International Journal of Physiotherapy and Research,
Int J Physiother Res 2023, Vol 11(2):4483-96. ISSN 2321-1822
DOI: https://dx.doi.org/10.16965/ijpr.2023.112

Original Research Article

Evaluation of FixaSpine and Mckenzie Exercises In Comparison with Postural Text Reminders on Neck Pain among Office Workers: A Pilot Study

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ABSTRACT

Background: Neck pain is a public health issue and the world's fourth-biggest cause of disability. Office workers are more affected by poor posture and different weight loads on the neck leading to the development of neck pain. FixaSpine is a wearable device allowing proper sitting or standing posture when using the computer. McKenzie exercises are inter alia used for decreasing neck pain, there are no studies on the combination of FixaSpine and McKenzie exercises.

Objective: to evaluate the change in perceived neck pain before and after the combination of training with FixaSpine and performing McKenzie exercises among office workers in comparison to postural text reminders.

Materials and methodology: a pre-post-interventional pilot study was carried out in Southern Sweden with 39 participants. The intervention group received training with FixaSpine and McKenzie exercises and the control group received postural text reminders for the duration of four weeks. The participants performed five days a week during working hours. The data was collected by Neck Pain and Disability Scale. Paired samples t-test and independent t-test were used for analysis.

Results: a total of 39 participants (intervention group (n = 25) and control group (n = 14)) were included in the study. The intervention group showed a statistically significant difference in neck pain (p = 0.000) and in the control group, there was no significant difference in neck pain (p = 0.57). There was a significant difference in post-total NPDS scores across the groups (p = 0.002). The magnitude of the mean differences was very large (mean difference = -26.21, 95 % confidence interval: -42.12 to -10.3; Glass'delta = 1.23).

Conclusion: There was a significant decrease in perceived neck pain measured before and after an intervention by a combination of training with FixaSpine and performing McKenzie exercises among office workers in comparison to postural text reminders. Further research is needed involving control groups (FixaSpine /McKenzie exercises).

KEYWORDS: FixaSpine, McKenzie exercises, Neck load, Neck pain, Office workers, Posture.

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Access this Article online	Journal Information	
Quick Response code	**International Journal of Physiotherapy and Research** ISSN (E) 2321-1822 | ISSN (P) 2321-8975 **https://www.ijmhr.org/ijpr.html** **DOI-Prefix:** https://dx.doi.org/10.16965/ijpr	
	Article Information	
DOI: 10.16965/ijpr.2023.112	Received: 06 Feb 2023 Peer Review: 08 Feb 2023	Accepted: 11 Mar 2023 Published (O): 11 Apr 2023 Published (P): 11 Apr 2023

INTRODUCTION

Neck pain is defined by the Global Burden of Health 2010 Study as "pain in the neck with or without pain referred into one or both upper limbs that lasts for at least 1 day"[1]. Neck pain (NP) is a public health issue and the world's fourth greatest cause of disability, resulting in a financial burden measured in terms of disability-adjusted life years [1-3].

The largest increase in age-standardized point prevalence of NP estimated per 100 000 population occurred in Sweden between 1990 and 2017 is 10.4% (6.0% to 15.4%) [3]. NP is mostly felt in the neck region of the cervical spine, although it can also spread to the shoulders or head [4-6]. It is experienced as sharp or dull, and constant or throbbing [4-8]. When a nerve is compressed or irritated as it exits the spinal cord, it can induce radicular NP, which manifests as radiating pain along the occipital or peripheral nerves [4-9]. The NP that arises from the first through fifth cervical vertebra (C1-C5) located in the upper neck, radiates pain cranially [9]. It induces symptoms such as a headache, blurred vision, facial numbness, dizziness, or tinnitus [7,8]. The NP that arises from the fifth through eighth cervical vertebrae (C5-C8) and from the first thoracic vertebra (T1) radiates the pain down the shoulder, arm, and fingers [9]. Additionally, sensory problems like tingling or numbness in the fingers may be reported [4].

The factors associated with NP are poor coping skills, poor physical work environment, being female, rheumatic disease, trauma, sedentary lifestyle, obesity, smoking, and headache [6,10]. Leading factors among office workers (OWs) to develop NP are prolonged sitting and flexed head and neck postures [11]. Prolonged use of a computer with 95 % of working time and with no break time in between the use of the computer [11]. The average weight of the head and neck is around 4.5-5.5 kgs. Forward bending of the neck carries different weight loads on the neck at different angles (at 15° = 12 kgs, 30° = 18 kgs, 45° = 22 kgs, and at 60° = 27 kgs) leading to overloading of the neck and development of NP and disability [12]. Other causes of NP could be postural or mechanical reasons [4,5,13]. According to Cohen et al. [11], the management for NP includes muscle relaxants and painkillers, which were found to be effective as conservative management for NP. Physiotherapy management for NP includes exercises that were found to have strong evidence [14] and are effective in improving posture among adults with forward head posture [15].

Previous studies reveal that McKenzie exercises were found to be more effective than isometric strengthening exercises in reducing NP [16-8]. According to Wani et al,[19] both groups (cervical retraction exercises group and cervical retraction exercises with pressure biofeedback group) experienced a considerable reduction in NP and disability. Cervical retraction exercises (McKenzie exercises) with pressure biofeedback, on the other hand, were found to be superior to cervical retraction exercises alone [19]. Previous studies on wearable posture correction sensors (WPCS) were found to be effective in improving posture and enhancing overall health [20,21]. WPCS were shown to reduce neck flexion angles by 8% and gravitational forces on the neck by 14% among OWs [22]. In a standing workstation, WPCS found significant results in lowering neck postural stress [22].

FixaSpine is a wearable device with integrated sensors providing automatic feedback about the user's posture. It facilitates correct sitting or standing posture during working on computers. It has a little box that identifies incorrect posture based on angle and distance. It provides feedback through sound and vibration to help OWs to improve their posture (Patent number 3326518) [23].

An unpublished master thesis study revealed that there is no statistically significant effect of FixaSpine in comparison with the control group among OWs with NP. However, in that study, the control group had a small intervention in terms of SMS-reminding twice a day and both groups decreased their NP [unpublished master thesis, Tintea A, Dec 2021]. There is no research study done in comparison to the combination of FixaSpine and McKenzie exercises in comparison with the control group among office workers with NP. The present study is guided by using the international classification of functioning, disability, and health framework (ICF) [24,25]. ICF is used to provide a common language that depicts how individuals with NP function in their daily lives, regardless of whether they have a specific diagnosis. ICF consists of two components: functioning and disability, and contextual factors. The functioning and disability focus on neck structure and function that includes anatomical status and impairment leads to restricted function of the neck [26]. Activity limitation, participation due to NP, environmental and personal factors contributing to NP are considered in this study [25].

Assessing these parameters before and after the intervention with the Neck Pain and Disability Scale aids in identifying the change in NP among OWs [27].

Aim of the study: the purpose of the present study is therefore to evaluate the change in perceived neck pain before and after an intervention with the combination of training with FixaSpine and performing McKenzie exercises in comparison with postural text reminders among office workers.

Objective: Is there any change in perceived neck pain before and after an intervention with the combination of training with FixaSpine and performance of McKenzie exercises among office workers compared to postural text reminders?

MATERIALS AND METHODS

Study design: pre-and post-interventional study is used to assess the change in perceived NP before and after intervention among OWs in comparison with the control group [28]. The study adheres to the Transparent Reporting of Evaluations with Nonrandomized Designs (TRENDS) [29]. A sample size of 39 participants is considered for this pilot study according to Hertzog [30].

Recruitment: The study was conducted in Southern Sweden from Jan-Dec 2022. The study was publicized (through pamphlets), and participants were recruited from three large major companies in Southern Sweden. The researcher received emails from interested participants. The eligible participants gave their consent after being evaluated by the researcher for inclusion in the study.

Eligible criteria: OWs working with computers for a minimum of 3 hours/day with NP, working age 22-67 years, sex-male, female and other. The participants (subjective assessment of pain) rating at least number three on an 11-point Numeric Pain Rating Scale (NPRS) was considered inclusive in this study. The number three on NPRS was selected based on two reasons,1. the previous unpublished study used that as a limit and 2. If the pain level would be too mild it would be difficult to evaluate any change in NP among OWs. Exclusion: cancer, use of a pacemaker, and metal implant were assessed by the researcher through the criteria survey and introduction meeting. NPRS is a self-reported scale, easily administered and scored from 0-10, where 0 = no pain,1-3 mild pain, 4-6= moderate pain, and 7-10= severe pain. It is used for measuring pain intensity (perceived level of pain intensity) in experimental and clinical settings. It consists of an 11-point numerical scale composed of 0 -10. It takes < 1 minute to complete. The NPRS was found to be valid and reliable with test-retest reliability of 0.67 to 0.96 [31]. It was applicable to individuals with NP and was found to be valid and reliable in Canada and Nepal [32,33].

Intervention: The researcher explained the instructions for the use of FixaSpine and McKenzie exercises to all the study participants included in the intervention group (IG). They were provided with FixaSpine. Instructions for the use of FixaSpine: The device is worn around the neck between 5-20 cm from the chin. The calibration button is pressed once, and the individual is asked to take a good posture, keep still, and wait for five signals for calibration to complete. The device alerts the individuals if their posture is protraction of the neck or flexion of the thoracic spine. The device is quite sensitive and reacts faster the stricter the individual has calibrated it; therefore, the participants were told not to calibrate too strictly to allow more movements before a signal from the device appeared. Presented in figure 1.

McKenzie exercises: exercise one (cervical retraction): the person was instructed to sit or stand up straight and cross their fingers with the index and thumbs facing upwards, keeping the index finger below the chin and the thumbs towards the chest. Retract the neck to the point where the individual can see the tips of their index fingers for one second, then release [34,35]. Presented in figure 2. Exercise two (thoracic spine extension) was performed with the help of a chair or adjustable table at two different levels - A: it is performed in a sitting position by placing the hands behind the head, maintaining an upright posture, and then extending the thoracic spine to the end range over the back of a chair and then relax for a second. B: keeping a distance of 10 cm between the back of the chair and the sitting posture, a similar exercise is performed resulting in an end range 10 cm higher up on the thoracic spine [36]. Presented in figure 3. Each exercise was repeated ten times [34-6].

The exercises were performed just before wearing the FixaSpine and after removing the FixaSpine. The FixaSpine should be worn for 15 minutes morning and afternoon for five days during working days with the computer [23, unpublished master thesis, Tintea A, Dec 2021]. The intervention lasted for four weeks [unpublished master thesis, Tintea A, Dec 2021]. Presented in figure 4. Control group (CG): the study participants received postural text reminders which was a self-improvement strategy. The text reminder was sent once a week to correct their posture during working days with the computer for four weeks.

Data Collection: the data were collected online using the electronic survey software SUNET (Artologic©, Sweden) organized by Lund University [37]. The demographic data included age group, sex, number of hours of usage of computer, interest in wearables and exercises, the self-perceived posture of the neck, duration of NP (weeks, months, and years), any medicine, and treatment for NP was collected along with the baseline data. The baseline and post-intervention data were collected by using the valid and reliable measurement instrument Neck Pain and Disability Scale (NPDS). Compliance was measured by conducting a zoom meeting with individual study participants after one week and by weekly follow-up surveys for four weeks. NPDS was developed by Wheeler et al in 1999. It measures NP and related disabilities. It consists of 20 items that measure neck movements, NP intensity, the effect of NP on emotion and cognition, and the level of interference with daily life activities. Applicable for individuals with age =22-72 years. The scale is easy to complete by the study participants with a time < 5 minutes [27]. How to use the NPDS: The participants respond to each item in the scale by marking along 10 cm on a visual analog scale. The score ranges from 0 to 5. The total score is a total of the item score (0-100), where the range zero indicates no pain and 100 indicates severe pain. Greater disability is indicated by higher scores. The NPDS has good reliability with Cronbach's á = 0.93 [27]. Available in an appendix. The test-retest reliability for German NPDS was found to be 0.97 for chronic NP and C1 fusion patients [38]. The NPDS was found to be valid and reliable in several countries including European countries (Italy, Germany, the Dutch, etc.) [39-42].

Data analysis: the pre-and post-intervention data were analyzed by using IBM SPSS Statistics, version 27. The descriptive statistics were carried out by using mean, and ± standard deviation (SD). The characteristics of the study participants and other information are presented in table 1. The distribution of the variables was checked by using a box plot and the Shapiro-Wilk test.

Normality of the variables: The assumption of normal distribution of the data (dependent variable -NP (metric scale)) was checked by using a box plot. The box plot is appropriate for the combination of variables (total scores of NPDS). The visuality of box plots reveals that: in the baseline total NPDS scores of IG and CG, the middle quartile (50% of the data) is closer to the lower quartile with asymmetrical whiskers. Figure 5 reveals that the distribution of data is non-normal. In the Post total NPDS scores of IG and GC, 50% of the

Fig. 1: the wearable posture correction sensor FixaSpine (source: Ekesbo E 28 Mar 2022).

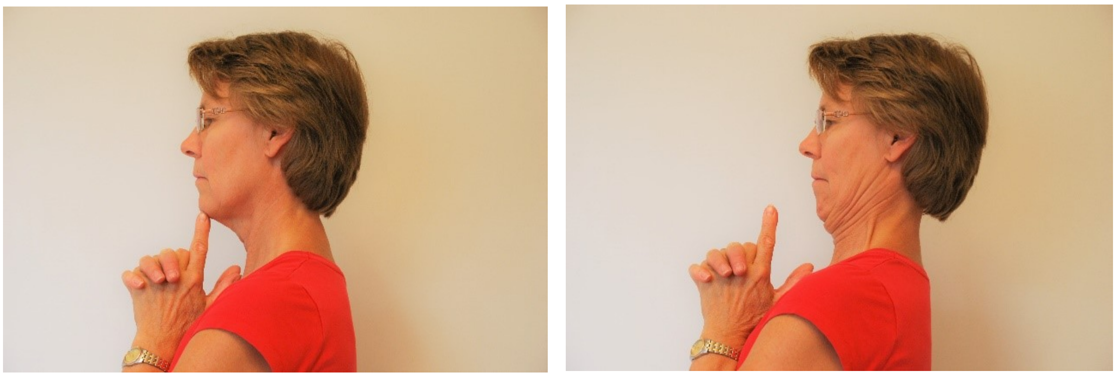

Fig. 2 (a,b): cervical retraction exercise (source: Ekesbo E 28 Mar 2022).

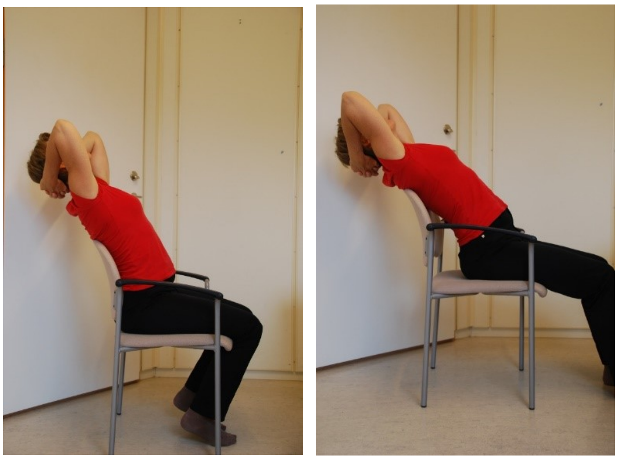

Fig. 3 (a & b): thoracic spine extension exercises (source: Ekesbo E 28 Mar 2022).

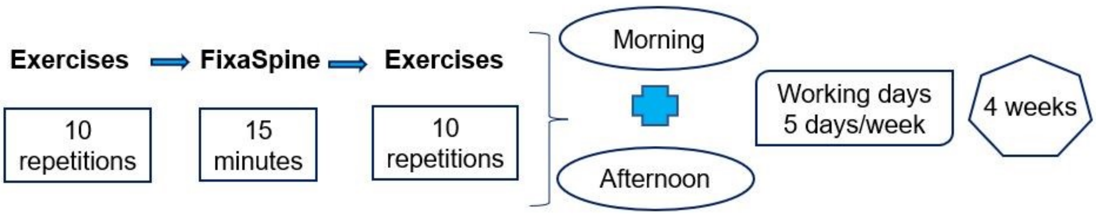

Fig. 4: Intervention group receiving FixaSpine and McKenzie exercises.

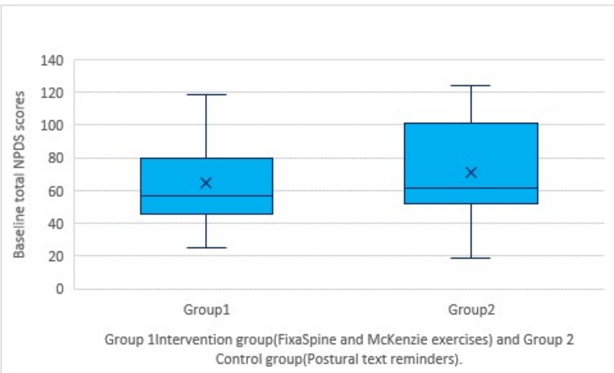

Fig. 5: baseline total NPDS scores for intervention and control group.

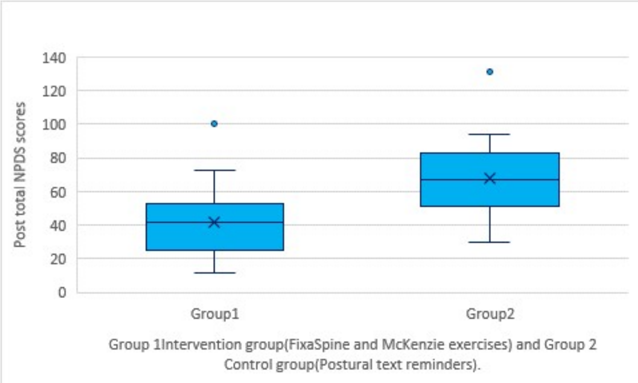

Fig. 6: post total NPDS scores for intervention and control group.

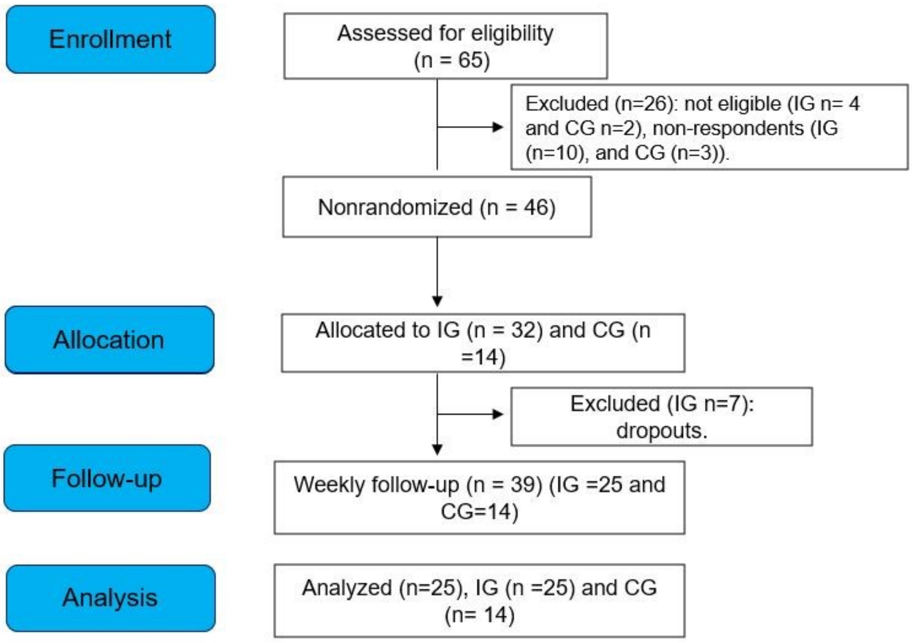

Fig. 7: TRENDS flow diagram representing enrolment, allocation, follow-up, and analysis of study participants(29).

data is at the middle quartile with asymmetrical whiskers and outliers. Figure 6 reveals that the distribution of data is non-normal [43].

Shapiro Wilk test: it is a statistical normality test and is appropriate for this study because it gives high power and applies to small sample size [44]. It checks the normality of the data. The baseline total NPDS scores data showed IG with a p= 0.074 and CG with a p= 0.394 and post-total NPDS scores data showed IG with a p= 0.290 and CG with a p= 0.460. The p-values in IG and CG were greater than the statistical significance level of the p-value of 0.05. This reveals that the data is normally distributed both in IG and CG.

A paired t-test is appropriate to answer the research question within the group and an independent t-test is appropriate to check the mean difference between the groups [45]. A P-value of < 0.05 was considered statistically significant [46]. The participant's NPDS scores on a scale from 0 to 100 were changed to a scale from 0 to 10 and the NPDS 20 items scores of 0-10 scores were added to form a total score. The variables were then converted, and the total score was obtained for examination of the baseline-and post-intervention data.

RESULTS

A total of 46 participants (IG (n =32) and CG (n=14)) were confirmed to be eligible based on the eligibility criteria. There were dropouts of seven participants in IG due to the several meetings on their computers and it was difficult for them to wear the FixaSpine during the meetings. A total of 39 participants reported 'moderate pain' with NPRS in IG 56 % (n = 14) and CG 92.9 % (n=13). Participants were allocated to IG and CG and weekly follow-up surveys were conducted to monitor them. Finally, a total of 39 participants were analyzed. As presented in figure 7 TRENDS flow

Table 1: presenting descriptive statistics of study participants.

Participant's characteristics and other information	IG (n=25)	CG (n=14)
Sex or gender, %(n)		
Female	**56 (14)**	**50.0 (7)**
Male	44 (11)	42.9(6)
Others		7.1 (1)
Age group, %(n)		
22-29		7.1 (1)
30-39	28 (7)	42.9 (6)
40-49	**52 (13)**	**50 (7)**
50-59	16 (4)	
60 and above	4 (1)	
NPRS, %(n)		
Mild pain	16 (4)	
Moderate pain	**56 (14)**	**92.9 (13)**
Severe pain	28 (7)	7.1 (1)
Number of hours /days spent by a computer, % (n)		
3-4	4 (1)	
5-6	32 (8)	**50 (7)**
7 and above	**64 (16)**	**50 (7)**
Number of hours sitting /standing by a computer, %(n)		
Was rather constant in the last year	**72 (18)**	**64.3 (9)**
Increased in the last year	24(6)	28.6 (4)
Decreased in the last year	4(1)	7.1 (1)
Interacting with computer screen getting NP, %(n)		
Rarely		7.1 (1)
Sometimes	**72 (18)**	**50 (7)**
Usually	20 (5)	42.9 (6)
Always	8(2)	
Duration of NP, % (n)		
0-6 months	8 (2)	
7-24 months	16 (4)	14.3 (2)
24 months and above	**76 (19)**	**85.7 (12)**
Easily maintain a proper neck posture, % (n)		
Never	4(1)	
Rarely	**48 (12)**	**57.1 (8)**
Sometimes	**48 (12)**	21.4 (3)
Usually		21.4 (3)
Believe in a proper neck posture to maintain good health, % (n)		
Somewhat important		
Very important	12 (3)	21.4 (3)
Extremely important	**60 (15)**	**71.4 (10)**
	28 (7)	7.1 (1)
Interested in trying a neck wearable device to improve posture, %(n)		
Not so interested		
Somewhat interested		7.1 (1)
Very interested	8 (2)	14.3 (2)
Extremely interested	44 (11)	**42.9 (6)**
	48 (12)	35.7 (5)
Interested in participating in daily exercises to improve posture, %(n)		
Somewhat interested		
Very interested	8 (2)	7.1 (1)
Extremely interested	44 (11)	**50 (7)**
	48 (12)	42.9 (6)
Taking any medicine for NP, %(n)		
Yes	16 (4)	21.4 (3)
No	**84 (21)**	**78.6 (11)**
Taking any treatment for NP, %(n)		
Yes	28 (7)	7.1(1)
No	**72 (18)**	**92.9 (13)**

Table 2: presenting descriptive statistics of IG and CG – baseline, and post-total NPDS scores.

		IG		CG	
	NPDS 20 items	Baseline (n=25)	Post (n=25)	Baseline (n=14)	Post (n=14)
		mean ± SD	mean ±SD	mean ± SD	mean ±SD
1	Pain on the day of questionnaire completion	3.9 ± 2.35	2.18 ± 1.92	3.96 ± 1.86	4.32 ± 2.24
2	Pain on average	4.32 ± 1.84	2.87 ± 1.56	4.5 ± 1.97	4.32 ± 1.37
3	Pain at its worst	6.90 ± 1.73	5.3 ± 2.48	7.36 ± 1.87	7.07 ± 1.78
4	Sleeping	3.41 ± 2.95	1.74 ± 2.26	4.93 ± 2.81	4.03 ± 2.37
5	Standing	3.18 ± 2.29	1.6 ± 1.71	3.14 ± 1.78	3.32 ± 2.24
6	Walking	2.48 ± 2.13	1.24 ± 1.51	2.43 ± 1.46	3.03 ± 2.23
7	Driving	2.5 ± 1.95	1.34 ± 1.36	3.75 ± 2.85	3.12 ± 2.61
8	Social activities	2.7 ± 2.22	1.48 ± 1.41	3.25 ± 2.56	3 ± 2.4
9	Recreational activities	2.7 ± 2.35	1.48 ±1.39	3.07 ± 2.34	2.42± 1.86
10	Working	3.98 ± 2.13	2.14 ± 1.65	3.46 ± 3.11	3.6 ± 2.62
11	Personal care	0.98 ± 1.26	0.68 ± 1.13	1.89 ± 1.82	1.96± 2.36
12	Relationships	2.12 ± 2.08	1.24 ± 1.46	1.75 ± 2	1.75 ± 1.55
13	Outlook on life and future	2.28 ± 2.88	1.3 ± 1.8	2.18 ± 2.13	1.5 ± 1.55
14	Emotions	3.61 ± 2.89	2.44 ± 2.53	3.53 ± 2.26	3.32 ± 2.35
15	Thinking /concentration	3.54 ± 2.6	2.3 ± 2.12	3.86 ± 2.77	3.5 ± 2.25
16	Stiffness	3.75 ± 1.53	2.7 ± 1.95	4.53 ± 2.38	4.18 ± 1.64
17	Turning the neck	2.78 ± 1.43	1.84 ± 1.4	3.36 ± 2.05	3.07 ± 1.85
18	Looking up /down	2.3 ± 2.14	1.5 ± 1.6	2.75 ± 2.4	2.68 ± 1.88
19	Working overhead	2.58 ± 2.26	2.18 ± 2.06	3.18± 2.5	2.64 ± 2.27
20	Effect of pain pills	4.82 ± 3.15	4.3 ± 3.65	4.25 ± 3.51	5.11 ± 3.32

Table 3: presenting paired samples t-test for IG and CG.

		Paired Differences					df	t	P-value
		N	Mean	SD	95% CI of the Difference				
					Lower	Upper			
IG	Baseline total NPDS scores - Post-total NPDS scores	25	23.02	22.94	13.55	32.5	24	5.02	0.00
CG	Baseline total NPDS scores - Post-total NPDS scores	14	3.06	19.63	-8.28	14.4	13	0.58	0.57

IG -intervention group, CG -control group, SD – standard deviation, CI- confidence interval, df – degree of freedom.

Table 4: presenting independent sample tests for IG and CG.

	IG			CG			Mean	95% CI Difference		df	t	p-value
	N	Mean	SD	N	Mean	SD	Difference	lower	upper			
Baseline total NPDS scores	25	64.82	25.54	14	71.07	30.1	-6.25	-24.66	12.17	37	-687	0.496
Post-total NPDS scores	25	41.8	21.32	14	68.01	27.14	-26.21	-42.12	-10.3	37	-3.34	0.002

IG- intervention group, **CG** - control group, **CI-** confidence interval, **df-** degree of freedom.

diagram. The descriptive statistics present the participant characteristics and other details as the majority of study participants were females 56 % (n = 14) IG and 50% (n = 7) CG. The major age group 40-49 falls in both IG 52 % (n = 13) and CG 50% (n = 7). The participants reported that they spent on a computer 6-7 hours/day was in IG 32% (n=8) and in CG 50% (n=7) and >7 hours/day was in IG 64% (n=16) and in CG 50% (n =7).

The participants reported the number of hours sitting or standing by a computer 'was rather constant in the last year' in IG 72 % (n = 18) and in CG 64.3 % (n =9). Participants 72 % (n = 18) IG and 50% (n=7) CG reported as 'sometimes' they develop NP while they interact with the computer screen. The duration of NP in IG was 76 % (n =19), and 85.7% (n=12) from 24 months and above. Easily maintenance of proper neck posture by the participants was reported by 48% (n = 12) as 'rarely' and 'sometimes' in IG and 21.4 % (n=3) as 'sometimes' and 'usually' in IG. They believed that it is 'very important' to maintain a proper neck posture for good health with 60 % (n = 15) IG and 71.4 % (n = 10) CG from the advertisement pamphlet of the present study. Participants reported that they were 'extremely interested' with 48 % (n=12) in IG and 'very interested' with 42.9 % (n = 6) in CG for trying a neck wearable device to improve posture. Participation in daily exercise to improve posture, 48 % (n = 12) in IG reported as 'extremely interested' and 50 % (n = 7) in CG reported as 'very interested'. The majority of them 84 % (n = 21) in IG and 78.6 % (n=11) in CG, reported that they do not take any medicine to relieve their NP. The majority of them, IG 72 % (n = 18) and CG 92.9 % (n = 13) were not receiving any treatment to aid in their NP recovery. Presented in table 1. Table 2 provides descriptive statistics for IG and CG for each item in the NPDS scale measured at baseline and post-intervention with mean and SD.

A paired-sample t-test was conducted within IG and CG to evaluate the change in perceived NP measured before and after the combination of training with FixaSpine and the performance of McKenzie exercises (IG) and posturaltext reminders (CG) among office workers. The total scores of NPDS (baseline and post) for IG and CG with mean ± SD and 95 % confidence interval (CI) are presented in table 3. The IG revealed that there was a statistically significant decrease in NPDS scores from time 1 (mean = 64.82, SD = 25.54) to time 2 (mean = 41.8, SD = 21.32), t (24) = 5.02, p = 0.000 (two-tailed). The magnitude of the differences in the means (mean difference = 23.02, 95% CI ranging from 13.55 to 32.5) was very large (effect size = 1.003) [47].

The CG revealed that there was no significant difference in NPDS scores from time 1 (mean = 71.07, SD = 30.10) to time 2 (mean = 68.01, SD = 27.14), t (13) =0.58, p = 0.57 (two-tailed). The mean difference in NPDS scores was 3.06, with a 95% CI ranging from -8.28 to 14.4. The magnitude of the differences in the means (mean difference = 3.06, 95% CI ranging from -8.28 to 14.4.) was very small (effect size = 0.155) [47].

An independent samples t-test was conducted to compare the baseline and post-total NPDS scores for IG and CG. Leven's test for equality of variance presents a p-value of 0.591 for baseline total NPDS scores and a p-value of 0.489 for post-total NPDS scores. This means that the variances are equal. There was no significant difference in baseline NPDS scores for IG (mean = 64.82, SD = 25.54) and CG (mean = 71.07, SD = 30.1; t (37) = -0.69, p = 0.496, two-tailed). The magnitude of the differences in the means (mean difference = -6.25, 95% CI ranging from -24.66 to 12.17) was small (Glass'delta = 0.24) [47]. There was a statistically significant difference in post-total NPDS scores for IG (mean = 41.80, SD = 21.32) and CG (mean = 68.01, SD = 27.14; t (37) = -3.34, p = 0.002, two-tailed). The magnitude of the differences in the means (mean difference = -26.21, 95% CI ranging from -42.12 to -10.3) was very large (Glass'delta = 1.23) [47]. Presented in table 4.

DISCUSSION

In this study, the IG received training for four weeks twice a day with FixaSpine and performance of McKenzie exercises (cervical retraction and thoracic spine extension) and CG received postural text reminders, once a week for four weeks. These interventions were used to evaluate the perceived change in NP measured before and after intervention among OWs. The results from this study revealed that the IG showed a significant difference from baseline to post-total NPDS scores among OWs. The CG revealed no significant difference from baseline to post-total NPDS scores among OWs. The test conducted between the two groups found no significant difference between the IG and CG at baseline however, revealed a significant difference in OWs' post-total NPDS scores. Therefore, the intervention had a significant effect on NP among OWs. This revealed the combination of the FixaSpine and McKenzie exercises' ability to decrease NP and related disabilities among OWs. The previous unpublished study conducted by Tintea [unpublished master thesis, Tintea A, Dec 2021] revealed no significant difference in NP between the FixaSpine and postural text reminders. However, both these two groups demonstrated a decrease in NP measured post-intervention among OWs. In Tintea's study [unpublished master thesis, Tintea A, Dec 2021], the CG got text reminders twice a day for four weeks which made the CG rather to an intervention group. This is the first pilot study performed with the novel approach of combining FixaSpine and McKenzie exercises for OWs with NP in Southern Sweden.

The results from this study are in line with Wani et al. [19], in their study, the combination of McKenzie exercise (cervical retraction exercises) and pressure biofeedback indicated that individuals with cervical spondylosis had much lower NP and disability. In a related study, McKenzie exercises (cervical retraction exercise) were found to be effective and superior in reducing NP, and significantly improved the cervical posture of individuals with a forward head posture [15-18,48]. In OWs with forward head posture, a combination of scapular stability and thoracic extension exercises, which are not directly applied to the cervical spine, improved posture, respiration, NP, and disability [49].

For OWs, using ergonomic solutions for the long term and receiving sufficient ergonomic training in the workplace continue to be challenging [50-2]. It is commonly advised to maintain an upright sitting position to minimize excessive external mechanical loading and muscle activity on the spine. However, OWs spend greater periods sitting with poor posture due to their intensive use of computers for work purposes [1-3,11,51-3].

Thus, increasing their chance of acquiring severe pain in the spine [1-3,53]. Another study [12] found that as neck flexion increases from a neutral position of the head and neck from 4.5–5.5 kg at 0° to 27 kg at 60°, the weight strain on the spine increases noticeably. When the head is in forward flexion for an extended period, the cervical lordosis is lost, and the thoracic kyphosis increases, thus resulting in NP and impairments [12,52,53].

FixaSpine will be useful for OWs with NP to maintain the correct sitting/standing position necessary for working with computers. When OWs divert from their usual sitting/standing position, FixaSpine prompts them to adjust their posture [23]. This is supported by the previous study [unpublished master thesis, Tintea A, Dec 2021], that FixaSpine, a neck wearable, helped OWs to become aware of their poor posture. Thus, lowering the strain on the cervical spine and resulting in reduced NP and disabilities among OWs. Numerous studies showed that WPCS were employed to lower NP among OWs in favor of the usage of FixaSpine in this study [11,20,21,54,55]. According to the study [12], OWs who used WPCS had decreased neck flexion angles and gravity stresses on their necks by 8% and 14%, respectively. Other studies indicated that WPCS were effective in enhancing general health, enhancing posture, and lowering NP [20,21,54,55]. Therefore, the combination of FixaSpine and McKenzies's exercises was an excellent idea to manage NP among OWs who experienced NP while they work with the computer. Based on this study's significant findings, this intervention would assist OWs in reducing NP, ideally, preventing NP while also enhancing posture. To confirm this a larger study randomized control trial (RCT) is needed involving the three intervention groups: FixaSpine and McKenzie's exercises, only FixaSpine and only McKenzie's exercises plus a CG.

Strength of this study: This study adheres to the TRENDS guidelines. The use of a combination of training with FixaSpine and McKenzie exercises among OWs with NP. There was no charge for the intervention. All OWs with NP, regardless of sex or ethnicity, were eligible to participate in this study. The data storage and collection are safe with the SUNET survey platform.

Limitations of this study: Employing different CGs (FixaSpine, McKenzie exercises) was not feasible due to the timeframe. Measurements of neck loading, cervical range of motion, and monitoring of posture, were not performed in this research. The participants and the researcher were not blinded to the intervention and data analysis in this study.

Significance of the study: The significant result from this study develops a hope that there is a better intervention for OWs with NP. This intervention raises awareness of the loading factor among OWs with NP. The use of FixaSpine and McKenzie exercises will benefit the OWs in the management of NP. This intervention would also be appropriate to practice as e-health to reduce NP among OWs and hopefully improve their posture and prevent NP. This study also guides the consideration of strengths and limitations while performing a clinical trial study such as a randomized control trial (RCT) with a large sample size among OWs with NP [56,57].

CONCLUSION

There is a decrease in perceived NP measured before and after the combination of training with FixaSpine and the performance of McKenzie exercises among OWs in comparison with postural text reminders. Thus, this intervention is found to be beneficial for OWs in the management of NP. However, incorporating considerations of limitations from this study will result in better results for OWs with NP. Further research is needed to consider these aspects following this intervention and considering RCT study with a large sample size.

ABBREVIATIONS

NP- Neck pain
OWs- Office workers
WPCS- Wearable posture correction sensors
ICF- International classification of functioning, disability, and health framework
TRENDS- Transparent Reporting of Evaluations with Nonrandomized Designs
NPRS- Numeric Pain Rating Scale
IG - Intervention group
CG- Control group
NPDS- Neck Pain and Disability Scale
SD- Standard deviation
CI- Confidence interval
RCT- Randomized control trial

ACKNOWLEDGEMENTS

I would like to thank Professor Fredrik Nilsson (Ph.D.) and physiotherapist Eva Ekesbo (RPT / Ergonomist) for introducing me to the Fixa Spine, and the exercises, and for guidance during the research project. I would like to thank all my participants for their participation in this study by providing their precious time.

ETHICS APPROVAL AND STUDY PARTICIPANTS' CONSENT:

An ethical application was sent to Swedish Ethical Review Authority (Dnr 2020 – 06967) for intervention studies using the wearable FixaSpine. The Ethical Review Authority did not consider the research to be covered by the law. However, a formal statement was given that the Ethical Review Authority had no ethical concerns about the FixaSpine research project (2021-02-03). The study was conducted according to the world medical association and the principles of the Declaration of Helsinki. The information letter (oral and written) was provided to all the study participants who fulfilled the inclusion criteria. The information letter consists of the purpose of the study, voluntary participation, ensuring anonymity, confidentiality, integrity, and protection of data. Informed consent was obtained from all the study participants before the study. The data was collected by using Lund University SUNET survey platform. The data gathered throughout the study was securely preserved. The data and report were not linked to any personal information.

Conflicts of interest: None

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How to cite this article: Naba Yasmeen. Evaluation of FixaSpine and Mckenzie Exercises In Comparison with Postural Text Reminders on Neck Pain among Office Workers: A Pilot Study. Int J Physiother Res 2023;11(2):4483-4496. **DOI:** 10.16965/ijpr.2023.112

Baseline survey questionnaires

Please read carefully: This questionnaire has been designed to enable us to understand how your neck pain has affected your ability to manage everyday activities. There are no foreseeable risks associated with this project and you can withdraw at any moment. I assure you that the survey response will be confidential. All the data from this research will be protected and reported appropriately. The publication of the study will not be linked to any personal information. The scale is easy, and it takes < 7 minutes to complete. Please select any one box below that describes your current situation regarding neck pain and some other boxes require a writing number. If you have any questions related to this research project, please contact Naba Yasmeen at the email address: na2788ya-s@student.lu.se

[1]. Please select the gender.

□Male □Female □Non-binary □I don't want to answer

[2]. Please select your age group.

□18 – 29 □ 30 – 39 □ 40 – 49 □ 50 – 59 □ 60 and above

[3].Please select the approximate number of hours /days, you spend working by a computer or at a desk.

□Less than 3 hours □ 3 -5 hours □ 5 -7 hours □More than 7 hours

[4]. Please select your number of hours sitting/standing by a computer or at a desk.

□Decreased in the last year □Was rather constant in the last year □Increased in the last year

[5]. Your interaction with the computer /laptop screen, during sitting/standing by a computer / at the desk, how often do you feel neck pain?

□Never □Rarely □ Sometimes □Usually □Always

[6]. Write the duration of neck pain, that you have been suffering from (weeks, months, and years) in numbers.

□ Week/s □ Month/s □ Year/s

[7]. I can easily maintain proper neck posture:

□Never □ Rarely □Sometimes □ Usually □Always

[8]. Do you believe that a proper neck posture is important to maintain good health?

□ Not at all importan □Not so important □ Somewhat important □Very important □ Extremely important

[9]. I would be interested in trying a neck wearable device to improve my posture.

□ Not at all interested □ Not so interested □ Somewhat interested □ Very interested □Extremely interested

[10]. I would be interested in participating in daily exercises to improve my neck posture.

□ Not at all interested □ Not so interested □ Somewhat interested □ Very interested □ Extremely interested

[11]. Do you take any medications for relieving neck pain?

YES, NO

[12]. Are you taking any treatment for neck pain?

YES, NO

The following answers require a number to enter that describes your current neck pain in different situations (0-100) (NPDS scale).

[13]. "How bad is your neck pain today?" [27]. (0 = no pain and 100 = most severe pain) [27].
[14]. "How bad is your neck pain in average?" [27]. (0 = no pain & 100 = most severe pain) [27].
[15]. "How bad is your neck pain at its worst?" [27].(0 = no pain & 100 = cannot tolerate) [27].
[16]. "Does your neck pain interference with your sleep?" [27]. (0 = not at all & 100 = cannot sleep) [27].
[17]. "How bad is your neck pain with standing?" [27]. (0 = no pain &100 = most severe pain) [27].
[18]. "How bad is your neck pain with walking?" [27]. (0 = no pain &100 = most severe pain) [27].
[19]. "Does your neck pain interference with driving or riding a car?" [27]. (0 = not al all & 100 = cannot drive or ride) [27].
[20]. "Does your neck pain interference with social activities?" [27]. (0 = not at all &100 = always) [27].
[21]. "Does your neck pain interference with recreational activities?" [27]. (0 = not at all &100 = always) [27].
[22]. "Does your neck pain interference with work activities?" [27]. (0 = not at all &100 = cannot work) [27].
[23]. "Does your neck pain interference with personal care (eating, dressing, bathing, etc...)?" [27]. (0 = not at all &100 = always) [27].
[24]. "Does your neck pain interference with personal relationships (family, friends, sex etc.)?" [27]. (0 =not at all &100 = always) [27].
[25]. "How your neck pain changed your outlook on life and the future (depression, hopelessness)?" [27]. (0 = not at all & 100 = completely changed) [27].
[26]. "Does pain affect your emotions?" [27]. (0 = not at all &100 = completely) [27].
[27]. "Does your pain affect your ability to think or concentrate?" [27]. (0 = not at all &100 = completely) [27].
[28]. "How stiff is your neck?" [27]. (0 = not stiff &100 = cannot move neck) [27].
[29]. "How much trouble do you have turning your neck?" [27]. (0 = no trouble &100 = cannot move neck) [27].
[30]. "How much trouble do you have looking up and down?" [27]. (0 = no trouble &100 = cannot look up or down) [27].
[31]. "How much trouble do you have working overhead?" [27]. (0 = no trouble &100 = cannot work overhead) [27].
[32]. "How much do pain pills help?" [27]. (0 = complete relief &100 = no relief) [27].

Thank you for participating in this survey.