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The effect of home exercises with kinesiotaping on pain, functionality, and work performance in bus drivers with non-specific neck pain

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Abstract.
BACKGROUND: Clinical research on the management and rehabilitation of work-related upper spinal pain in bus drivers is sparse, indicating a gap in knowledge and treatment strategies. This highlights the growing need for innovative approaches to rehabilitation programs in this area.
OBJECTIVE: To examine the effects of kinesio taping (KT) on pain, functionality, and work performance in bus drivers experiencing neck pain.
METHODS: The study involved 44 participants who were randomised into two different groups: the exercise group ($n = 22$) and the kinesio tape group ($n = 22$), with participants in both groups undertaking exercise interventions. Evaluations were made before and after 6 weeks of treatment. At the end of the 6-week, the participants' ROM, pain evaluations and functional scales were evaluated with disability, and work functionality.
RESULTS: Neck pain severity decreased in both groups ($p < 0.001$ for each value), but there was no difference between the groups (p: 0.071). When disability scores were evaluated, improvement was noted in both groups (p: 0.001 for each value), but no statistically significant difference was found (p: 0.754). When the improvements in ROM values before and after the treatment were examined, the difference between the groups was recorded only in the neck extension ROM value (p: 0.011). Significant improvement was noted in all sub-steps of job performance in both groups ($p < 0.05$).
CONCLUSION: KT added to ergonomic training and home exercise programmes is effective in controlling work-related musculoskeletal pain in drivers with neck pain. However, the addition of KT to exercise therapy was found to be no more effective than exercise therapy alone in improving pain control, functionality and work performance.

Keywords: Ergonomics, muscle stretching exercises, occupational diseases

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1. Introduction

Driving is a profession that entails operating motor vehicles for extended periods as a duty. Negative conditions in traffic (such as interrupted traffic, anxiety about catching up, and increased physical load) can compromise the health of drivers and expose them to musculoskeletal system problems [1,2]. Bus drivers are among the top three professional drivers with the highest incidence of musculoskeletal disorders [3,4].

Neck pain is a common musculoskeletal complaint and can significantly affect an individual's quality of life and work performance. Bus drivers are particularly susceptible to neck pain due to prolonged static postures, vibrations, and repetitive movements. There is insufficient epidemiological data to support a link between whole-body vibration and neck pain. However, studies have reported that neck symptoms in bus drivers are associated with exposure to whole-body vibration, as well as other physical risk factors such as poor posture and heavy lifting [2,5]. A previous study reported that drivers who drove for long periods were more likely to experience neck pain than drivers who drove for shorter periods [6]. In recent years, the prevalence of neck pain among drivers has become a growing concern, affecting both their health and their ability to do their jobs [6,7]. Workability refers to employees' ability to efficiently perform their jobs, considering job demands, health, and psychological fitness. Studies are conducted to enhance health, prevent diseases and injuries, ultimately aiming to improve job performance and employee well-being [8].

Exercise approaches for mechanical neck pain in bus drivers have been a focus of research, with studies highlighting the effectiveness of specific interventions. When looking at systematic reviews for the treatment of mechanical neck pain, non-pharmacological interventions have been shown to be effective. Specifically, interventions such as manipulation, joint mobilisation, strengthening exercises, massage therapy, stretching exercises and kinesio taping (KT) have been recommended [9,10,11]. Research has shown that a multimodal approach combining manual therapies for cervical musculoskeletal disorders, active neck exercises and therapeutic interventions can lead to improvements in pain control and disability in people with chronic neck pain, including bus drivers. In addition, studies have highlighted the importance of tailored exercise programmes, such as cervical-scapulothoracic and upper extremity strength training, scapulothoracic and upper extremity endurance training, and combined cervical, shoulder and scapulothoracic strengthening and stretching exercises, which have shown beneficial effects on pain and function at various follow-up periods [12,13]. These findings highlight the importance of personalised exercise programmes targeting specific muscle groups and postural corrections to improve outcomes in people with mechanical neck pain, particularly in occupational settings such as bus driving where ergonomic factors play a crucial role in neck health [12]. Further high-quality research is needed to investigate the effectiveness of different treatment modalities and their specific impact on functional outcomes and pain management in patients with mechanical neck pain [14].

KT is recognized as an effective adjunct treatment for various conditions, including neck pain, and is easy to apply, making it increasingly popular as part of supplementary treatments to enhance existing treatment programs [1,15,16]. Studies have shown that KT can aid in pain management and improve muscle strength, which is particularly beneficial for bus drivers [17,18]. The application of KT has shown a significant reduction in pain levels after treatment, highlighting its efficacy in pain control. The mechanisms underlying its effectiveness include mechanical effects such as reducing muscle load, improving circulation by reducing pressure on blood vessels, and providing pain relief through the gate control theory [15]. Research examining the impact of KT on neck pain across various age groups indicates that utilizing KT alongside stretching exercises among professional drivers could result in enhancements in neck pain, pressure pain threshold, neck pain-related disability, and active cervical range of motion [17]. Notably, a separate study involving bus drivers underscored notable enhancements in cervical range of motion movements – such as flexion, right lateral flexion, left lateral flexion, right rotation, and left rotation – through the combination of KT and stretching exercises [1]. Self-administered stretching combined with KT emerges as a potentially effective intervention for managing neck pain among bus drivers. These findings underscore the potential benefits of combining KT with appropriate exercises for effectively managing neck pain in bus drivers. However, there are not enough studies to confirm the effectiveness of self-stretching combined with KT in the treatment of chronic neck pain in bus drivers.

Pain assessment in bus drivers focuses on the lumbar region in most articles. The number of studies investigating the evaluations of the upper spinal region and the mechanism of pain is few and insufficient. Despite the increase in preventive rehabilitation programs aimed

at improving job performance, rehabilitation programs aimed at improving bus drivers' pain and pain-related disabilities and job performance are limited. The literature highlights the need for appropriate rehabilitation programs and ergonomic interventions to prevent and manage neck pain among bus drivers [19].

The study aims to address the gap in existing research by investigating the effects of integrating KT with ergonomic training and a structured home exercise programme on pain, functionality and work performance in bus drivers with neck pain. By focusing on this understudied area of pain management in bus drivers, the study aims to provide valuable insights into the effectiveness of this multifaceted intervention approach.

Expected outcomes include a reduction in neck pain levels, improved functional ability and improved work performance in participants following the intervention. In addition, the study aims to contribute to the development of more comprehensive rehabilitation programmes specifically tailored to the needs of bus drivers, ultimately improving their overall wellbeing and job satisfaction.

2. Materials and methods

2.1. Participants and sample size

Bus drivers with more than 1 year of experience who experienced chronic nonspecific neck pain (visual analog scale [20] $>$ 3/10 at rest and while driving) lasting more than 12 weeks were included in this study [21]. A herniated disc, cervical stenosis, history of neck and shoulder surgery, structural deformity, positive findings due to nerve root compression (abnormal sensation such as muscle weakness, decreased deep tendon reflex in the upper extremity, tingling, numbness in the upper extremity), inflammatory rheumatoid disease, tumor, osteoporosis, or severe psychological disorders were excluded from the study. Those who received any hospitalised intervention, including exercising or physiotherapy, were also excluded. Additionally, participants with allergic reactions to KT were excluded from the study [1].

G-power 3.1.9.2 was used to calculate the sample size. An appropriate sample size of 36 participants was obtained by applying repeated measures two-way ANOVA and three repeated measures with a medium effect size of 0.25, significance level of 0.05, and statistical power of 0.9 as recommended by Cohen J [22]. Considering a rate of 20%, the dropout rate and a total sample size of 45 people were calculated.

53 volunteers, aged between 25 and 55, working as bus drivers in the Municipality's Home Health Services unit, were included in the research.

2.2. Study design and ethics

The study was a prospective, randomized controlled trial and was conducted with the approval of the Üsküdar University Non-Interventional Ethics Committee (decision no: 2022-95). The study was registered with the Clinical Research Information Service (ClinicalTrials.gov). Patients were verbally informed about the study before written informed consent was obtained.

The patients were randomly divided into two groups using block randomization (random allocation software). The flowchart of the study is shown in Fig. 1.

- Exercise group (Ex-G): Controlled home exercise + ergonomics training ($n = 22$)
- Kinesio tape group (KT-G): Kinesio taping + controlled home exercise + ergonomics training ($n = 22$).

Participants were included in the treatment program for 6 weeks between September and November 2023. All participants were given ergonomics training before starting the treatment program. Patient follow-up was done via phone-based interviews.

2.3. Intervention

Ergonomics training: Bus drivers are a professional group that experiences increased stress on the spine due to the long-term static posture they exhibit due to the nature of the profession. In this study, to prevent risks arising from ergonomics, the risks faced by the body and possible consequences during long-term driving were explained to the participants. Bus drivers are advised to wear comfortable and supportive shoes to maintain good posture and reduce tension on their bodies during long hours of driving. Additionally, they should choose appropriate clothing that allows ease of movement and does not restrict range of motion, contributing to overall comfort and reducing the likelihood of musculoskeletal problems [23]. Training includes regulations on factors such as lumbar support, selecting cushioned seats that provide a balance between softness and hardness, and using a waist belt to increase comfort, maintain proper posture, and reduce tension on the spine [24]. Engaging in physical activity is recommended to reduce musculoskeletal tension caused by prolonged sitting and improve neck comfort. Stretching

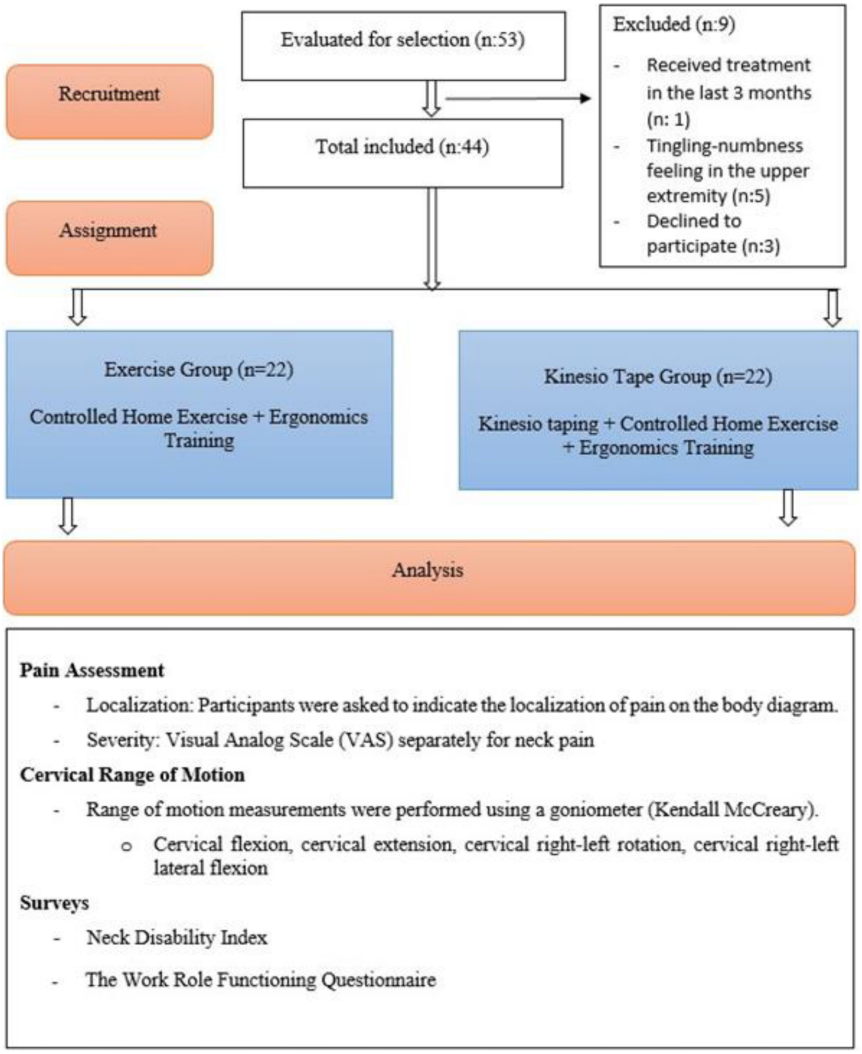

Fig. 1. Flowchart of the study.

movements during breaks can be beneficial in relieving neck pain and enhancing overall comfort [25].

Body stretching exercises performed during breaks: Bus drivers can perform body stretching exercises during breaks to counteract the effects of their sedentary work. These exercises can help reduce pain and musculoskeletal symptoms. One example is the "active movements and stretching at the end", rotation and lateral flexion of the neck to the right, rotation and lateral flexion of the neck to the left, stretching of the shoulder forward. Subjects performed each stretching movement three times per set, five times a week for six weeks. They were instructed to hold each stretch for more than 25 seconds to achieve maximum benefit, followed by relaxation [25,26]. Another exercise is "Chin tucks", where you gently tuck your chin towards your chest. Lastly, "Arm circles" involve making small circles with your arms outstretched, forward and backward 10 times each.

Controlled home exercises: The home exercise program was designed to relieve neck pain in bus drivers and consisted of a combination of stretching and strengthening exercises. These exercises aim to increase flexibility, strengthen muscles, and prevent strain. The recommended exercises include [27,28]:

- Flexion, extension, lateral flexion, and rotation of the cervical region to the maximum range of motion in three planes, and chin-tucks.
- Stretching exercises for the upper trapezius, levator scapula, and pectoralis major muscles.
- Thoracic mobility exercises to increase mobility in the thoracic region.

Strengthening exercises

They were asked to do the exercises 3 times a week for 6 weeks. 2 sets, 10-12 repetitions.

Target muscles: Back extensors

Stretching exercises

They were asked to perform the exercises twice a day for 6 weeks. Stretch for 30 seconds, 3-5 repetitions, until discomfort occurs.

Target muscles: Levator scapula, upper trapezius, pectoralis major

Fig. 2a. Controlled home exercises: strengthening and stretching exercises.

– Strengthening exercises focusing on the back muscles.

Participants are advised to perform these exercises twice a day, with 10 repetitions each, for a duration of 6 weeks. During strengthening exercises, they should hold the position for 3–5 seconds before returning to the starting position. For stretching exercises, participants are instructed to stretch the muscle to maximum tension, hold for 30 seconds, and then return to the starting position (Fig. 2a, and Fig. 2b). Exercises were followed up through phone-based interviews.

Kinesio taping: Kinesio Tex Gold FX was used as the tape material in KT applications. Two different KT techniques were applied to the participants bilaterally. The first technique is the inhibition technique for the upper trapezius muscle, and the second technique is the mechanical correction technique applied to the trapezius muscle to support postural posture (Fig. 3). After each application, the tape remained on the body for 4 days and a 3-day break was taken for the next taping. It was stated that the area to be taped should not contain substances such as cream, hair, or oil. It was announced that the bands are water resistant and there is no harm in taking a bath.

2.4. Outcomes measures

Baseline values were recorded before the patients were taken into treatment. Re-evaluation was made after 6 weeks for before-after value comparison.

Posture exercises

Cervical region joint range of motion exercises, chin-tuck, thoracic mobility exercises, thoracic rotation in quadruped position, cat-camel

Target area: Cervical and upper thoracic region

Fig. 2b. Controlled home exercises: posture exercises.

Pain assessment: Participants were asked to indicate the location of pain on the body diagram. VAS [20] was used to indicate the severity of neck and back pain; 0: no pain, 10: worst pain. The distance between the starting line and the marked point was measured and recorded in centimeters [29].

Joint range of motion: To measure the possible range of motion of the cervical spine joints, flexion, extension, left and right lateral flexion, and rotation were measured, respectively. Participants sat in a neutral position on a stable chair. The shoulders of the subjects were fixed by the assistant to avoid affecting their neck movements. With the help of a goniometer, angular intervals were recorded by determining the last point at which pain did not occur during the person's active movement [30].

The Neck Disability Index (NDI): The NDI is a patient-completed questionnaire that assesses func-

Inhibition technique

In Upper Trapezoidal taping, the participants were asked to hold the tape on their shoulder while standing upright and keep their ear inclined towards the other ear at the maximum degree.

Application: Y tape, from insertion to origin, 0% tension on the tip and final parts of the tape, 20% tension on the remaining part of the tape.

Mechanical correction technique

Taping started from the middle part of the upper trapezium. Before applying the rest of the tape, the participant was asked to bring their shoulder blades closer together and stand upright.

Application: It was glued as an I tape with 35-50% tension.

Fig. 3. Kinesio taping application.

tional status related to neck pain. It consists of 10 items, each scored from 0 to 5, with a maximum total score of 50. The scoring intervals for interpretation are as follows 0–4 points (0–8%) indicates no disability, 5–14 points (10–28%) mild disability, 15–24 points (30–48%) moderate disability, 25–34 points (50–64%) severe disability, and > 34 points (70–100%) total disability [31,32].

The Work Role Functioning Questionnaire (WRFQ): The WRFQ assesses, as a percentage of the time, the difficulties individuals experience performing their jobs, given their physical health or emotional problems. In addition, the survey evaluates the effectiveness of the applied treatment. The original survey consists of 27 items divided into five subscales: Work schedule (5 questions), Productivity (7 questions), Physical demands (6 questions), Mental demands (6 questions), and Social demands (3 questions). In this scale, people are evaluated on how often they had difficulty doing their jobs in the last four weeks. Scoring is done on a scale of 0–4; 0: always difficult (100%), 4: never difficult (0%). The total score for work role functioning typically ranges from 0 to 100, with higher scores indicating better functioning. [35,36]. In the research conducted, the mean total score for work role functioning was reported as 77.3 with a standard deviation of 17.6 [37].

2.5. Statistical methods

Statistical analyses were performed using the SPSS for Windows version 21.0 software (IBM Corp., Armonk, NY, USA) and R version 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria). The Shapiro-

Wilk test was used to determine whether the sample data had been fitted to a normally distributed population. Since the sample distribution was not distributed normally, non-parametric tests were used. To compare participants between groups Mann-Whitney U test was used. Wilcoxon test was performed for pre-post comparisons within a group. The α level was 0.05. $p < 0.05$ was considered statistically significant.

3. Results

All participants who participated in the study were male. 53 volunteer participants were included in the evaluation. 9 people (17%) were excluded from the study because they did not meet the inclusion criteria. The study continued with a total of 44 participants, who all completed the study. During the treatment and follow-up period, no side effects were observed in any of the subjects (Fig. 1).

Table 1 shows that there was no significant difference between the Ex-G and KT-G groups in terms of baseline characteristics. All participants are manual vehicle drivers and drive an average of 8 hours a day. There were no differences in pre-treatment ROM, pain, disability, and work role functioning questionnaires between the groups ($p > 0.05$).

Although there was an improvement in cervical joint range of motion values at the end of the 6-week treatment program, no significant improvement was noted in statistical evaluation. A significant difference in favour of the KT group was only found for neck extension range of motion when comparing the groups (p: 0.011). When looking at the changes in NDI and WRFQ values for disability and work role functionality values, no significant difference was found between the groups ($p > 0.05$) (Table 2).

When the changes in pain measurements were evaluated statistically, significant improvements were recorded in both groups after the 6-week treatment program ($p < 0.001$). In the comparison between the groups, no superiority was found between the two groups ($p > 0.05$) (Table 3).

When the effect sizes of the outcome measures shown in Table 4 are analysed, small effects were found for the ROM of the cervical spine, the NDI, the WRFQ, and the VAS scores.

4. Discussion

This study confirmed that ergonomic training and a home exercise program were effective in improving chronic nonspecific neck pain, cervical ROM, and job performance in bus drivers, but showed that the addition of KT to exercise therapy was not superior to exercise therapy alone in improving outcomes. Chronic neck pain in bus drivers can affect driving safety and work performance. The results of this study show that stretching-based exercises, which are easy to apply and will not take much time, can be used in combination with training in the treatment of neck pain in bus drivers.

The current study focused on addressing chronic nonspecific neck pain among bus drivers through a multifaceted intervention approach involving ergonomics training, self-stretching exercises, and posture exercises. Our findings corroborate previous literature suggesting the efficacy of stretching exercises in alleviating neck pain among professional drivers [1,25,38]. Ylinen et al. [39] and Häkkinen et al. [40] also support the efficacy of stretching exercises in alleviating nonspecific neck pain, emphasizing their cost-effectiveness and minor differences in effectiveness compared to manual therapy. Consistent with existing research, our results demonstrated significant improvements in neck pain following a 6-week intervention period. This aligns with studies conducted on taxi drivers and office workers, which reported similar benefits of regular stretching exercises in reducing neck pain [9,41]. Notably, our study adds to the body of evidence supporting the effectiveness of stretching exercises as a low-cost and accessible intervention for managing chronic neck pain in occupational settings.

The mention of ergonomics training, self-stretching and postural exercises for bus drivers with chronic neck pain, leading to improvements in work performance and pain disability scales, underlines the multifaceted approach needed to address occupational neck pain. Interestingly, while our intervention led to improvements in neck pain and work performance, we did not observe significant changes in measures of neck joint range of motion [1,25,26,28,38]. This contrasts with previous studies that have reported improvements in range of motion following stretching exercises. This discrepancy may highlight the complexity of assessing functional outcomes and suggests the need for further investigation into the mechanisms underlying pain reduction in occupational settings. Comparing our results with the broader literature, it is evident that stretching exercises offer a practical and cost-effective approach to managing chronic neck pain in occupational settings. While our study focused specifically on bus drivers, the findings are likely applicable to other professions characterized by prolonged sitting and repet-

Table 1
Statistical analysis of age, body mass index (BMI) and Pre-treatment VAS, ROM, NDI, and WRFQ assessments between groups

	Ex-G ($n = 22$)	KT-G ($n = 22$)	p
Age (years)	39.64 ± 5.577	36.64 ± 5.430	0.054
BMI (kg/m^2)	27.54 ± 3.377	26.46 ± 2.100	0.318
Job experience (year)	9.32 ± 4.168	7.59 ± 3.362	0.172
Average daily driving time (hours)	10.32 ± 1.05	10.37 ± 1.02	0.658
VAS			
Neck	3.41 ± 1.563	4.32 ± 1.756	0.084
Interscapular	3.95 ± 0.35	4.05 ± 1.558	0.729
Cervical ROM (°)			
Flexion	55.86 ± 5.401	55.36 ± 5.525	0.849
Extension	47.64 ± 2.574	48.23 ± 5.580	0.230
Right lateral flexion	37.50 ± 2.110	36.95 ± 3.934	0.197
Left lateral flexion	37.95 ± 3.826	37.45 ± 3.826	0.701
Right rotation	50.14 ± 2.850	49.73 ± 2.334	0.461
Left rotation	50.86 ± 2.696	50.23 ± 1.950	0.397
NDI	8.55 ± 4.867	11.00 ± 5.005	0.144
WRFQ			
Work schedule	3.84 ± 1.056	3.83 ± 1.151	0.925
Productivity	4.04 ± 0.924	3.77 ± 1.160	0.721
Physical demands	3.83 ± 0.924	3.89 ± 1.087	0.618
Mental demands	3.69 ± 0.811	3.90 ± 1.257	0.318
Social demands	3.93 ± 0.814	4.06 ± 1.041	0.355

Mann-Whitney U test, values are expressed as mean ± standard deviation, $p < 0.05$.
Abbreviations: Ex-G: exercise group, KT-G: kinesio tape group, BMI: body mass index, VAS: visual analog scale, ROM: range of motion, NDI: neck disability index, WRFQ: work role functioning questionnaire.

itive neck movements [13,39,40,41]. Future research should explore the long-term efficacy of multifaceted interventions and investigate the optimal combination of strategies for maximizing pain relief and improving occupational outcomes among at-risk populations.

The application of KT, which has recently been increasing in use, is used alone or as an adjunct to classical physiotherapy techniques. Morris et al. [42] stated that KT can be used in musculoskeletal problems such as low back and neck pain, knee pain, and shoulder pain. When the literature is examined, it is seen that the early effects of KT are mostly examined in patients with mechanical neck pain [43,44,45]. Rasti et al. [46] examined the short and long-term results of the KT application on neck pain, range of motion, and disability together and determined 2 weeks as a long-term treatment. In this study, the treatment program was planned for 6 weeks and it is among the first studies to examine the long-term effects of KT on musculoskeletal problems in drivers.

Ay et al. [47] applied KT for the treatment of pain in the cervical region and performed the application on the levator scapula muscle. At the end of their fifteen-day treatment, they reported an improvement in pain values. Halksi et al. [48] applied KT for trigger point treatment in the neck region and applied the application to the upper trapezius muscle. Although they recorded a decrease in VAS scores after treatment, they did not record a statistically significant difference in the sham group. Rasti et al. [46] performed two separate evaluations of 3 days and 2 weeks on the upper trapezius muscle to evaluate the short and long-term effects of KT application in neck pain. KT application was effective in pain, limitation of movement, and neck injuries within three days, but longer-term use was more effective; they also reported that clinically and statistically greater reductions in parameters were observed 2 weeks after baseline compared to 3 days. In the present study, since the participants' pain localizations on the body diagram were on the upper trapezius muscle, supportive application was performed on the upper trapezius muscle to benefit from the effects of KT to correct abnormal muscle tension in weak muscles and its benefits on muscle fatigue. There was a significant decrease in neck-back pain VAS values in both groups before and after treatment, but there was no significant difference in the amount of reduction in pain after treatment when compared between the groups. According to these results, KT was found to reduce neck-back pain. However, the only difference in treatment methods between the groups was KT. Therefore, the home exercise program in addition to KT was not superior to the home exercise program only. However, the statistically significant reduction in pain in both groups suggests that

Table 2
Intra- and intergroup changes in functional measurement and job performance values

		Ex-G (n:22)			KT-G (n:22)			
		Pre-treatment	Post-treatment	p-value within group	Pre-treatment	Post-treatment	p-value within group	p-value between groups
Cervical ROM (°)	Flexion	55.86 ± 5.401	55.76 ± 4.763	0.773	55.36 ± 5.525	54.55 ± 12.137	0.372	0.669
	Extension	47.64 ± 2.574	47.19 ± 2.960	0.615	48.23 ± 5.580	48.41 ± 10.944	0.083	**0.011**
	Right lateral flexion	37.50 ± 2.110	38.38 ± 1.910	0.186	36.95 ± 3.934	38.45 ± 4.394	**0.039**	0.444
	Left lateral flexion	37.95 ± 2.171	38.19 ± 2.379	0.623	37.45 ± 3.826	39.05 ± 3.031	0.067	0.382
	Right rotation	50.14 ± 2.850	51.14 ± 3.151	0.143	49.73 ± 2.334	50.05 ± 3.592	0.684	0.286
	Left rotation	50.86 ± 2.696	50.90 ± 3.375	0.751	50.23 ± 1.950	51.36 ± 3.094	0.053	0.520
NDI	Total score	8.55 ± 4.867	4.95 ± 2.958	**0.001**	11.00 ± 5.005	5.67 ± 4.376	**0.001**	0.754
WRFQ	Work schedule	3.84 ± 1.056	6.28 ± 8.900	< **0.001**	3.83 ± 1.151	4.35 ± 0.716	**0.001**	0.495
	Productivity	4.04 ± 0.924	4.67 ± 0.295	**0.001**	3.77 ± 1.160	4.33 ± 0.665	**0.002**	0.759
	Physical demands	3.83 ± 0.904	4.45 ± 0.556	< **0.001**	3.89 ± 1.087	4.47 ± 0.512	**0.001**	0.622
	Mental demands	3.69 ± 0.811	4.36 ± 0.542	< **0.001**	3.90 ± 1.257	4.41 ± 0.679	**0.004**	0.241
	Social demands	3.93 ± 0.814	4.60 ± 0.554	**0.002**	4.06 ± 1.041	4.63 ± 0.494	**0.003**	0.370

Wilcoxon test, Mann-Whitney U test, bold values indicate statistical significance at $p < 0.05$. Values shown are mean ± standard deviation. Abbreviations: Ex-G: exercise group, KT-G: kinesio tape group, ROM: range of motion, NDI: neck disability index, WRFQ: work role functioning questionnaire.

Table 3
Statistical evaluation of the changes in pain measurements within and between groups

	Ex-G (n:22)			KT-G (n:22)			
	Pre-treatment	Post-treatment	p-value within group	Pre-treatment	Post-treatment	p-value within group	p-value between groups
VAS							
Neck	3.41 ± 1.563	1.57 ± 0.811	< **0.001**	4.32 ± 1.756	2.09 ± 1.477	< **0.001**	0.071
Interscapular	3.95 ± 2.035	2.00 ± 1.265	< **0.001**	4.05 ± 1.558	2.14 ± 1.612	< **0.001**	0.371

Wilcoxon test, Mann-Whitney U test, bold values indicate statistical significance at $p < 0.05$. Values shown are mean ± standard deviation. Abbreviations: Ex-G: exercise group, KT-G: kinesio tape group, VAS: visual analog scale.

Table 4
Effect size of the outcome measures

		Ex-G (n:22)				KT-G (n:22)			
		Δ-SD	95% CI		Cohen's d	Δ-SD	95% CI		Cohen's d
			Lower	Upper			Lower	Upper	
Cervical ROM (°)	Flexion	1.556	−3.040	3.244	0.002	2.843	−4.920	6.556	0.009
	Extension	0.845	−1.260	2.152	0.016	2.619	−5.467	5.104	0.002
	Right lateral flexion	0.615	−2.122	0.360	0.044	1.257	−4.037	1.037	0.036
	Left lateral flexion	0.694	−1.638	1.166	0.011	1.041	−3.691	0.509	0.046
	Right rotation	0.915	−2.855	0.842	0.033	0.913	−2.161	1.525	0.011
	Left rotation	0.929	−1.918	1.836	0.001	0.780	−2.719	0.446	0.044
NDI	Total score	1.235	1.098	6.088	0.089	1.509	−3.045	3.045	0.000
WRFQ	Work schedule	1.910	−6.300	1.416	0.039	0.289	−1.105	0.069	0.054
	Productivity	0.207	−1.053	−0.200	0.091	0.285	−1.144	0.015	0.060
	Physical demands	0.228	−1.083	−0.159	0.083	0.256	−1.100	−0.053	0.068
	Mental demands	0.211	−1.098	−0.244	0.097	0.305	−1.127	0.113	0.050
	Social demands	0.213	−1.104	−0.242	0.097	0.246	−1.080	−0.076	0.071
VAS	Neck	0.377	1.069	2.606	0.148	0.489	1.240	3.215	0.137
	Interscapular	0.514	0.911	2.998	0.115	0.478	0.945	2.874	0.120

Abbreviations: Ex-G: exercise group, KT-G: kinesio tape group, ROM: range of motion, NDI: neck disability index, WRFQ: work role functioning questionnaire, VAS: visual analog scale. Δ: an absolute value of differences baseline and after six weeks; SD: standard deviation; CI, confidence interval; Cohen's d: effect size. Intragroup effect size statistics were calculated to evaluate the significance of changes before and after treatment. Cohen's d was used as a measure of effect size: 0.20 or less was a small effect; 0.20 to 0.50 was a moderate effect; 0.50 to 0.80 was a large effect, and 0.80 or greater was a huge effect.

a controlled home exercise program is also effective on work-related musculoskeletal pain in drivers with neck-back pain.

Applying KT to the cervical region for 15 days, Ay et al. [47] reported improvement in cervical ROM (flexion, extension, lateral flexion, and rotation) values at the end of their treatment. However, when this improvement was compared with the sham group, statistical significance was found only in flexion and extension values. In our study, there was no statistically significant difference between the groups in cervical range of motion values after treatment except for the neck extension value.

Neck pain may cause disability with daily life activity limitations. Among the self-report scales used for neck pain, the Neck Disability Index (NDI) is the most commonly used scale in clinical evaluations and research studies, and many studies have investigated its validity and reliability. The NDI scale, which has been reported to be a reliable and useful tool for neck pain, was used in our study to evaluate daily life limitations due to neck pain and to compare the effectiveness of treatment. The NDI scale did not reveal a significant difference between the groups in the pre-post values. Longer and more comprehensive studies are needed to make progress on disability.

Interest in the relationship between quality of work and health is increasing worldwide. In parallel, approaches to better understand and measure the multidimensional concept of 'quality of work' are increasing [49]. In the current study, we used the WRFQ to assess the work performance of bus drivers. Ergonomic interventions and training programs can provide drivers with information on correct posture, stretching exercises, and strategies to manage stress and fatigue, all of which can help prevent neck pain [50]. Farioli et al. [51] found that physical activities were effective in preventing neck pain in professional drivers. Drivers with chronic neck pain may also benefit from vocational rehabilitation services that can guide job adapta-

tion, adaptive equipment, and strategies to minimize the impact of neck pain on work performance and overall quality of life [52]. According to the results of the comparison between the groups before and after treatment, there was a statistically significant difference in all sub-parameters of the questionnaire. In a more detailed evaluation between the groups, there was no statistically significant difference in all sub-parameters of the WRFQ questionnaire (work schedule, physical demands, mental demands, and social demands). These results suggest that exercise and KT is an effective method of work performance, but KT is not superior to exercise. The effectiveness of KT may depend on the specific condition being treated, the duration and intensity of the exercise program, and the characteristics of the patient group [53,54].

This study has some limitations. First, this study has a randomized but non-blind plan. The risk of performance prejudice associated with lack of blindness should be taken into consideration for the participatory groups [55]. Secondly, psychosocial factors, general health and fitness levels, including participation in sport or regular exercise, were not part of the study. It would be beneficial to include these factors in future research as they may have an impact on the musculoskeletal health of bus drivers. Since the exercises were given as home training, the treatment could not be managed continuously under the supervision of a physiotherapist. We also do not know for sure whether the subjects were stretching regularly because exercise tracking was assessed only with a self-administered checklist and followed up with phone calls.

The study also has its strengths. Pain assessment in bus drivers mostly focuses on the lumbar region. Evaluation and treatment programs for the upper body are limited. This study focuses on drivers with neck and back pain. Based on the results of this study, research on alternative methods in addition to traditional treatments should be continued for the prevention and treatment of musculoskeletal diseases in people who drive for long periods of time.

5. Conclusion

The results of the study suggest that the implementation of a 6-week exercise programme led to significant improvements in pain in bus drivers suffering from neck pain. However, the addition of KT did not provide any further benefit in reducing pain. Both intervention approaches showed positive effects on functionality and work performance, with no significant difference observed between them over the 6-week period. These results suggest that KT can be safely incorporated into treatment programmes alongside ergonomics and exercise, potentially improving outcomes for people with musculoskeletal conditions. However, it is important to conduct larger studies to gain a deeper understanding of the effects of post-intervention physiotherapy, particularly in occupational settings such as professional driving where musculoskeletal problems are common.

When considering the impact on the performance and safety of professional drivers, these results suggest that while both exercise programmes and the addition of KT can improve functionality and work performance, they may not have a significant impact on pain levels in the short term. This highlights the importance of comprehensive rehabilitation programmes tailored specifically to the needs of professional drivers to effectively address musculoskeletal problems. In addition, future research should explore alternative methods of applying KT and consider its effects on different muscle groups, which may provide insights into optimising treatment strategies for occupational groups with work-related musculoskeletal pain. By refining intervention approaches, there's potential to improve the work performance and safety of professional drivers, ultimately contributing to their overall wellbeing and productivity on the road.

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Author contributions

Concept/idea/research design: H. Zengi, Ö. Sevgin; Writing: EE. Safran, H. Zengi, Ö. Sevgin; Data collection: H. Zengi; Data analysis: H. Zengi, Ö. Sevgin, EE. Safran; Consultation (including review of manuscript before submission): EE. Safran, Ö. Sevgin, H. Zengi.

Conflict of interest

The authors declare that they have no conflict of interest.

Data availability

Data is not publicly available due privacy/ethical restrictions, but is available from the corresponding author upon reasonable request.

Ethical approval

All study procedures were conducted in line with the rules and principles of the Declaration of Helsinki and approved by the Üsküdar University Non-Interventional Ethics Committee (decision no. 2022-95).

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Informed consent

Patients were verbally informed about the study and subsequently provided written informed consent.

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