



The Efficacy of Ruesi Dadton and Yoga on Reducing Neck and Shoulder Pain in Office Workers

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ABSTRACT

International Journal of Exercise Science 16(7): 1113-1130, 2023. Work-related Musculoskeletal Disorders can cause neck and shoulder pain in office workers. The research objective was to investigate the efficacy of Ruesi Dadton exercise (RD) and Yoga exercise (YE) compared with Stretching exercise (SE) on reducing neck and shoulder pain in office workers. A single-blind randomized controlled trial was conducted at Thai Traditional Health Promotion Center, Thai Traditional and Alternative Medicine Hospital. A total number of 80 participants, equally divided into three groups: two intervention groups of RD (n=26), YE (n=28), and a control group of stretching exercise (SE) (n=26) who completed the 4-week intervention program. The primary outcomes were pain relief assessed by Visual Analog Scale, Pressure Pain Threshold, muscle flexibility by Cervical Range of Motion. The secondary outcome was World Health Organization's Quality of Life test. ANOVA, paired t-tests and repeated ANOVA were used to analyze the data. The results showed that the comparison of all three groups before and after the exercises revealed a decrease in pain, better tolerance to pain and more flexibility of the neck muscles with statistical significance ($p < 0.05$). With respect to the quality of World Health Organization's Quality of Life, the comparison of all four domains in all three groups before and after the exercises indicated a statistically significant improvement in quality of life ($p < 0.05$). However, there were no differences in pain, neck muscle flexibility and quality of life between groups.

KEY WORDS: Stretching exercise, musculoskeletal disorders, flexibility, quality of life

INTRODUCTION

Work-related musculoskeletal disorders have been found to be the second common cause of disability in workplaces (3). Work-related musculoskeletal disorders caused by repetitive movements or poor working postures adversely affect physical health including shoulders, limbs and back (29). Work-related musculoskeletal disorders are reported to increase considerably in office workers (45). The office workers who use computers or perform sedentary

work may suffer from neck and shoulder pain, which refers to symptoms triggered by prolonged sitting or inappropriate sitting postures leading to physical pain and damaging nervous system (28). A 2022 study reported that Thai office workers experienced musculoskeletal disorders with the most affected areas of pain ranging from the neck (27.5%), the shoulders (22.7%) and the lower back (17.6%) (36).

Increasing physical activity may lead to an increase in physical fitness and respiratory function. As a subset of physical activity, exercise is defined as an organized, recurring activity whose purpose is to promote or to maintain physical fitness while physical function means the ability of humans to execute daily physical activities (16). The World Health Organization has recommended working adults aged 18-64 years to follow these general guidelines on exercise: 1) 150 minutes of moderate intensity of aerobic exercise or 75 minutes of vigorous intensity, 2) aerobic exercise in bouts for at least 10 minutes, 3) more exercise for better health benefits and 4) muscle strengthening exercise at least twice a week (8).

Ruesi Dadton exercise (RD) refers to a traditional Thai exercise known as Thai yoga, which incorporates slow physical movements, deep breathing and breath holding to support well-being for adults and older adults (32). It was first practiced and introduced a thousand years ago (47). RD encompasses a low-impact, low-to-moderate intensity range of motion integrating basic components of balance, flexibility, muscle strength and body alignment. It includes slow, gentle movements, meditation, breathing and relaxation (46). Besides, RD is a form of mind-body exercise similar to yoga and Tai Chi (25). RD's principles and practices are comparable to the hatha yoga and both RD and yoga are categorized as low-intensity exercises (19, 9). Previous research has employed RD as a flexibility exercise to alleviate musculoskeletal disorders in humans. For example, a previous study was conducted to determine the effectiveness of RD in patients suffering from office syndrome. The results indicated that the range of motion increased significantly in the intervention group compared to the control group. The researchers suggested that RD could improve the range of joint motion and cognitive functions in these patients (40). Yoga is a set of early Indian exercises which integrate three yoga elements, including exercise postures (Asana), breathing techniques (Pranayama) and meditation (Dyana) (20). A recent study in 2021 investigated the effects of daily yoga exercises (YE) on musculoskeletal discomfort and mood disturbance in office workers working from home. The findings showed that YE could reduce musculoskeletal discomfort such as neck, upper, lower back and mood disturbance significantly in the intervention group compared to the control group. The researchers suggested that the yoga intervention program seemed to relieve musculoskeletal discomfort and mood disturbance in these office workers (17). Previous studies have confirmed the effects of stretching exercise (SE) on neck and shoulder pain in office workers. For example, Shariat et al., (2018) investigated the effectiveness of stretching, ergonomic adjustments, and an integration of both in office workers who had neck, shoulders, and lower back pain. The results stated that the SE could decrease shoulders and lower back pain significantly and was more effective compared to ergonomic adjustments after four months (37).

Current literature has reported the positive effects of RD on fitness and physical performance in humans. For instance, a 2022 study determined the effects of RD on vital capacity and the physical performance in healthy older adults. The health benefits of RD, including better pulmonary and musculoskeletal functions have validated RD for health promotion. In another previous study with a quasi-experimental design, the effects of RD on balance ability and quality of life were determined in middle-aged female participants with an early stage of knee osteoarthritis. The findings showed that the balance ability and quality of life in all the domains were significantly higher compared to the control group. It was suggested that RD seemed to be effective in promoting the balance ability and quality of life in middle-aged female adults with knee osteoarthritis (38). Flexibility exercises including RD, YE and SE seem to promote muscle flexibility leading to better fitness and physical performance. RD and YE are traditional flexibility exercises while SE is a standard flexibility exercise. Office workers can perform these body & mind exercises by themselves. However, the research conducted on the efficacy of RD and YE on reducing neck and shoulder pain in working adults is still lacking and the comparison between RD, YE and SE has never been conducted before. This research is the first study to compare these three exercises which help relieve musculoskeletal pain in office workers. This research aimed to investigate the efficacy of RD and YE on reducing neck and shoulder pain in office workers with neck and shoulder pain. The research objective was to investigate the efficacy of Ruesi Dadton exercise (RD) and Yoga exercise (YE) compared with Stretching exercise (SE) on reducing neck and shoulder pain in office workers. This research hypothesis was that RD and YE could reduce neck and should pains and improve quality of life in office workers compared to SE.

METHODS

The current research was a single-blind randomized control trial (RCT). The patients from Thai Traditional Health Promotion Center, Thai Traditional and Integrative Medicine Hospital and Department of Thai Traditional and Alternative Medicine, Bangkok, Thailand volunteered to participate in this intervention program from December, 2020 to February 2021. The clinical register number was TCTR20210426002. The Research Ethics Review Committee for Research Involving Human Subjects in Thai Traditional and Alternative Medicine, Department of Thai Traditional and Alternative Medicine, Ministry of Public Health granted an approval to this study with approval number 09/2561. Additionally, this research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (30).

Participants

A power analysis was calculated by G*Power 3.1.7 program using an effect size d of 0.5 based on the Cohen's d values representing medium level of effect size (26), 80% power ($1-\beta$ error probability) and 0.05 significance level with statistical ANOVA that was equal to 0.5 while the significance level (α) of 0.05 and the power of the test of 0.8 were used (15). The sample size was calculated using an effect size d of 0.5, 80% power ($1-\beta$ error probability) and 0.05 significance level. The effect size estimated number of participants was 74 patients and was increased by 10% for expected dropouts to 84 patients divided into 3 groups each of which required 28

participants. There were 118 volunteers who were eligible to participate in this study. Thirty-four volunteers were excluded from this study. This study recruited a total number of 84 participants divided into three groups: two intervention groups of RD (n=28), YE (n=28) and 1 control group of SE (n=28). Four participants (RD=2, SE=2) dropped out from this study. Therefore, there were 80 participants (RD=26, YE=28, SE=26) for data analysis. The participants aged 20-59 years had suffered from neck and shoulder pain for more than 3 months and gained Visual Analogue Scale scores from 4 to 6.9 (34). All the participants had given their written consent before taking part in this intervention program. The participants were recruited between December 2018 and February 2019 (Figure 1.).

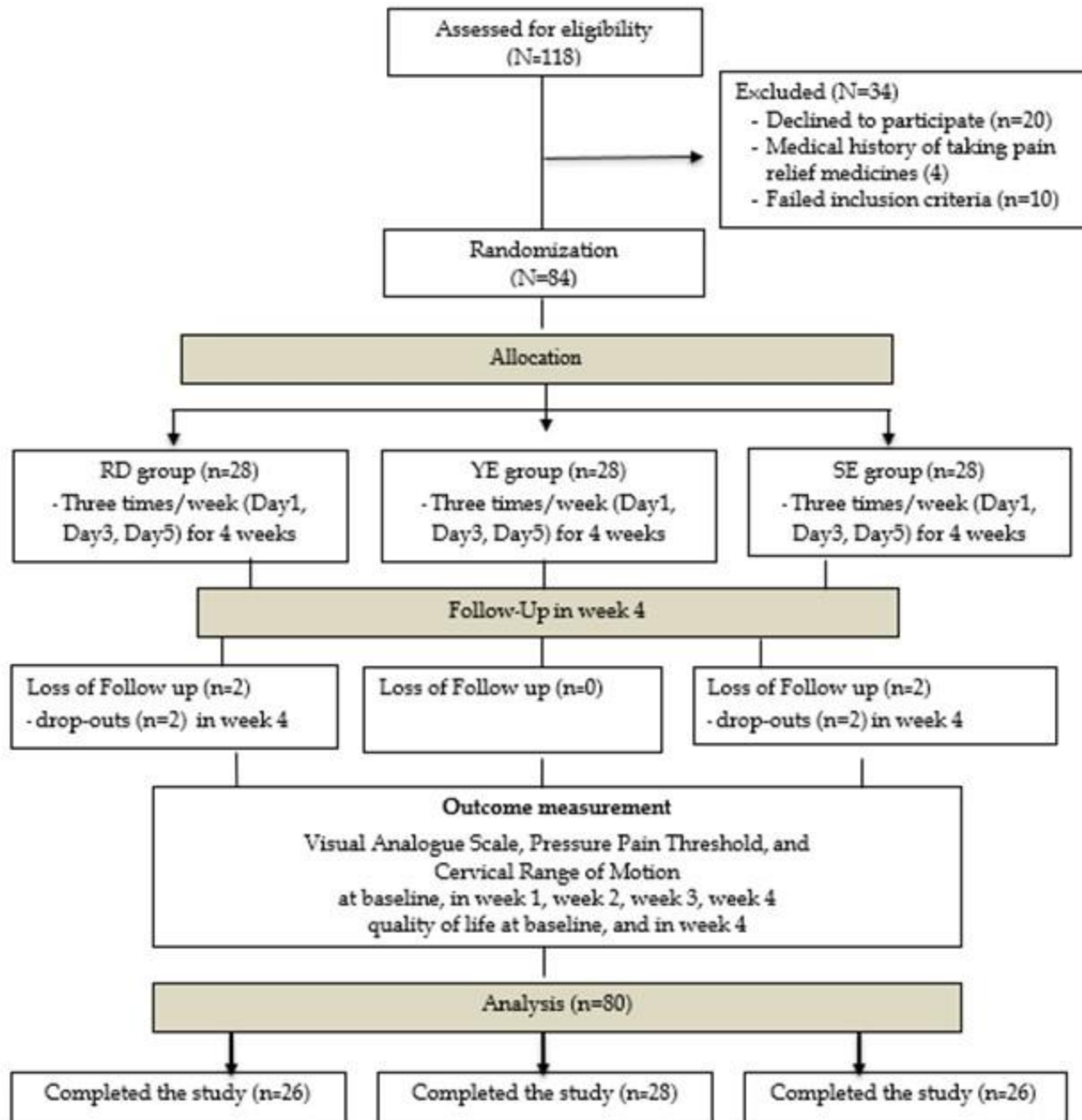


Figure 1. Study flowchart

This study included the participants who met the inclusion criteria: 1) males and females aged 20-59 years, 2) having suffered from the neck and shoulder pain for at least 3 months diagnosed by an orthopedic physician and Thai Traditional Medicine doctor, 3) having pain level (VAS) for at least 4 to 6.9, 4) having worked on a computer for at least a year, for at least two hours per day, four days per week and 5) having at least one trigger point in neck and shoulder area. Regarding the exclusion criteria, this study excluded the participants with the following conditions: 1) structural and muscular diseases namely arthritis, rheumatoid, 2) other diseases triggered by connective tissue disorders, 3) a history of physical surgery of muscle or upper body, 4) severe injuries, 5) spinal disorders including spine dislocation, broken spine, herniated disc, degenerative spinal disease, 6) systolic blood pressure higher than 160 and diastolic blood pressure lower than 100 mmHg (measured while resting), 7) high fever with body temperature more than 38.0 degrees Celsius, 8) cardiovascular conditions, 9) pregnancy, and 10) a medical history of taking pain-relief medicines, namely nonsteroidal anti-inflammatory drugs (NSAIDs).

Protocol

During the research procedures, the participants in each group performed their own 45-minute exercise/session, 3 sessions a week for 4 consecutive weeks (day 1, 3, 5). The licensed instructors leading each session were the same appraisers who evaluated three measures in all the three groups at baseline, in week 1, week 2, week 3, and week 4. A licensed Thai Tradition Medicine doctor taught RD exercise while a physical therapist taught YE and SE. Both the doctor and the therapist have had previous experiences in leading classes and teaching experiences for at least 5 years to lead each session. The RD group performed 12 RD postures applied by a previous study (41), which included 1) Throat's problem, 2) Vertigo, 3) Arm discomfort, 4) Back pain, 5) Generalized weakness of not alert, 6) Secretion in throat, 7) Abdominal pain and scapular discomfort, 8) Waist trouble of low back pain, 9) Generalized muscle cramp or spasm, 10) Shoulder pain, 11) Shoulder and neck discomfort and 12) Stiffness of neck and shoulder. The YE group performed 16 YE postures such as sitting, lying and standing positions applied by previous trial (14, 13), which included 1) Balasana (Child's posture), 2) Marjaryasana (Cat's posture), 3) Bhujangasana (Snake's posture), 4) Tadasana (Mountain posture), 5) Ardha Uttanasana, 6) Chair Bharadvajasana (Body twisting with a chair posture), 7) Adho Mukha Virasana (Child crouching posture), 8) Adho Mukha Swanana (Dog stooping posture), 9) Utthita Trikonasana (Triangle posture), 10) Virabhadrasana II (Warrior posture), 11) Utthita Parsvakonasana (Triangle pose), 12) Prasrita Padottanasana (Standing posture with legs and body apart), 13) Supta Padangusthasana (Lying down with leg pulling pose), 14) Supta Pavanamuktasana, 15) Prone savasana and 16) Supta savasana. The SE group performed 15 SE postures including sitting, lying and standing positions applied by a previous study (41), which included 1) Shoulder blade stretch, 2) Rotator cuff stretch, 3) Neck stretch/rotating head from side to side, 4) Shrug stretch, 5) Trap stretch, 6) Shrug stretch, 7) Trap stretch, 8) Pec stretch, 9) Upper back stretch/Biceps stretch, 10) Long stretch, 11) Chest stretch/Pectoralis major stretch, 12) Delt stretch, 13) Forearm stretch, 14) Lat stretch and 15) Posture stretch/Tile from front to back. No adverse effects nor injuries were observed in all the three groups throughout the intervention program.

Four measures used in this study were divided into three primary outcomes consisting of Visual Analogue Scale, Pressure Pain Threshold, Cervical Range of Motion and one secondary outcome, namely quality of life. The first three measures were assessed at baseline, in week 1, week 2, week 3 and week 4 while the last measure was assessed at baseline and in week 4.

Visual Analogue Scale is a measure used to mark personal pain level by applying a 0-10 scale on a long 10cm line with two end points from 0 (no pain) to 10 (worst pain) (18). Scores 1-4 are interpreted as the mild burden, scores 5-6 as moderate burden and scores 7-10 as severe burden (34). High Visual Analogue Scale scores mean more pain. Each participant was asked to rate his/her perceived pain as personal characteristics or attitudes by marking the pain level on the scale. Visual Analogue Scale was reported to be a valid and reliable measure by a previous study in 2018 (1).

Pressure Pain Threshold is another measure used to determine induced pain at 1 kg/cm² when the minimum force is applied by using the pressure algometry technique. An electronic pressure algometry device known as the Commander™ Algometer (JTech Medical, USA) with surface area at the round tip of 1 cm² was employed to progressively rise compression pressure at 1 kg/s on the trigger point within muscles in neck and shoulders. Each participant was informed to indicate when a sensation of pain was felt after certain compression pressure. High Pressure Pain Threshold scores mean better ability to endure physical pain. The validity and reliability of Pressure Pain Threshold was proven by a previous study in 2009 (27).

Cervical Range of Motion is a reliable measure for neck range of motion including flexion, extension and lateral bending (22). Cervical Range of Motion measured in degrees by the Goniometer (Faculty of Physical Therapy, Mahidol University) aimed to assess the maximum movement of head and neck which contained five postures including extension, lateral flexion left, lateral flexion to right, rotation to left, and rotation to right. High Cervical Range of Motion scores mean more flexibility for Cervical Range of Motion. A 2010 study on the validity and reliability of Cervical Range of Motion and found that it was a valid and reliable measure (5).

World Health Organization's Quality of Life Questionnaire (WHOQOL-BREF-THAI) was used to measure different domains in quality of life. It is an instrument with 26 items divided into 4 domains in the quality of life: physical health (7 items), psychological health (6 items), social relationships (3 items), and environmental health (8 items). The questionnaire rating had a possible range of 26 to 130. A high score indicates a better quality of life (96-130 as good, 61-95 as fair, 26-60 as poor) (44). High quality of life scores mean better quality of life. Awasthi et al. (2012) assessed World Health Organization's Quality of Life and revealed that it was valid and reliable (6).

Statistical Analysis

The descriptive statistics was used to explain the database of participants in mean±SD and number (percentage). The factorial ANOVA was employed to analyze the differences between groups. Paired t-tests were utilized to analyze the data between two periods. Repeated ANOVA

was used to analyze the differences within groups in different periods. The Cohen's *d* formula was employed to determine the effects within and between groups. The effect size *d* of 0.2, 0.5 and 0.8 represented a small, medium and large effect size, respectively (12). This study employed the medium effect size of 0.5, which was consistent with a previous study in 2019 since the previous study reported that the results of yoga intervention in the participants suffering chronic pain found the moderate effect size of 0.5 (37). All data were analyzed by SPSS version 23.0 with statistical significance at $p < 0.05$.

RESULTS

After having passed the inclusion and exclusion criteria, the data of 80 participants randomly assigned by a simple computer-generated sampling method into three groups: two intervention groups of RD ($n=26$), YE ($n=28$) and 1 control group of SE ($n=26$) were analyzed.

The demographic characteristics of participants are presented in Table 1. Four participants (2 drop-outs from RD at week 4 and 2 drop-outs from SE at week 4) who did not wish to take part in the exercises dropped out from this study. Therefore, a total number of 80 participants divided into RD group ($n=26$), YE group ($n=28$) and SE group ($n=26$) completed the intervention program in this study. The demographic characteristics of the participants in all the three groups in mean \pm SD values and number (percentage) were similar in terms of age, gender, status, congenital disease and field of job at baseline.

Table 1. Demographic characteristics of participants.

Characteristics	Group		
	RD (N=26)	YE (N=28)	SE (N=26)
Age (year) ^a	36.19 \pm 11.63	39.96 \pm 10.59	42.23 \pm 11.63
Gender ^b			
- Male	8(30.77)	6(21.43)	4(15.38)
- Female	18(69.23)	22(78.57)	22(84.62)
Status ^b			
- Single	13.00(50.00)	12.00(42.86)	18.00(22.50)
- Married	8.00(30.77)	14.00(50.00)	8.00(30.77)
- Widow	5.00(19.23)	2.00(7.14)	0.00(0.00)
Congenital disease ^b			
- Yes	6.00(23.08)	2.00(7.14)	5.00(19.23)
- No	20.00(76.92)	26.00(92.86)	21.00(80.77)
Field of job (used the computer >2 hours per day) ^b	26(100)	28(100)	26(100)

Notes: Age expressed in ^amean \pm SD. Gender, Status, Congenital disease and Field of job (used the computer >2 hours per day) expressed in ^bNumber (Percentage).

From Table 2, the results on the comparison of Visual Analogue Scale scores within all three groups before and after the exercises reported a decrease in pain but an improvement in PPT with statistical significance ($p < 0.05$). The results on VAS scores within each group showed that RD, YE, SE decreased VAS scores significantly within each group from week 1, week 2, week 3

and week 4. Therefore, RD and YE were as effective as SE in relieving neck and shoulder pain in the participants within each group. The results on Pressure Pain Threshold scores within each group indicated that RD increased Pressure Pain Threshold scores significantly within each group from week 1, week 2 and week 4.

Table 2. VAS and PPT parameters within and between groups at baseline, in week 1, week 2, week 3 and week 4

Measure	Baseline Mean ± SD	Week1 Mean ± SD	Week2 Mean ± SD	Week3 Mean ± SD	Week4 Mean ± SD	P-value	Eta-squared
Visual Analogue Scale							
RD	5.92±0.56	5.15±0.78†	4.69±0.78†	4.11±0.65†	3.76±0.42†	0.019*	0.822
YE	6.10±0.73	5.07±0.76†	4.32±0.72†	3.75±0.58†	3.50±0.69†	0.009*	0.955
SE	5.46±0.95	4.50±0.70†	3.76±0.65†	3.19±0.49†	2.96±0.44†	0.038*	0.907
	0.009*	0.004*	0.000*	0.000*	0.000*		
Eta-squared	0.982	0.975	0.966	0.967	0.967		
Pressure Pain Threshold							
RD	18.45±1.83	18.98±1.73†	18.55±2.32	17.05±1.75†	18.76±2.15	0.001*	0.695
YE	16.52±1.29	16.72±1.17	15.81±1.20†	16.11±1.68	16.45±1.56	0.000*	0.393
SE	18.28±1.68	18.42±1.74	18.14±1.63	18.60±2.06	17.00±1.22†	0.001*	0.482
	0.000*	0.000*	0.000*	0.000*	0.000*		
Eta-squared	0.990	0.990	0.985	0.986	0.988		

Values are expressed in mean ± standard deviation. p-value is significant difference for within groups. *The mean difference is significant at the p-value<0.05 level using paired t-test and repeated ANOVA to analyze within groups. †The measure was significantly different between baseline and each week by paired t -test (p-value<0.05). ETA-ETA-squares; 0.01 low impact; 0.06 medium impact; 0.14 high impact

The results showed that the comparison of all three groups before and after the exercises revealed a decrease in pain (Visual Analogue Scale), better tolerance to pain and more flexibility of the neck muscles with statistical significance (p< 0.05). When the mean Visual Analogue Scale scores were compared between groups, the scores showed a downward trend (week 1 to week 4). There was a statistically significant decrease in RD group from 5.92±0.56 to 3.76±0.42, in YE group from 6.10±0.73 to 3.50±0.69 and in SE group from 5.46±0.95 to 2.96±0.44 between baseline and week 4. RD and YE could reduce the Visual Analogue Scale scores significantly. However, RD was more effectively in decreasing the Visual Analogue Scale scores from moderate level of pain at baseline to mild level of pain in week 4. When the mean Pressure Pain Threshold scores were compared between groups, the mean Visual Analogue Scale scores between groups showed a fluctuating trend with statistical significance (week 1 to week 4). RD group showed a fluctuating upward trend with statistical significance from 18.45±1.83 to 18.76±2.15 from baseline to week 4. In contrast, there was a fluctuating downward trend in YE group from 16.52±1.29 to 16.45±1.56 and in SE group from 18.28±1.68 to 17.00±1.22 from baseline to week 4.

The values of ETA squares test higher than 0.14 confirmed that the impact of all the exercises on reducing pain in office workers was significant.

Table 3 indicates that Cervical Range of Motion scores after the exercises improved statistically significantly compared to those at baseline while there were no differences in Cervical Range of Motion scores between groups after the exercises. The mean scores of Cervical Range of Motion including lateral flexion to left, lateral flexion to right, rotation to left, and rotation to right between the three groups were similar without statistical significance at baseline.

The results on the mean Cervical Range of Motion scores within each group found that there was a significant increase in the extension scores within RD group, YE group and SE group from baseline to week 4 ($P < 0.05$). There was a significant increase ($P < 0.05$) in lateral flexion to left within RD group (week 1, week 3) and YE group (week 1 to week 4) while there was no significant increase in this motion within SE group. RD and YE increased lateral flexion to right significantly ($P < 0.05$) within groups (week 1 to week 4) while SE increased it significantly from week 2 to week 4. RD and YE increased rotation to left significantly ($P < 0.05$) (week 1 to week 4) within groups. In SE group, SE increased the rotation to left significantly (week 1 to week 4) within group. RD, YE and SE increased rotation to right significantly ($P < 0.05$) (week 1 to week 4). Therefore, RD, YE and SE helped improve Cervical Range of Motion including the extension, the rotation to left, and the rotation to right effectively.

When the mean Cervical Range of Motion scores were compared between groups, the mean Cervical Range of Motion scores between groups were different with statistical significance since YE was more effective than RD, SE in increasing the mean Cervical Range of Motion scores of extension (week 2, week 3 and week 4), lateral flexion to left (week 1 to week 4), lateral flexion to right (week 1 and week 4), rotation to left (week 1 to week 4) and rotation to right (week 3 and week 4). The values of ETA squares test confirmed the impact of Cervical Range of Motion on flexibility in office workers. The values of ETA squares test higher than 0.14 considered as large confirmed that CROM extension within groups was significant and between groups was significant (week 2, week 3, week 4). CROM lateral flexion to left between groups was significant (week 1 to week 4). Cervical Range of Motion lateral flexion to right within YE group was significant and between groups was significant (week 1, week 4). Cervical Range of Motion rotation to left within groups was significant and between groups was significant (week 1 to week 4). The values of ETA squares test higher than 0.14 were large in RD and YE groups while those higher than 0.06 were medium in SE group. The values of ETA squares test confirmed that Cervical Range of Motion rotation to right within groups was significant and between groups was significant (week 3, week 4).

Table 3. Cervical Range of Motion within and between groups at baseline, in week 1, week 2, week 3 and week 4

Measure	group	Baseline Mean±SD	Week1 Mean±SD	Week2 Mean±SD	Week3 Mean±SD	Week4 Mean±SD	^a p- value	Eta- squared
Cervical Range of Motion Extension	RD	49.96±9.81	59.65±12.90 [†]	56.42±8.17 [†]	55.92±8.89 [†]	60.19±8.77 [†]	0.016*	0.236
	YE	44.00±9.71	43.86±8.29 [†]	58.82±10.34 [†]	60.29±10.26 [†]	64.75±9.72 [†]	0.028*	0.597
	SE	46.27±9.63	57.04±10.62 [†]	55.54±8.59 [†]	57.08±8.22 [†]	59.23±8.25 [†]	0.022*	0.370
	^b p-value	0.082	0.397	0.002*	0.001*	0.000*		
	Eta-squared	0.958	0.965	0.968	0.971	0.971		
Lateral flexion to left	RD	38.81±13.19	44.85±13.84 [†]	43.19±9.70	44.88±8.22 [†]	41.96±11.54	0.162	0.444
	YE	32.43±8.64	49.36±9.80 [†]	46.57±9.72 [†]	45.79±12.48 [†]	52.25±12.80 [†]	0.055	0.749
	SE	35.85±10.22	40.31±8.75	40.38±7.14	38.92±7.84	42.54±8.76	0.090	0.192
	^b p-value	0.101	0.000*	0.000*	0.004*	0.000*		
	Eta-squared	0.957	0.957	0.975	0.975	0.971		
Lateral flexion to right	RD	36.81±10.67	44.50±11.41 [†]	42.85±10.46 [†]	46.62±7.14 [†]	44.31±11.17 [†]	0.053	0.124
	YE	32.57±7.34	43.86±8.29 [†]	43.14±7.31 [†]	44.32±8.93 [†]	50.79±10.83 [†]	0.040*	0.371
	SE	35.81±7.87	39.92±6.54	41.88±7.53 [†]	43.58±7.84 [†]	44.73±7.56 [†]	0.064	0.176
	^b p-value	0.179	0.003*	0.086	0.308	0.000*		
	Eta-squared	0.914	0.940	0.958	0.948	0.938		
Rotation to left	RD	57.12±9.38	63.46±7.40 [†]	65.31±8.37 [†]	69.69±8.11 [†]	68.85±8.02 [†]	0.014*	0.191
	YE	57.07±8.42	67.89±10.75 [†]	69.54±8.11 [†]	75.50±9.45 [†]	79.57±8.66 [†]	0.004*	0.421
	SE	62.08±14.26	64.81±9.42	65.50±8.58	65.69±8.42	67.19±7.66	0.050*	0.307
	^b p-value	0.167	0.005*	0.005*	0.000*	0.000*		
	Eta-squared	0.941	0.957	0.963	0.969	0.954		
Rotation to right	RD	60.58±9.66	66.96±9.06 [†]	68.85±8.78 [†]	71.50±8.66 [†]	72.31±6.87 [†]	0.007*	0.452
	YE	58.57±8.61	64.93±8.23 [†]	64.93±8.23 [†]	76.39±8.81 [†]	80.04±8.95 [†]	0.007*	0.683
	SE	64.27±9.51	69.46±8.13 [†]	70.04±8.01 [†]	70.46±7.66 [†]	70.15±9.69 [†]	0.023*	0.082
	^b p-value	0.079	0.814	0.060	0.000*	0.000*		
	Eta-squared	0.966	0.980	0.964	0.982	0.982		

Values are expressed in mean ± standard deviation. ^ap-value is significant difference within groups from that at 4 weeks by Repeated Measures ANOVA. ^bp-value is significant difference between groups by ANOVA. *The mean difference is significant at the p-value<0.05 level using paired t-test and repeated ANOVA to analyze within groups. [†]The measure was significantly different between baseline and each week by paired t -test (p-value<0.05). ETA-ETA-squares; 0.01 low impact; 0.06 medium impact; 0.14 high impact

Table 4 presents the mean scores of quality of life divided into four domains, including physical health, psychological, social, environment and total quality of life within each group at baseline and in week 4. RD increased the mean scores of three domains including physical health, social and environment significantly within RD group while YE and SE increased the mean scores of four domains significantly within groups. Moreover, RD, YE and SE increased total quality of life significantly within groups. When the mean scores were compared between groups, RD, YE and SE increased four domains and total quality of life effectively since the mean quality of life scores in all the domains and total quality of life were comparable between groups in week 4. The values of ETA squares test confirmed the impact of all the exercises on quality of life in office workers. The values of ETA squares test higher than 0.14 considered as large confirmed that most domains, including physical health, social, environment and total quality of life within groups were significant while psychological domain within YE, SE groups was significant.

Table 4. Quality of life within and between group at baseline and week 4.

Quality of life Domain Score	Group	Baseline (Mean ±SD)	Week 4 (Mean ±SD)	^a p-value	Eta-squared
Physical Health (7 to 35 scores)	RD	22.35±2.45	24.27±2.03	<0.001*	0.690
	YE	22.86±2.59	23.82±2.14	0.002*	0.629
	SE	23.69±1.81	24.35±1.77	0.012*	0.452
	^b p-value	0.110	0.623		
	Eta-squared	0.990	0.994		
Psychological (6 to 30 scores)	RD	20.42±5.02	20.58±2.44	0.859	0.320
	YE	19.68±1.98	20.46±1.90	0.002*	0.298
	SE	21.04±7.97	21.62±1.79	0.016*	0.298
	^b p-value	0.319	0.087		
	Eta-squared	0.975	0.990		
Social (3 to 15 scores)	RD	10.31±1.51	11.00±1.26	0.001*	0.367
	YE	11.04±1.60	11.50±1.20	0.003*	0.287
	SE	11.23±1.27	11.65±0.89	0.019*	0.202
	^b p-value	0.068	0.099		
	Eta-squared	0.981	0.990		
Environment (8 to 40 scores)	RD	25.58±3.68	26.65±3.03	0.002*	0.314
	YE	25.71±2.97	26.17±3.07	0.004*	0.275
	SE	27.12±3.01	27.73±2.82	0.029*	0.176
	^b p-value	0.168	0.343		
	Eta-squared	0.985	0.988		
Total Quality of life (26 to 130 scores)	RD	78.15±9.60	82.26±6.70	<0.001*	0.368
	YE	78.46±6.64	82.25±6.17	<0.001*	0.651
	SE	82.46±6.19	84.96±5.56	<0.001*	0.488
	^b p-value	0.079	0.192		
	Eta-squared	0.991	0.995		

Values are expressed in mean \pm standard deviation. ^ap-value is significant difference within groups by paired t - test. ^bp-value is significant difference between groups by ANOVA. * = p-value <0.05. ETA- ETA-squares; 0.01 low impact; 0.06 medium impact; 0.14 high impact

DISCUSSION

This research aimed to investigate the efficacy of RD and YE on reducing neck and shoulder pain in office workers with neck and shoulder pain. The demographic characteristics of the participants in all the three groups were similar at baseline. In this study, most of the office workers were found to be more females than males. the majority of office workers are reported to be female workers since they choose to be computer-using office workers and neck pain is more prevalent in female office workers (49).

Neck and shoulder pain caused by extensive computer use and sedentary work is one of the major complaints among office workers. A 2018 study investigated gender and posture as significant risk factors to musculoskeletal disorders during touchscreen tablet computer use and revealed that musculoskeletal disorders during computer use was found to be prevalent at 67.9% with neck symptoms at 84.6% and shoulder/upper extremity at 65.4% (28). Sedentary work particularly sitting for long hours can cause neck and shoulder pain in office workers. A recent study in 2021 reported a significant association between the total sitting time per week and neck and shoulder pain in office workers. Long sitting time per week was found to be related to higher neck and shoulder pain intensity compared to short or moderate sitting time.

RD could help reduce neck and shoulder pain within group but the participants in YE group and SE group were less likely to endure the pain leading to more aching neck and shoulder pain. The results on Visual Analogue Scale scores and Pressure Pain Threshold scores indicated that RD and YE were as effective as SE in reducing neck and shoulder pain based on the Visual Analogue Scale scores while RD was more effective in increasing Pressure Pain Threshold scores compared to YE and SE. RD and YE are the types of mind-body flexibility exercises (40) which could reduce pain based on the results of this study. Both exercises which are similar to SE could increase muscle flexibility and promote quality of life. According to the pain pathophysiology, contraction knot is defined as the band of dark muscle fibers in the muscle triggered by more tension in palpable taut band fibers. The nodular region of band center is known as a central trigger point while the end of the taut band is called attachment trigger points. The persistent tension in the fibers causes attachment trigger points leading to inflammatory response or enthesopathy. Therefore, a central trigger point displays many swollen contraction knots (7). When RD and YE are performed continuously, consistently at least three times a week, they can reduce pain and improve muscle flexibility. A 2021 study revealed that performing RD exercise three times/week for 12 consecutive weeks could improve physical functions and reduce cognitive decline (25).

When office workers maintain improper postures while sitting and working on computer, the improper postures weaken the related muscles including rhomboids, serratus anterior, and trapezius leading to pain because of muscle imbalance (35). Certain neck/shoulder muscle exercises could have positive effects on neck and shoulder pain (50). Chaowpeerapong et al.

(2022) examined 3-D upper extremity joint angles and muscle activities in selected RD exercises and found that most RD postures were performed within the normal range of motion and the Trapezius muscle seemed to be the most dynamic in these postures (10). During these exercises, office workers gain health benefits of relaxing these muscles, relieving pain and promoting blood circulation and blood supply to the brain. Previous research also shared these similar health benefits of these exercises. RD has been employed in Thai traditional medicine to relieve musculoskeletal symptoms of neck pain (24). A recent study in 2022 measured the effect of physical activities including RD on the physical fitness in old adults. The findings showed that RD exercise improved body balance, muscular strength in limbs, cardiovascular and pulmonary endurance and shoulder flexibility. The researchers suggested the health benefits of RD exercise on physical fitness including strength, endurance, mental health and body balance in old adults (31).

Office workers are advised to perform exercises at work to reduce neck and shoulder pain. It is recommended that health benefits of stretching exercise range from relieving pain or discomfort and office workers should perform it at work since it takes a short time to complete (42). Besides, current research has revealed that yoga and stretching exercises are effective in relieving neck and shoulder pain in office workers (21). RD performed with slow-deep breathing technique helps promote blood circulation, better concentration (40), improve lung functions (48) and reduce musculoskeletal disorders (24) while yoga helps alleviate neck and shoulder pain in office workers who need to perform extensive computer use. The frontline treatment which the physicians prescribe to patients with pain is non-steroidal anti-inflammatory drugs (NSAIDs). The physicians encounter pain conditions divided into acute stage and chronic stage and musculoskeletal injury has been found in both stages (33).

The results on the mean Cervical Range of Motion scores within each group found that RD, YE and SE improved all the five motions of Cervical Range of Motion including extension, lateral flexion to left, lateral flexion to right, rotation to left and rotation to right. Furthermore, the comparison of Cervical Range of Motion scores between groups indicated the difference with statistical significance in the mean Cervical Range of Motion scores between groups because YE was better in improving all the five motions of Cervical Range of Motion compared to RD and SE. The results in this study validated the health benefits of RD on physical fitness involving Cervical Range of Motion. Tanasugarn et al. (2015) utilized RD exercise as an intervention to study its effects on physical properties of shoulder joints and cognitive function in office workers with extensive computer use at least three hours per day. The findings indicated that a significant increase in left and right shoulder flexion was observed in the intervention group compared to the control group. It was suggested that RD exercise can be practiced safely to improve range of joint motion with possible benefit of joint and cognitive functions in office workers (17). RD should be applied as a safe flexibility exercise for office workers since it can improve Cervical Range of Motion but prevent musculoskeletal disorders caused by extensive computer use (39) while YE should be practiced in office workers for its health benefits of strength, muscle flexibility and better work performance (11). Likewise, SE also offers multiple health benefits including range of motion in office workers (43).

The results on the mean quality of life scores from World Health Organization's Quality of Life Questionnaire reported that three domains increased significantly within RD group while all four domains increased significantly within YE group and SE group. In addition, total quality of life increased significantly within all the three groups. The comparison of the mean scores between groups found that RD and YE increased all four domains and total quality of life as effectively as SE.

YE was the most effective in improving quality of life followed by RD and SE based on the highest scores of four domains while RD was more effective in improving total quality of life followed by SE and YE. The results on quality of life in this study were relevant to prior research which indicated that RD exercise could promote overall health as well as health associated with quality of life (21). A 2016 trial employed stretching exercises for neck and shoulders to relieve neck pain and determined its effects in office workers. The findings revealed that all the outcomes including neck pain, neck functions and quality of life improved statistically significantly in the intervention group compared to the control group. The researchers advised that a frequent stretching exercise for four weeks helped relieve neck and shoulder pain, improve neck function and quality of life in office workers with moderate to severe neck and shoulder pain (43).

Cohen's *d* test was employed to measure the treatment effect sizes within and between all the three groups based on the measures, including Visual Analogue Scale, Pressure Pain Threshold, Cervical Range of Motion and quality of life. This study found the effect size in all the measures as medium ($d = 0.5$). This positive medium effect size was consistent to that of a 2020 study on efficacy of combination therapies, including stretching on neck pain measured by Visual Analogue Scale and Pressure Pain Threshold (2). Moreover, extension exercises with Cervical Range of Motion caused a large effect size in office workers in a 2021 study (23). A 2022 study administered Sun Salutation yoga as an intervention to treat low back pain and revealed a large effect size measured by quality of life (4).

The use of Visual Analogue Scale scores to select volunteers with subjective feelings was a limitation of this study. As a result, these scores varied greatly at baseline. Furthermore, only a small number of participants were recruited for this study. The participants continued to work on the computer for hours, causing pain to persist greatly between periods. Further research should be conducted to measure laboratory values such as substances in saliva or substances that can indicate the participants' pain. Furthermore, future research should extend the duration of the intervention program and include a larger sample size. Future research should conduct a follow-up to measure the prolonged effects of the interventions. This study can be applied to a larger population who have excessive use of smartphones and may suffer from musculoskeletal disorders.

In conclusion, this research is the first study to compare the efficacy of the three exercises on relieving musculoskeletal pain in office workers. RD and YE were effective as SE in relieving

neck and shoulder pain and improving quality of life in office workers. RD and YE are considered as safe, low-impact and low-intensity exercises suitable for office workers.

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