry remains the standard for diagnosing and assessing the severity of airflow limitation in COPD patients. However, spirometry may not be available in all hospitals due to limitations of personnel and equipment. For that reason, conducting the 6MWT annually in COPD patients is beneficial for monitoring disease progression, especially in patients with severe or very severe degrees COPD. The FEV_1 behaves as a more rigid and less sensitive parameter for detecting clinical changes which can be used with patients when it is not possible to perform spirometry. This finding is consistent with the study by C. Casanova et al.[8] which suggested that the 6MWD is particularly helpful in long-term evaluations, especially in patients with severe and very severe degrees of COPD. This study does have some limitations. First, this was a retrospective study, meaning the researcher could not select the study participants, there was a disparity in the ratio of males and females. Second, 50.3% of the patients had moderate degree COPD, and only 4.1% had very severe degree COPD. A future prospective study should be conducted to include an equal distribution across all levels of severity of COPD and gender.

Conclusions

In conclusion, 6MWD decreases as pulmonary function declines. The study showed a significant weak positive correlation between 6MWD and FEV_1 and a negative correlation between 6MWD and mMRC dyspnea score. In patients with very severe degree COPD, the correlation between 6MWD and mMRC dyspnea score was stronger than in others. The author suggests that 6MWT, and mMRC dyspnea score should be routinely evaluated in patients with COPD, especially in those with severe and very severe degree, to monitor clinical change.

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