Ergonomic Management and Muscle Strengthening in Thai Aged Farmers with Knee Osteoarthritis

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Background: Ergonomic hazards are the most important causes of knee osteoarthritis (OA) in aged para rubber farmers. Ergonomic management comprising working condition improvement and muscle strengthening exercise has been well-documented in terms of workers’ health benefit. However, those interventions were not adequate to sustain the advantage. Few studies have demonstrated the effect of integrating participatory ergonomic management (PEM) in Non-Weight-Bearing Exercise (NWE) and Progressive Resistance Exercise (PRE) and none has focused on aged para rubber farmers with knee osteoarthritis. This study investigated the effect of PEM-NWE, PEM-PRE and standard treatment (STG) on self-care and functional ability in the aged population.

Methods: A single-blinded, clustered randomized controlled trial was carried out. Participants (n =75) from 3 different communities in southern Thailand were randomly assigned to PEM-NWE, PEM-PRE, and STG. Self-care and functional ability (pain, stiffness, and physical function) were examined at baseline (B), during the intervention at week 5 (W5) and after its completion at week 9 (W9). Mean comparison of those outcomes overtime was made using Generalized Linear Mixed Models (GLMM).

Results: Compared to the standard treatment, the means both groups PEM-NWE and PEM-PRE were significantly increased in self-care. However, no significant difference between PEM-NWE and PEM-PRE was found.

Conclusions: Either or both interventions should be incorporated into nursing practice in order to promote occupational health and enhance quality of work life for the Thai aged farmers. The further study on their cost-effectiveness is highly recommended.

Key words: aged para rubber farmers, knee osteoarthritis, participatory ergonomic, self-care, functional ability
Introduction

The rising prevalence of functional impairment with age increases the potential impact of knee osteoarthritis (OA) upon health care. The association of knee OA with increasing obesity, sequela of joint injury, and occupational risk factors has been established. Generally, aged para rubber farmers in Thailand habitually tasks that involve perform high loading intensity on the knee from inappropriate postures and repetitive muscle work. Squatting or kneeling is usually performed during low tapping, molding, or filtering latex while knee bending is observed during knife sharpening. In addition, heavy lifting or carrying is found in the latex handling process. According to a problems survey of the population, approximately 38% of aged para rubber farmers reported knee pain related to occupational activities. Moreover, the impacts of those hazards on their occupational activities are the leading cause of functional impairment, loss of work productivity, and disability.

To improve physical function and occupational performance, ergonomic management comprising joint protection strategies related to modified working conditions and muscle strengthening exercise have been well-documented on workers’ health benefit especially in persons with knee osteoarthritis. However, ergonomic intervention focusing improvement of working conditions only may not be sufficient for the aged individuals in enhancing functional ability. Combination of the measure with muscle strengthening exercise need to be performed.

According to the Cochrane review on exercise for osteoarthritis of the knee, both Non-Weight-Bearing Exercise (NWE) and Progressive Resistance Exercise (PRE) reduce pain and increase functional ability in older individuals. Compared to PRE, NWE is more effective for short-term reduction of pain in people with knee OA, whereas PRE specifically improves physical functioning, strength and performance of either simple or complex activities, and reduces adverse events including muscle strain and joint pain from excessive weight. However, the benefit of both exercise types on functional ability remains unclear.

In addition, a systematic review found that participatory ergonomic approaches (PEA) could significantly maximize workers’ health outcomes such as musculoskeletal symptom relief and muscle injury prevention. The main concept of PEA is that self-care behavioral promotion requires strategies for enhancing ergonomic management, and helps to overcome barriers of behavioral changes. PEA processes comprise raising risk awareness and attitudes towards ergonomic measures by problem-solving approaches. Consequently, solution
implementation will be carried out for enhancing ability to change behaviors\textsuperscript{12}. Thus, the theory of self-care operations: estimative, transitive, and productive operations\textsuperscript{13} was adopted to enhance the PEA processes.

However, the existing knowledge of integrating effect of PEA and strengthening exercises (NWE and PRE) is limited. This study developed those strategies in ergonomic management for investigating the effect of PEA-NWE, PEA-PRE, and standard treatment on self-care and functional ability in aged para rubber farmers with knee OA. It might be worthwhile in terms of cost effectiveness and efficacy of the intervention to promote self-care and functional ability for the population.

**Study design**

Three primary care units (PCUs) were randomly allocated to one or other of 3 intervention arms, comprising PEM-NWE, PEM-PRE, and STG conducted over an 8-week periods, during January to March 2015 after approval by Research Ethics Committee of Faculty of Medicine, Prince of Songkhla University.

**Subjects**

Fifty Para rubber farmers aged $\geq$ 60 years who currently had symptomatic knee OA as determined by the clinical and radiographic criteria of the American College of Rheumatology\textsuperscript{14} and the Kellgren-Lawrence radiographic grading scale (less than 4) were selected from each 3 PCUs. Patients with a history of major knee injury, knee surgery or steroid injection; having a contraindication to strengthening exercise such as uncontrolled hypertension, inflamed knee during exercise, cognitive dysfunction, or planning for knee surgery were excluded. All potential participants were informed about: the study purpose; what their participation would involve; confidentiality and autonomy issues; and, the right to withdraw at any time. Those who agreed to participate were asked to sign a consent form. Evaluators were blinded to the intervention received. All participants completed the study program to which they were allocated.

**Interventions**

A pretest of participants’ demographics, self-care behaviors and functional ability was performed in PEM-NWE, PEM-PRE, and STG groups. STG received usual care services based on
standard protocols coupled with 2-hour boosted educational session, whereas PEM-NWE and PEM-PRE received both center-based and home-based activities as follows.

Center-based interventions were held at community centers.

1. Twenty-minute job hazard analysis: group discussion using flip chart on ergonomic risk factors in working process that increase severity of knee OA such as low level tapping, knife sharpening and latex manual handling and their self-care management was performed.

2. One hour-health education session: A 20-minute teaching and a 40-minute exercise demonstration on ergonomic management (working conditions and muscle strengthening exercise) through participatory group discussion.

3. Thirty-minute mutual goal setting: The identified risks factors from job hazard analysis and actions that needed to be performed were analyzed. Individual goals and action plans were designed into daily living activities under the supervision of ergonomists, physical therapists and nurse practitioners. Ten-minute guiding for self-monitoring record on ergonomic management using logbook was provided.

Home-based interventions were conducted every other week.

Thirty-minute home visits were carried out for providing guidance and support. The participants’ ergonomic management barriers were analyzed and alternatives were suggested and participants encouraged implementing in their daily livings.

**Exercise procedures**

Regarding to the procedures of both exercise programs, all participants were required to complete their own exercise programs at least 3 days per week for 8 weeks. Both exercise programs were designed to increase lower extremity muscle strength bilaterally around hip and knee joints.

The exercise sessions included at least 3 sets of 10 repetitions of 9 exercises. Each exercise started with dynamic movement through the full range of motion and continued to a 10-second hold static movement at the end of the range of movement. The repetitions and durations of exercises were self-prescribed by participants based on PEM.

In the PRE group, intensity was based on participants’ ability to execute a maximum of 10 repetitions (10 RM). Sandbags were used for the weight increments starting from 50% of 10 RM in the 1st-2nd week and increasing to 75% of 10 RM in the 3rd-4th week and reaching to 100% of
10 RM in the 5th–8th week. The load adjustment took place under the supervision of an experienced physical therapist to yield a gradual progression of training.

Additionally, a muscle strengthening training booklet was given to each exercise group. The NWE booklet explained 9 exercises of unweighted leg movement while the PRE booklet described 9 sandbag exercises. All exercise sessions were self-instructed and took place at home. Home visitation by a physical therapist and nurse practitioner was conducted to enhance participants’ compliance and exercise every two weeks.

**Instruments**

The Demographic and Health Information Form (DHFF), developed by the principal researcher, consists of close-ended checklists of participants’ general data such as gender, age and education level, work characteristics such as working areas-flat, slope and hillside, tapping level and extra work including health status such as waist circumference, symptoms and pain onset.

The Thai Version of Self-Care Questionnaires (Thai-SCQ), modified from Boonsrichan, (2006)\(^{15}\) comprises three phases of self-care (estimative, transitive and productive). A total of 15 items were scored on 5-point Likert scale, the higher score indicating the higher self-care. Its Cronbach’s alpha coefficient was 0.82.

The Modified Thai Version of Western Ontario and McMaster Universities Osteoarthritis (WOMAC), comprises 24 self-report items with numeric rating scale categorized into pain (5 items), stiffness (2 items), and physical function (17 items). A higher score indicates a lower functional ability. Its reliability evaluation using test-retest method yielded 86 percent agreement.

**Data analysis**

Data analyses were conducted with R version 3.2.5. One way-ANOVA, Krusskal Wallis and Chi squared test were used to compare data of three randomized groups at baseline. Means of self-care and functional ability were compared between PEM-NWE versus STG and PEM-PRE versus STG with Generalized Linear Mixed Model (GLMM) using package “nlme” and additional p-values were calculated based on Satterthwate’s approximations using “lmerTest”. Stepwise regressions were conducted considering Akaike Information Criterion (AIC) or log-likelihood depending on their intraclass correlation of variances. The significance level was set at 0.05 (two-tailed).
Results

At the end of the trial, the GLMM analyses revealed statistically significant differences in self-care between groups in the mixed-effect model in which all time points were included (p<.001; R^2_{GLMM(c)}=0.59). Both PEM-NWE and PEM-PRE showed a significant difference in the total mean score of self-care (p<.05).

The total self-care mean score of the PEM-NWE considerably increased from 49.60±14.87 at baseline (B) to 67.40±10.86 at W5 and slightly increased to 68.52±10.99 at W9. Similarly, the total mean scores of the PEM-PRE increased from 51.96±9.21 at B to 65.92±10.64 at W5 and slightly increased to 67.6±12.35 at W9. The total mean scores of the STG increased from 48.48±9.68 at B to 59.76±8.78 at W5 and to 59.52±7.57 at W9.

In addition, significant differences on functional ability between groups in the mixed-effect model in which all time points were included (p<.001; R^2_{GLMM(c)}=0.93). Both PEM-NWE and PEM-PRE showed a significantly difference from STG in the total mean score of functional ability (p<.05).

The total mean scores of functional ability in the PEM-NWE considerably decreased from 52.76±24.56 at B to 28.20±27.02 at W5 and slightly increased to 20.64±23.97 at W9. Similarly, the total mean scores of the PEM-PRE also decreased from 51.20±38.66 at B to 29.32±30.62 at W5 and slightly increased to 20.08±20.08 at W9. The total mean scores of the STG decreased from 59.08±37.91 at B to 51.64±31.89 at W5 and to 49.60±30.05 at W9.

Moreover, pain was significantly adjusting working experience, working area (slope) and Kellgren-Lawrence grade 3 (p<.05). There was a significant time-by-group and age interaction for physical abilities (p<.01). In contrast, the improvement in stiffness subdomain was not significantly greater in the PEM-NWE and PEM-PRE compared with the STG (p>.05).

In conclusion, the findings obtained from this study support the hypothesis that integrating the PEM in NWE and PRE based on theory of self-care operations contributes to the positive effects of self-care and functional ability for aged para rubber farmers with knee OA in two months. The program may be a beneficial intervention which could be used for improving health and work capability in informal aged workers with chronic conditions, as previously mentioned in the literature.
References


