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ARTICLE

Comparison of two different delivery methods of home-based exercise on neck pain

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ABSTRACT

Aim: This study aimed to compare the effects of two different home-based exercise delivery methods on compliance, pain, and disability in participants with non-specific neck pain.

Materials & methods: The study, which was carried out at Istanbul Arel University between February and May 2018, was carried out with 60 participants from university staff, aged 25–60, suffering from non-specific neck pain. The cases were randomly assigned to two groups. A home exercise method with printed material exercise was given to the patients in Group 1, and a video phone reminder exercise was given to Group 2 for six weeks in both groups. Pain severity and neck disability were evaluated before and after the exercise with the 'Visual Analogue Scale' and the 'Neck Pain and Disability Score.'

Results: Descriptive statistics showed that the video phone reminder exercise group had greater compliance. Neck pain and neck disability assessments improved before and after the exercise in both groups ($p < .001$). Statistical analysis revealed that video phone reminder exercise scores were significantly higher than those of the control group. Effect sizes were evaluated between the two groups, and the difference between them were found to be clinically significant ($d > 0.8$).

Conclusions: The home exercise method with video and telephone reminders, which can be applied instead of the traditional method provided with printed materials, is more effective for compliance, pain severity, and neck disability.

Trial registration: NCT04135144. Registered on 21 September 2019. Retrospectively.

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KEYWORDS
Neck pain; Visual Analogue Scale; mobile applications; exercise therapy

Introduction

Neck pain is among the most common complaints of the musculoskeletal system. Approximately two-thirds of individuals in society will experience neck pain at some point in their lifetime. Thirty percent of patients with acute neck pain develop chronic symptoms. The prevalence of disability increases when pain becomes chronic (Haldeman et al. 2010).

The number of people with neck posture disorder and pain has increased proportionally as a result of working conditions at a desk, which has increased as a result of modern living conditions (Mohan et al. 2015). Due to working in the same position for long periods of time, many people today suffer from musculoskeletal problems such as shoulder, neck, and low back pain. The term 'work-related musculoskeletal disorder' refers to injuries or disorders of the musculoskeletal system, which includes muscles, nerves, tendons, joints, cartilage, and spinal discs, which may be caused by exposure to risk factors at work. Several studies have demonstrated that academicians in higher learning institutions suffer from neck pain more frequently than other musculoskeletal disorders (Klaber Moffett et al. 2005; Shariat et al. 2016).

Conservative approaches are the first treatment of choice in the management of non-specific neck pain. There is moderate to high-quality evidence that exercise therapy can reduce neck pain intensity and disability. In spite of this, it is not yet clear which approach would be most appropriate. Klaber Moffett et al. (2005) stated that studies are needed to investigate more effective treatment methods for neck pain. There is no doubt that home exercises are an essential part of the treatment of neck pain. The most significant problems are adherence to exercise therapy and the lack of compliance with exercise therapy (Bertozzi et al. 2013).

There is generally low compliance with the exercise. As a result, Rainville et al. (2004) emphasize the importance of determining the factors affecting compliance and devising new methods to ensure compliance.

The PhysioTools software is a kind of exercise portal that features pictures, illustrations, and videos. In this software (PhysioTools Sverige, Malmo, Sweden), the physiotherapist prescribes appropriate exercises through the compatible

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phone application. In the phone application, a reminder feature and the ability to mark whether or not the exercise has been performed increase the patient's motivation to continue exercising. In addition, it facilitates the follow-up of the patient by the physiotherapist (Walther et al. 2004).

There are limited studies in the literature comparing the effectiveness of different home-based exercise methods for individuals with non-specific neck pain. A video-based reminder application is hypothesized to increase compliance with home-based exercise, which is why PhysioTools was used. Therefore, this study is of special value. This study aimed to compare the effects of two different home-based exercise delivery methods on compliance, pain, and disability in individuals with non-specific neck pain.

Materials and methods

Trial design

The study was designed as a prospective, randomized trial. The study was conducted at Haliç University. Haliç University's Non-Interventional Clinical Research Ethics Committee approved the study on 26 December 2017, number 223. A Helsinki Declaration was followed during the conduct of the study. Trial registration number NCT04135144 has been assigned to this study by ClinicalTrials.gov.

Participants

The study was conducted between February 2018 and May 2018 with the participation of academic and administrative university staff at Istanbul Arel University Vocational School with neck pain. An e-mail was sent to 210 people to inquire about their neck pain. There were 149 responses received. The study included 84 participants who reported symptoms of neck pain and were screened by a general practitioner at a public primary care centre and diagnosed with NSNP. There was a requirement that participants be between 25 and 60 years of age. A participant who has undergone neck surgery, suffered severe trauma, or had a neck-related diagnosis and regularly took pain medication was excluded. All participants gave written informed consent.

The study was conducted on 65 individuals who met the study criteria (Figure 1). Researchers (H.G.Y.) divided participants into two groups by giving them numbers rather than names.

Outcome measures

Physiotherapist (H.D.) collected demographic information at the beginning of treatment. The same researcher evaluated all study outcomes at baseline and immediately following treatment for six weeks.

It was determined the severity of the pain using a Visual Analogue Scale (VAS). There is a 10-cm line on the VAS, with the left end indicating no pain and the right end indicating intolerable pain (Crichton 2001). Pain during rest was asked of each participant.

The Neck Pain and Disability Scale (NPDS) was used to assess pain and disability associated with daily living activities in Turkish people (Bicer et al. 2004). An NPDS

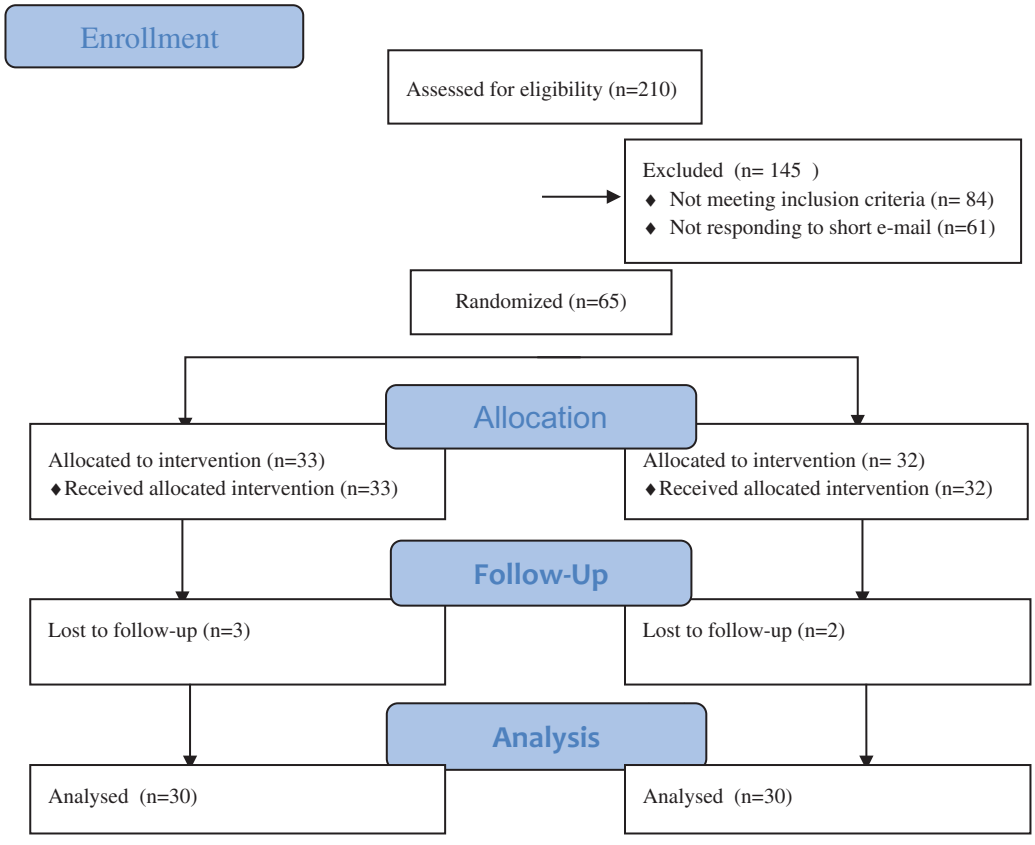

Figure 1. Flow chart.

questionnaire consists of 20 items addressing neck problems, pain intensity, emotion and cognition, and interference with daily activities. It is possible to score each item between 0 and 5, with a maximum score of 100 (0: no pain limitation, 5: maximum pain limitation). According to Wheeler et al. (1999), higher scores indicate a lower quality of life.

The participant's compliance with the online chart or brochure was recorded in days as completed or not completed.

Interventions

The participants were randomly divided into two groups. The first group was provided with printed materials and a home exercise method (printed material exercise [PME]), whereas the second group was provided with a video and telephone reminder system with a home exercise method (video phone reminder exercise [VPRE]) as well as the materials needed to perform home exercises. PME group completed the exercise program and marked the attendance schedule for the exercise. These charts were collected from the participants at the end of the program and their compliance was evaluated (Figure 2(a,b)). The VPRE group used the app to mark completed exercises. Using this application, users will receive notifications when it is time for them to perform exercises, watch videos of exercising, mark their exercises, and receive a reminder. According to the program used, compliance with the cases was measured in terms of days (Figure 3(a–c)).

The physiotherapist (Ö.Y.) presented information to all participants about neck pain, risk factors, exercises used to treat neck pain, and prevention methods. Physiotherapists explained and demonstrated the home-based exercises that would be given to all participants before the exercise program began. All exercises were performed in the same order in the Physiotools application and the brochure for both groups. Exercises were performed at least three times per week. During the six weeks of home training, each movement was performed 10 times with one set per day.

In seated position, participants were instructed to perform range of motion exercises (neck flexion, lateral flexion, rotation, extension, and retraction); isometric exercises (cervical flexion, extension, rotation, and lateral flexion in the seated position) and stretching exercises (cervical flexion, extension, rotation, and lateral flexion in the seated position) (Appendix). A number of studies have examined the effectiveness of range of motion exercises, strength exercises, and stretching exercises in the treatment of patients with neck pain (Bertozzi et al. 2013; Fredin and Lorås 2017). As stated in the JOSPT Neck Pain: Revision 2017 guidelines, cervical stretching and strengthening exercises have been recommended in order to reduce pain and improve function in patients with chronic neck pain and limited range of motion (Blanpied et al. 2017).

Data analysis

The sample size was estimated using G Power v. 3.1. A sample size of 30 patients per group was sufficient for repeated measures with a power of 0.8, an effect size of 2.4, and an alpha of 0.05 (Lee and Kim 2016). Considering the possibility of dropouts, 65 participants were recruited for the study.

The data were collected using the SPSS 22.0 Program (Statistical Package for Social Sciences). A significance value of 0.05 was considered significant statistically. In order to determine the normal distribution of the variables, the Kolmogorov Smirnow and Skewness and Kurtosis tests were used, since the Shapiro and Wilk test was initially limited to a sample size of less than 50 and this study concluded with 60 participants (Razali and Wah 2011). In the descriptive analysis, means (95% confidence intervals, CIs) and standard deviations (SDs) or percentages were used. Parametric and non-parametric tests were used to analyse the data. Independent sample T-tests were used to evaluate age since it was a normal distribution. VAS and NPDS values and compliance did not fit the normal distribution. Therefore, Wilcoxon analysis was used to evaluate within-group variation. The Mann–Whitney-U test was used to compare VAS and NPDS values between groups and compliance. ESs were calculated by dividing the difference in the baseline and follow-up means by the SD at baseline; for intragroup comparisons, ESs of 0.2, 0.5, and 0.8 were considered small, moderate, and large, respectively.

Results

There were 33 participants in the PME group and 32 participants in the VPRE group. Three participants in the PME group and two participants in the VPRE group did not finish the study; therefore, 30 participants were included in the assessment (Figure 1). There was a mean age of 34.5 with 9.2 years for the PME group, while a mean age of 33.4 with 5.7 years for the VPRE group. A gender distribution of 55% indicated female cases and 45% indicated male cases. Among the participants in the PME group, 56.7% were female and 43.3% were male. Of the participants in the VPRE group, 53.3% were female and 46.7% were male. There were no significant differences in demographic characteristics between the groups at baseline ($p > .05$) (Table 1).

It was not found that there was a significant difference in the baseline VAS and NPDS values between the two groups ($p > .05$). When comparing the VAS values and the NPDS values before and after the exercise program, it was found that they decreased significantly (p .05) (Table 2). According to the results of the mean comparison, the VPRE group experienced a greater reduction in pain and disability than the PME group ($p < .05$). In both groups, there was a significant difference in VAS and NPDS scores, indicating that the ESs for the VPRE group were larger than in the PME group (Table 2).

There was a significant difference in compliance between the PME group and the VPRE group (p .05). When descriptive statistics were analysed and the averages were compared, it was found that the VPRE group had greater compliance than the PME group. The difference between the two groups was found to be significant enough to be considered clinically significant when the effect sizes of the outcome measures were evaluated between the two groups. There was a

EGZERSİZ PROGRAMI

EGZERSİZ DEVAM ÇİZELGESİ

		PAZARTESİ	SALI	ÇARŞAMBA	PERŞEMBE	CUMA	CUMARETESİ	PAZAR
1.HAFTA	Hiç Yapmadım							
	Kısmen Yaptım							
	Tamamen Yaptım							
2.HAFTA	Hiç Yapmadım							
	Kısmen Yaptım							
	Tamamen Yaptım							
3.HAFTA	Hiç Yapmadım							
	Kısmen Yaptım							
	Tamamen Yaptım							
4.HAFTA	Hiç Yapmadım							
	Kısmen Yaptım							
	Tamamen Yaptım							
5.HAFTA	Hiç Yapmadım							
	Kısmen Yaptım							
	Tamamen Yaptım							
6.HAFTA	Hiç Yapmadım							
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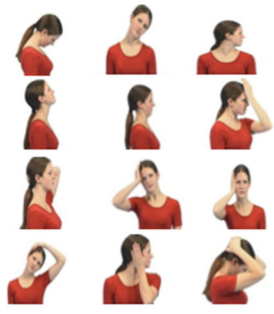
	Tamamen Yaptım							

EV EGZERSİZ PROGRAMI VE ÇİZELGESİ



- **Egzersizleri haftanın her günü ve günde bir defa uygulayınız.**
- **Egzersizlere devamlılığınız boyun ve çevresindeki kaslarınızın gevşemesini ve kuvvetlenmesini sağlayıp, boyun ağrısı şikayetinizin azalmasına katkı sağlayacaktır.**
- **Çalışmanın güvenilirliği için lütfen işaretlemelerinizi gerçekçi yapınız.**

'Boyun Ağrısında İki Farklı Ev Egzersizi Programının Etkinliğinin Karşılaştırılması' İsimli tez çalışması için hazırlanmıştır.

ÖĞR. GÖR. FZT. ÖZDEN LAÇİN

Figure 2. (a,b) Printed materials exercises.

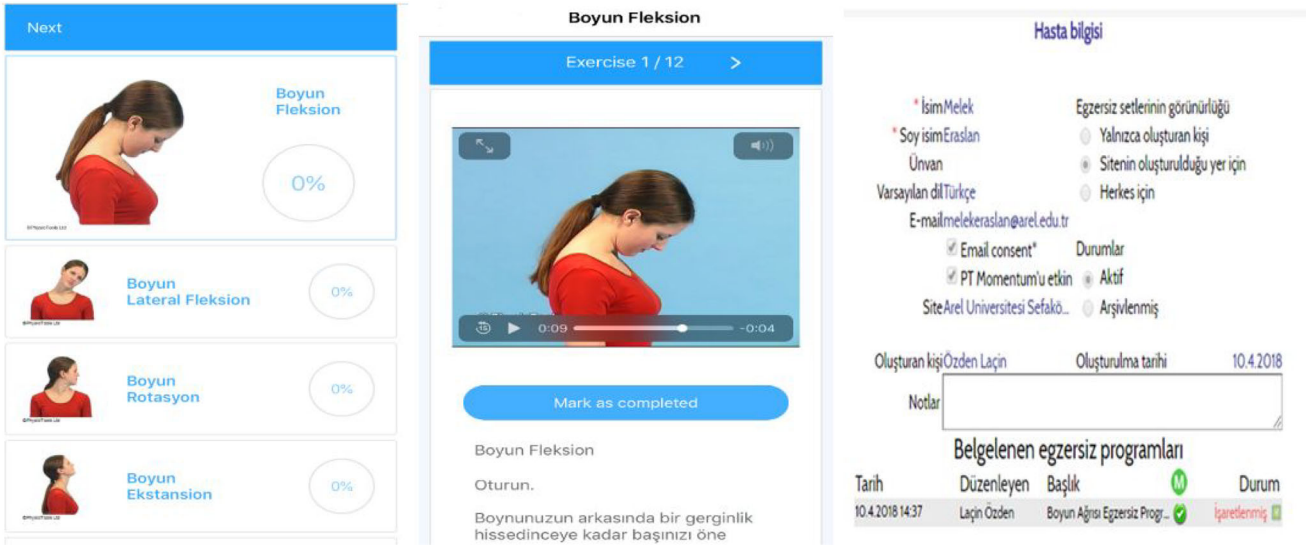


Figure 3. (a–c) Video phone reminder exercise (Physiotools program).

Table 1. Baseline demographics of groups.

	PME group ($N = 30$)	VPRE group ($N = 30$)	p between groups
Age (year) X ± SD (min–max)	34.5 ± 9.2	33.4 ± 5.7	.5[a]
Gender (female/male(%))	17/13 (56.7/43.3%)	16/14 (53.3/46.7%)	.7[b]

Note: VAS: Visual Analogue Scale; NPDS: Neck Pain and Disability Scale; PME: printed material exercise; VPRE: video phone reminder exercise; SD: standard deviation; p: .05.
[a]Independent sample T-test.
[b]Chi-square test.

Table 2. Comparison of pain, disability, and compliance within the group and between groups.

	Baseline mean ± SD *(min–max)*	After six weeks: Mean ± SD (min–max)	After six weeks: Mean difference within group	After six weeks: Mean difference between groups 95%CI	Effect size	p[a] Within group	p[b] Between groups
VAS (cm)							
PME group	4.7 ± 2.2(1–10)	3.1 ± 1.5(1–6)	−1.6 ± 1.0	−0.9 (1.45 to 0.35)	0.44[d]	<.001	.001
VPRE group	5.1 ± 1.4(2–8)	2.6 ± 0.9(1–5)	−2.5 ± 1.13		0.80[c]	<.001	
NPDS							
PME group	36.3 ± 21.5(11–78)	28.8 ± 16.5(8–58)	−7.5 ± 6.4	−6.8 (−9.17 to 4.43)	0.34[d]	<.001	.000
VPRE group	31.4 ± 15.9(8–84)	17.1 ± 9.4(5–54)	−14.3 ± 7.8		0.90[c]	<.001	
Compliance							
PME group		23.9 ± 5.7		−5.3 (−8.38 to −2.22)	0.89[c]		.001
VPRE group		29.2 ± 6.2					

Note: VAS: Visual Analogue Scale; NPDS: Neck Pain and Disability Scale; PME: printed material exercise; VPRE: video phone reminder exercise; min–max: minimum–maximum; SD: standard deviation.
[a]Willcoxon Signed Rank test.
[b]Mann–Whitney U test.
[c]Large effect size.
[d]Small effect size.
$p < .05$.

greater ES of exercise compliance in the VPRE group than in the PME group (Table 2).

Discussion

A significant improvement in pain and disability scores was observed for patients in the VPRE group following six weeks of exercise. Furthermore, they showed lower pain and disability scores than patients in the PME group, indicating that mobile phone applications may be useful for patient management.

Studies show that neck pain is predominantly female in the distribution of neck pain by gender. According to research, neck pain is associated with physical and psychosocial factors, including a lack of movement, constant posture, and office work. This study included academic university employees who have been using desktop

computers for many years (Ye et al. 2017; Kim et al. 2018). In this study, 55% of the subjects were women, and 56% of the instructors who were reached by SMS reported neck pain, which is consistent with the literature.

A total of 268 participants were divided into three groups by Van den Heuvel et al. Computer employees. Software program was used to remind employees to take breaks or exercise. One group took a break during the study and the other group was instructed to exercise during breaks for eight-weeks. It was observed that exercise significantly reduced work-related neck and upper extremity pain (Van den Heuvel et al. 2003). The study by Hodges and Moseley demonstrated the reduction of neck pain. As stated in Linton and van Tulder's review of exercise therapy for neck pain, exercise therapy prevents neck pain (Linton and van Tulder 2001; Hodges and Moseley 2003). According to Shafer-Crane (2006) study conducted with musicians, posture exercises, stretching exercises, and strengthening exercises should be provided as home exercises for neck and shoulder pain. Lin et al. (2017) divided patients into two groups for their study on chronic neck pain. In both groups, exercise was performed three times a week for six weeks and significant improvements in cervical muscle strength were observed after the exercise program. It has been shown that regular exercise helps reduce chronic pain by increasing endogenous opioid production, which is an important factor in modulating pain (Lima et al. 2017).

Jull et al. (2007) compared multimodal physiotherapy (deep neck flexor and extensor muscle training, scapula stabilization exercises, cervical mobilization techniques and training program) with home exercises for 10 weeks. In another study by França et al. (2008), patients with tense neck syndrome were randomly divided into three groups and the results of the multimodal physiotherapy group were significantly better than the home program. For the first group, acupuncture was administered in conjunction with physiotherapy, for the second group only acupuncture was administered, and for the third group, physiotherapy was administered only once per week. Physiotherapy included deep neck flexion muscle training as well as stretching and strengthening exercises for the neck and shoulder girdle. Disability status improved in all groups.

In this study, the exercise programs included normal joint movements and isometric and stretching exercises for six weeks. The results of our study suggest that exercises applied at home provide statistically significant positive effects on patients' recovery when compared to both methods. According to the literature, we believe that the significant decrease in pain and disability was due to exercise in both groups. However, the fact that this decrease was higher in the VPRE group suggests that exercise compliance was higher in this group. Even though pain decreases, it does not disappear because patients did not change their living conditions, they continued to work hard at the desk, and other psychosocial factors remained the same.

An evaluation of supervised exercise training for chronic neck pain has been published in the literature. According to Bunketorp et al. (2006), exercise training reduces pain and disability more effectively than self-administered exercise training. As shown by Pedersen et al. (2013), patients who received supervised strength training sessions for back, neck, and upper extremity claws at their workplace exhibited a greater level of adherence. This examination indicates that supervised training improves compliance with home exercises and improves pain and disability in patients with neck pain. As a consequence of our findings, home exercise is more effective when accompanied by continuous monitoring, which is consistent with this performance.

It has been shown that home exercises have a positive effect on treatment in Ludewig and Borstad (2003) and Capodaglio et al. (2002), despite concerns regarding adaptation and compliance. Exercise is an integral part of all conservative treatment methods (Fiebert et al. 2004). The effectiveness of home exercises grew in importance at this point as people should continue their daily exercise programs during and after the treatment. The effectiveness of home exercise programs and not the following treatment may, however, decrease the success of the treatment (Flynn 2018) when the effectiveness is unclear. A study conducted by Capodaglio et al. (2002) investigated the effectiveness of home exercises taught to patients, and telephone follow-up and control were enabled by the treatment. According to the findings, home exercises were more effective than those given solely as recommendations. Furthermore, compliance can be monitored by the therapist, which increases compliance and provides quantitative data as a result of continuity of treatment. The physiotherapist who instructs the patient on the exercise program increases the patient's ability to perform the exercises with visual reinforcement, as demonstrated by Ay et al. (2013). In this group, a follow-up feature was thought to have affected the outcome of the exercise method.

Several studies have suggested that the decrease in compliance is associated with patients' forgetfulness about exercise. As a result, they have difficulty fitting exercise into their daily routines. A significant difference was observed between patients who performed regular home rehabilitation at month 6 and those who performed home-based telemedicine at day 15 in one study: 27.7% in the control group and 6.4% in the telemedicine group. As a result of the telemedicine program, the tendency to forget to exercise may be reduced (Gialanella et al. 2017).

The aim of Stookey and Katzel (2020) was to provide an overview of the most recent studies on home-based exercise interventions for frail older adults. According to them, supervision may enhance accountability that cannot be achieved by sporadic supervision or no supervision at all. This may result in a higher rate of adherence. To clarify the most efficient method of delivery and the optimal components of home exercise programs, future research will be required. Takatori et al., 2016 examined whether home exercise to prevent aspiration pneumonia and accidental falls improves swallowing and physical functions in frail elderly women living in the community using a randomized controlled trial. The six-month intervention period was found to be highly conducive to high compliance with the exercise program. It

is stated that this result was due to the fact that the intervention group participants were provided with the original exercise DVD and a brochure describing the exercise program free of charge. They could easily perform the exercise at home and without supervision.

According to this study, VPRE compliance was higher than PME compliance. This result supports studies indicating that follow-up should be followed to ensure compliance. By reminding the patient of the exercises and supporting the movement execution with visual stimuli such as videos, the patient's compliance with the exercise program and treatment can be increased at a level that alleviates the symptoms of neck pain.

Limitations and suggestions

This study has some limitations. It is important to note that the present study was conducted for six weeks, so longer follow-up studies are required. Additionally, it is possible that the primary outcomes associated with cognitive processes were not evaluated (i.e., distress and quality of life). Additionally, the current study has a small statistical sample size, which may make it difficult to generalize the results to a wider population.

In our opinion, further studies should focus on the long-term effectiveness of home-based exercises with visual support for neck pain. Furthermore, future studies that will contribute to health practice in physiotherapy should also examine other variables, including muscle strength, muscular endurance, cervical range of motion, distress, quality of life, or pressure pain threshold.

Conclusion

In terms of whether new methods for increasing the compliance of patients can contribute to the solution to this problem, this study is one of the first studies in this field with a randomized controlled design. The results of this randomized controlled trial demonstrated that this software providing home-based exercises with video and reminders significantly increases patient compliance and reduces neck pain and disability as compared with conventional home exercise methods delivered through printed materials with a clinically larger effect. For non-specific neck pain, home-based exercise using these types of phone applications appears to be more effective in reducing pain and disability.

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Appendix. Exercise program

Exercise	Description
	All movements are done in a sitting position, held in position for 10 s. Repeats 10 times.
Range of motion exercises	Tilt the head forward until the participant feels a stretch in the back of their neck.
Neck flexion	He feels the other side coming as he bends his neck towards one shoulder.
Neck lateral flexion	As the participant moves his neck towards the right and then the left shoulder, he feels the other side being stretched.
Head rotation	The participant turns his head to the right and left until he feels tension.
Head extension	The participant tilts his head back as far as he feels comfortable
Head retraction	The participant tries to straighten his neck by pulling his chin inward. He holds it at the last point and feels the tension in his neck.
Isometric exercises	While the participant tries to tilt his head forward, he prevents the movement by giving resistance with his
Neck flexion	hand.
Neck extension	While the participant tries to tilt his head back, he prevents the movement by giving resistance with his hand.
Neck lateral flexion	The participant resists this movement with his hand while tilting his head to the side.
Head rotation	While the participant tries to turn his head to the right and left, he prevents the movement by giving resistance with his hand.
Streching exercises	The participant sits with his hands clasped behind his head. Tilt your head forward until you feel a stretch in
Neck flexion	the back of your neck. He pushes his head slightly forward with his hands.
Neck lateral flexion	The participant tilts their head towards your right and left shoulders until they feel a stretch on the opposite side. He tries to bend his head a little more with his hand.
Head rotation	The participant turns his head to one side until he feels a stretch. Slowly turn your head a little further with your hand.