Title: Efficacy of Home- Based Exercise Program for Amelioration of Mechanical Neck Pain Among Lab Technicians

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Abstract

Purpose: Mechanical neck pain is an occupational health problem with prevalence of 18-78% among laboratory technicians, primarily caused by prolonged static postures during microscope work. This condition leads to musculoskeletal pain, disability, reduced work efficiency, and absenteeism. Consequently, effective management strategies, such as home-based exercise programmes, are critically needed to address this. So, this study aims to estimate efficacy of Home-based Exercise program on mechanical neck pain among lab technicians.

Methods: In this pre-test post-test experimental study, 60 lab technicians with mechanical neck pain were allocated into two cohorts using criterion-based purposive sampling. The experimental cohort underwent a structured Home-based Exercise Program for Mechanical Neck Pain (HBEP-MNP), whereas the control cohort was treated with conventional therapy. Both interventions were administered five days weekly for four weeks. To assess efficacy, outcome measures including the Visual Analogue Scale (VAS) for pain, the Neck Disability Index (NDI) for disability, and the Craniovertebral Angle (CVA) for posture were recorded at baseline and upon completion of the four-week program.

Results: Initial assessments confirmed the two groups were comparable at baseline, with no significant differences ($p>0.05$). Post-intervention, significant improvements were evident across all variables for both groups ($p<0.001$). In a between-group analysis, the experimental intervention proved superior, yielding significantly greater improvements in pain ($p=0.001$) and disability ($p=0.026$) relative to conventional treatment. Conversely, the greater mean improvement in craniovertebral angle (CVA) observed in the experimental group was not statistically significant ($p=0.246$).

Conclusion: Home-based exercise program might be an effective intervention for significantly reducing pain and functional disability in lab technicians with mechanical neck pain, demonstrating proving to be more effective compared to conventional treatment. The findings of this study suggests that a home-based exercise program can be clinically applied as an cost effective and practical intervention for reducing pain and improving neck function.

Key words: Exercise Therapy, Health Care, Neck Pain, Posture

Highlights:

- More pain reduction was found in experimental group
- Neck function was improved more in experimental group
- Both groups showed equal posture improvement
- Treatment improved both pain and function

Plain language summary: This study was performed to address mechanical neck pain, commonly occurring in people with desk-jobs such as lab technicians, due to fixed postures leading to sore necks. Since most treatments are require several clinical visits which may be expensive and difficult to attend due to busy day-to-day life, researchers wanted a more flexible solution that could be performed at home. They wanted evidence to prove whether this practical and low-cost method would provide better results than standard care. Results came out favourably positive. After a 4-week program, home exercise program group presented more improvement than the conventional treatment group. Particularly, their pain decreased more notably and their daily activities such as driving and lifting were much easier to perform due to less neck pain. Although both groups showed improvements, home exercise program proved to be better method to reduce pain and improve function. It offers evident, convenient and cost-effective option that enable people to manage their neck pain more efficiently without much cost or inconvenience, thus providing active solution which can be effortlessly adapted by the workplace individuals.

INTRODUCTION:

Musculoskeletal disorders (MSDs) represent a growing occupational health concern and are a major cause of disability, absenteeism, and reduced work productivity worldwide (1). Work-related musculoskeletal disorders (WRMSDs) are multifactorial conditions in which occupational activities play a major, though not exclusive, role in their development, with certain MSDs recognized as occupational diseases (2,3). Laboratory technicians are a particularly vulnerable population, with global prevalence rates of WRMSDs reported between 40–80%, and the neck is consistently one of the most frequently affected regions (4,5). This high prevalence, coupled with the adverse effects on work efficiency and long-term function, underscores an urgent need for practical and effective intervention strategies.

The development of mechanical neck pain in this group is primarily driven by biomechanical exposures inherent to laboratory work, such as sustained awkward postures, repetitive movements, and prolonged static loading during activities like microscope use (6). These exposures lead to specific muscular dysfunctions, including increased activation and fatigue of cervical and shoulder girdle muscles, such as the upper trapezius, levator scapulae, cervical extensors, and deep neck flexors (7,8). This disrupts normal neuromuscular control, leading to overactivity of superficial muscles and weakness or delayed activation of the deep cervical flexors. The consequent muscle ischemia, metabolic byproduct accumulation, and altered proprioception compromise cervical stability and increase mechanical stress on cervical structures, resulting in pain and movement dysfunction (9,10,11). Therefore, effective management must target these specific muscular impairments.

Current scientific management of mechanical neck pain emphasizes conservative, exercise-based strategies targeting muscle strength, endurance, flexibility, and motor control to restore normal function (7). Among these, home-based exercise (HBE) programs represent a scientifically supported, practical, and cost-effective approach. They enable consistent performance of targeted exercises outside the clinical setting, promoting long-term symptom management, and emerging evidence supports remotely delivered exercise for working populations (12,13). However, there is a paucity of research specifically evaluating structured HBE programs for laboratory technicians, a group with a documented high burden of neck pain stemming from identifiable muscular dysfunctions.

Therefore, the present study aims to evaluate the efficacy of a home-based exercise program in reducing mechanical neck pain among laboratory technicians. The alternate hypothesis states that a home-based exercise program will result in significant improvement in mechanical neck pain.

Materials and Methods:

This study utilizes pre-test post-test experimental design conducted at tertiary care teaching hospital. Participants were selected using a criterion-based purposive sampling technique based on predefined inclusion and exclusion criteria, after which they were randomly allocated into two groups using computer-generated random numbers. Simple randomization was performed using Random Allocation Software to ensure equal probability of assignment to each group. Participants were screened based on daily screen time and forward head posture at baseline using a self-reported screen-time questionnaire and craniovertebral angle measurement. As participants in both groups reported high baseline pain levels, discontinuation of prescribed or self-administered analgesic and anti-inflammatory medications was not ethically appropriate. Therefore, participants were allowed to continue their usual pain medication as advised by their treating physicians. To minimize potential confounding effects, participants were instructed to maintain consistent medication use throughout the study period and to adhere strictly to the prescribed physiotherapy intervention protocol. Participants included were lab technicians between the age of 20 to 40 years, of both genders, who were experiencing neck pain. Individuals with any other musculoskeletal disorders, a history of recent surgery or trauma to the neck region, or participants with specific cervical spine conditions, including ankylosing spondylitis, radiculopathy, tumour, infection, or disc prolapse, were excluded from the study. [14,15,16]

Sample size:

We utilized G*Power software to perform power analysis for sample size estimation. We assume effect size of 0.8 and power 80%. The minimal sample size required was 52 but assuming a dropout rate of 15%, we planned to recruit 60 participants.

Outcome Measure:

Neck Pain: Neck pain was evaluated using the Visual Analogue Scale (VAS), an instrument demonstrating high reliability with a coefficient of 0.97 for pain measurement. (17)

Neck Disability Index (NDI): Neck disability was measured by NDI. The NDI exhibited excellent reliability (ICC = 0.88). The MDC (Minimal detectable change) for the NDI was 6.9, and the MCID (Minimal clinical important difference) for the NDI was 5.5 (18)

Craniovertebral Angle (CVA): It is measured by Photogrammetry method. The C7 spinous process and tragus of ear were marked of all the participants and picture were taken from a distance of 150 cm and a height of 110 cm in side view to measure craniovertebral angle. The reliability of measuring CVA is very high with intra rater reliability (ICC = 0.999) and inter-rater reliability (ICC = 0.892). In MB Ruler software (www.markus-bader.de/MB-Ruler/download.php) the pictures were analysed and the angles of CVA were calculated, and the final data were obtained. (19)

Study Procedure:

After receiving approval from the Institutional Ethics Committee (Ethical No: IEC-3137), laboratory technicians presenting with neck pain were recruited and screened for eligibility based on the predetermined selection criteria. Eligible candidates were subsequently requested to provide written informed consent, confirming their voluntary participation in the study. The enrolled participants were then randomly allocated into two cohorts of equal size (n=30 per group): an experimental group and a control group. A comprehensive pre-intervention assessment was administered to all subjects, which included the documentation of demographic profiles, a detailed explanation of the study protocol, and a clinical evaluation establishing baseline values for all outcome measures. The experimental group received a structured home-based exercise program for mechanical neck pain (HBEP-MNP) (Table 1), administered five days per week over a four-week period, with adherence supported through an instructional pamphlet. In contrast, the control group received a conventional treatment regimen for neck pain, comprising hot fomentation and neck isometric exercises. The control intervention comprised conventional physiotherapy, including hot fomentation and neck isometric exercises, which is standard clinical practice. The experimental intervention was purposefully more extensive to assess its additional benefit over routine care, and this difference does not constitute bias but reflects the study's objective. Following the four-week intervention period, all outcome measures were re-evaluated in a post-intervention assessment, and the collected data were subsequently compiled for statistical analysis. Exercise adherence was monitored by instructing participants to maintain written notes of their daily exercise routine. In addition, participants attended weekly follow-up visits, during which exercise performance was reviewed, compliance was checked, and any difficulties were addressed. All outcome measurements were taken by the same evaluator at baseline and post-intervention to minimize inter-rater variability.

Data analysis: The data were analysed using the SPSS software. Prior to inferential analysis, the normality of the dataset was verified using the Kolmogorov-Smirnov test, which is recommended for sample sizes exceeding 50. All variables conformed to a normal distribution, justifying the use of parametric statistical tests. Between group comparisons were conducted with an independent samples t-test, and within group changes from baseline to the post-intervention assessment were analysed with a paired samples t-test. The progression of the data analysis is illustrated in the flowchart in Figure 1.

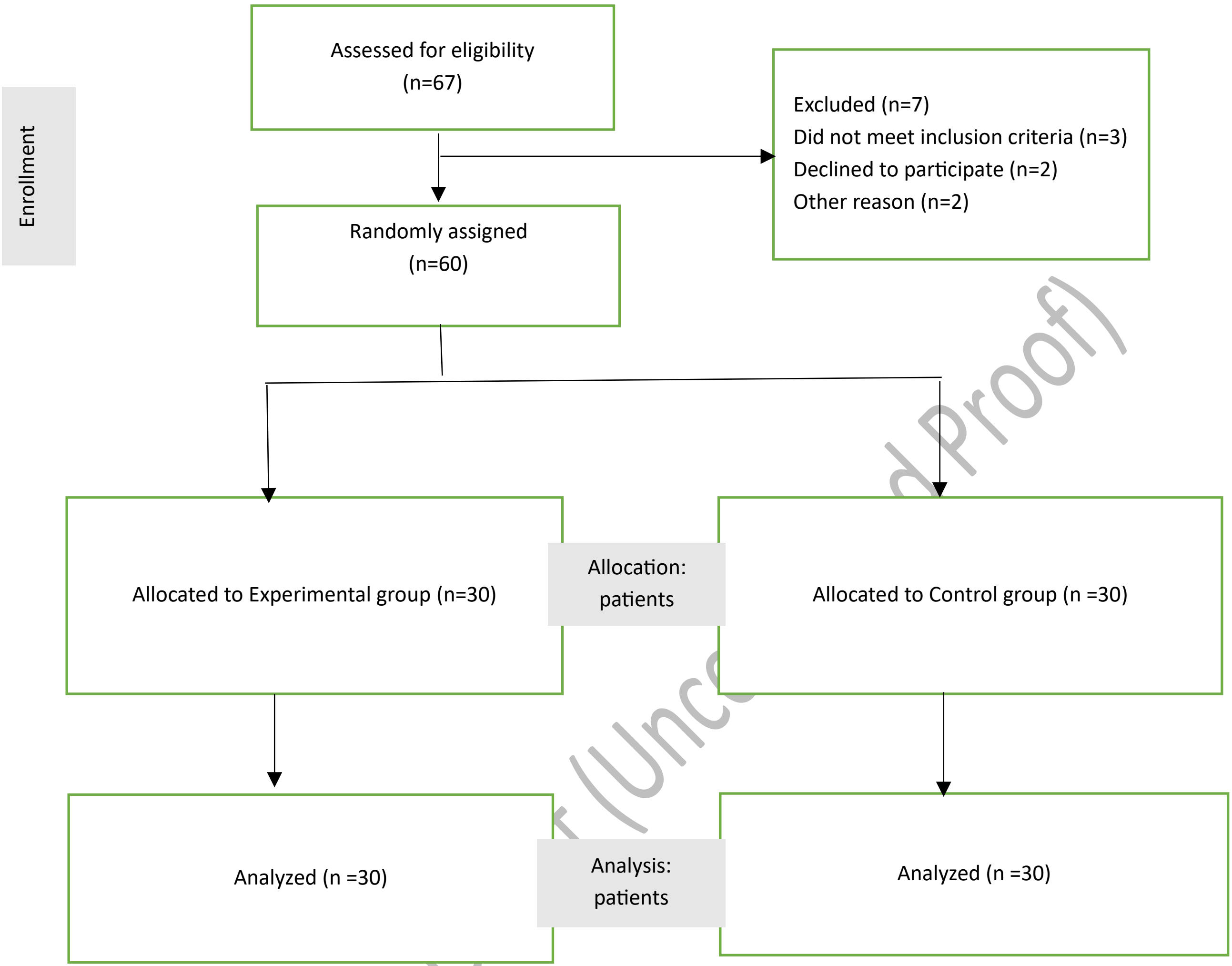

Fig 1: Consort flow chart

Results:

60 Participants with mean age of 35.20 ± 2.69 years were recruited; the demographic characteristics and for normality are presented in Table 2.

The outcome measures compared at baseline shows no statistically significant differences at baseline ($p > 0.05$).

Participants in experimental group experienced statistically significant reduction in pain (VAS) and neck disability (NDI), as well as an improvement in the craniovertebral angle (CVA) ($p < 0.001$ for VAS and NDI; $p < 0.05$ for CVA) as compared to control group after 4 weeks of intervention. The intervention group demonstrated significantly greater improvements in VAS ($p=0.001$) and NDI ($p=0.026$) compared to the control group. Although a greater mean improvement in CVA was observed for the intervention group, this difference was not statistically significant (p=0.246).

Importantly, the reduction in pain, which was the primary outcome measure of the study, demonstrated a large effect size (d = 0.87), indicating a strong and clinically meaningful treatment effect of the intervention. In contrast, improvement in neck disability showed a moderate effect size (d = 0.58), suggesting a meaningful but comparatively smaller impact on functional outcomes. Although the experimental group exhibited a greater mean improvement in CVA, the between-group difference did not reach statistical significance (p = 0.246), and the effect size was small, indicating limited postural correction within the four-week intervention period.

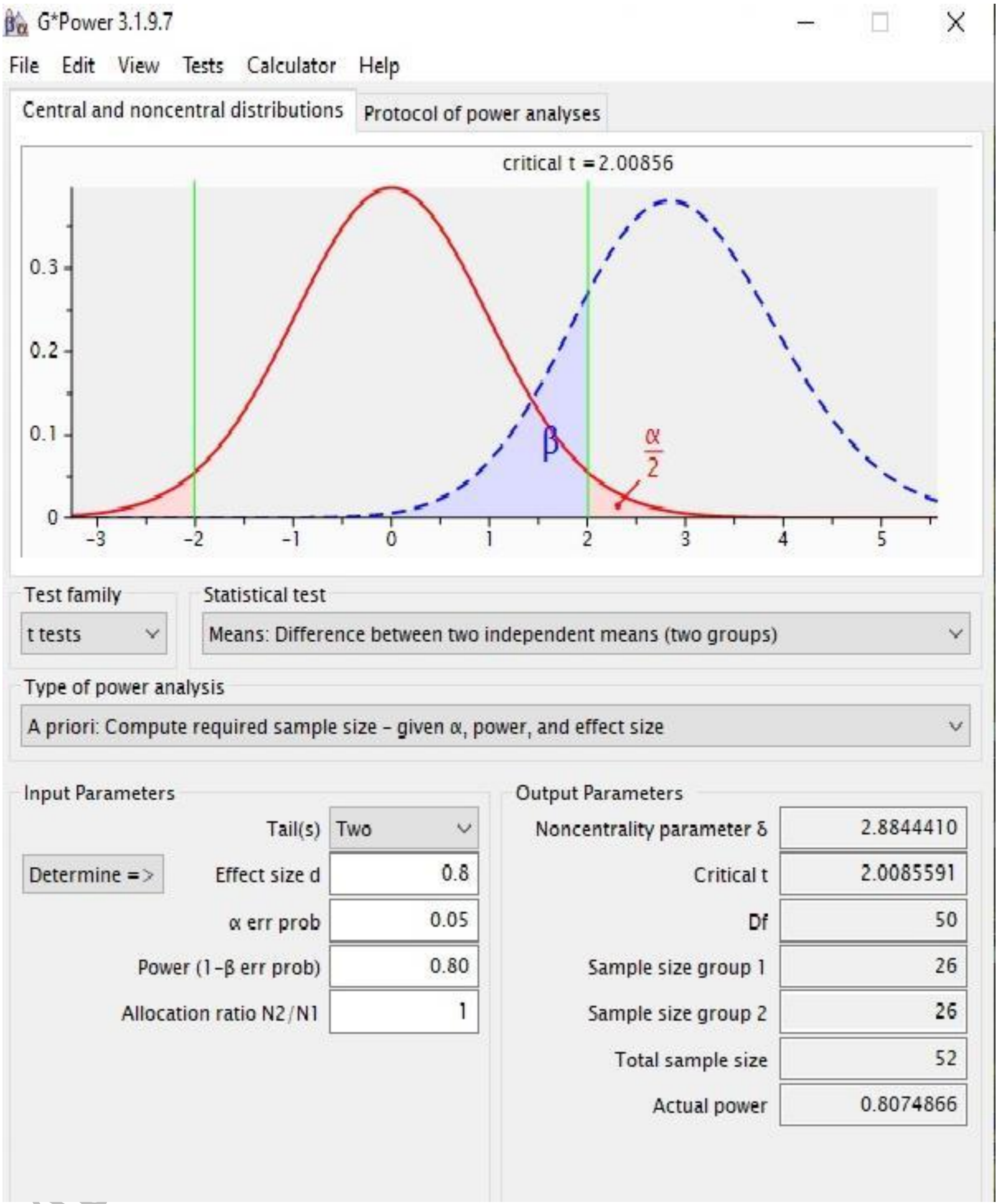

Figure 2: Sample size estimation from G power Software

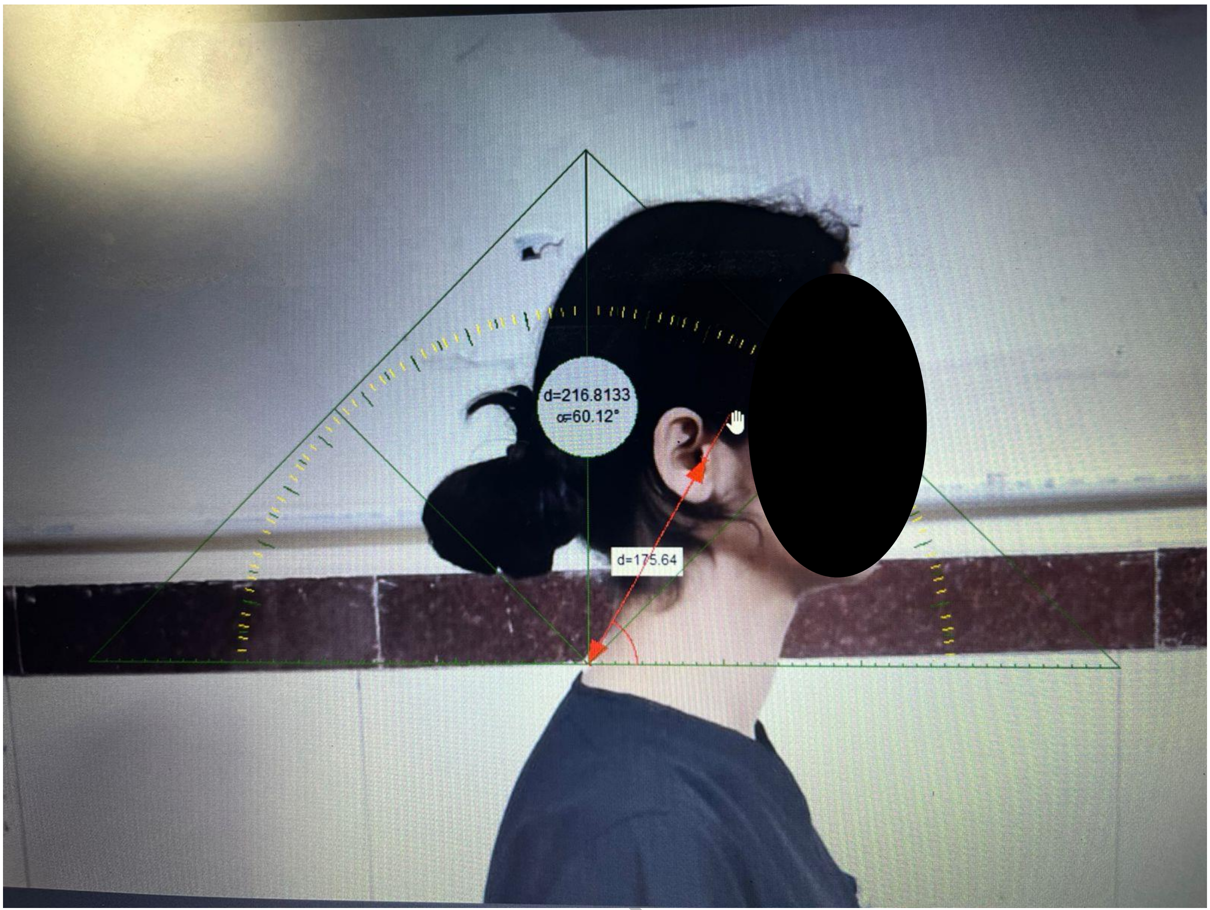

***Figure 3**: CVA measurement using MB ruler software (α=Angle between C7-tragus line and horizontal line and d= linear distance between two marked points)*

Discussion:

The present study demonstrates that the experimental intervention produced greater improvements in pain intensity and functional disability compared with the control group after four weeks. At baseline, both groups were comparable, with no statistically significant differences in pain intensity (VAS: experimental mean = 6.47, control mean = 6.37; $p = 0.617$), neck disability (NDI: experimental mean = 38.20, control mean = 37.67; $p = 0.758$), or craniovertebral angle (CVA: experimental mean = 40.52°, control mean = 39.63°; $p = 0.536$), indicating appropriate group matching and minimizing selection bias.

Following the intervention, both groups demonstrated highly significant within-group improvements in pain, disability, and posture ($p < 0.001$), confirming that conventional physiotherapy is effective in managing mechanical neck pain. However, between-group analysis revealed that the experimental group achieved significantly greater reductions in pain and disability. The experimental group's VAS score decreased from 6.47 to 2.57, compared with a reduction from 6.37 to 3.27 in the control group ($p = 0.001$). Similarly, NDI scores improved from 38.20 to 18.20 in the experimental group, whereas the control group improved from 37.67 to 21.70 ($p = 0.026$). These findings indicate that the addition of a structured home-based exercise program provided an incremental benefit beyond conventional treatment alone.

These results are consistent with previous evidence demonstrating that exercise-based interventions significantly reduce pain and disability in individuals with mechanical neck pain. (20) Freimann et al. also reported significant reductions in neck pain and improvements in cervical mobility following a home-based exercise intervention, supporting the present findings. (21)

In contrast, although CVA improved within both groups, the between-group difference was not statistically significant. The experimental group's CVA increased from 40.52° to 43.38°, while the control group improved from 39.63° to 41.64° ($p = 0.246$). This suggests that while both interventions positively influenced posture, the experimental protocol was not superior in correcting forward head posture over the short intervention period. Previous studies have shown that postural adaptations require prolonged neuromuscular retraining and motor control learning, often extending beyond four weeks. (22,23) Additionally, CVA may be less sensitive to short-term changes compared with pain and disability measures, which may explain the absence of a significant between-group difference.

Each session began with hot fomentation to promote muscle relaxation, reduce pain, enhance local circulation, and prevent the formation of myofascial trigger points, thereby preparing the soft tissues for exercise. (24) This was followed by stretching exercises performed as a warm-up to improve muscle extensibility, reduce stiffness, and enhance tissue flexibility, allowing safer and more effective movement. Active range of motion (AROM) exercises were then incorporated to maintain and improve cervical mobility, minimize joint stiffness, and facilitate neuromuscular control without exacerbating symptoms. (25) Scapular stability exercises were included to address postural dysfunction by correcting protracted shoulder posture, enhancing scapular retraction and stabilization, and restoring normal scapulothoracic rhythm essential for optimal cervical and shoulder biomechanics. Finally, strengthening exercises targeted weak cervical and scapular stabilizing muscles to improve muscle strength and endurance, enhance postural control, reduce mechanical stress on cervical structures, and prevent symptom recurrence. (26)

The observed improvements in pain and disability may be explained by both physiological and behavioral mechanisms. Regular active exercise enhances local blood circulation, facilitating the removal of inflammatory mediators and reducing ischemia in chronically overloaded cervical muscles, thereby decreasing pain sensitivity. (27,28) Active exercises also stimulate proprioceptive input and may activate descending inhibitory pain pathways, contributing to modulation of central sensitization commonly associated with chronic mechanical neck pain. (29)

Home-based exercise programs may further enhance outcomes through improved adherence and consistency. Patients are more likely to perform exercises regularly when they are accessible, flexible, and integrated into daily. (30) Moreover, home-based programs promote autonomy and self-efficacy, which may reduce fear-avoidance behaviours and improve engagement with treatment, contributing to sustained functional improvements. (31) However, the present study design does not allow separation of the effects of physical exercise from psychological or behavioural factors, and both likely contributed to the observed improvements.

Although statistically significant, the magnitude of the intervention effect—particularly for postural alignment—appears modest. Therefore, the findings should be interpreted cautiously, and the intervention should be considered as an effective adjunct rather than a definitive standalone solution.

Limitations

Several limitations must be acknowledged. The absence of follow-up data limits conclusions regarding the long-term sustainability of pain reduction, functional improvement, and postural correction. The total exercise volume was not fully balanced between the experimental and control groups, which may have influenced outcome differences. Pain and disability outcomes were assessed using self-reported measures (VAS and NDI), which are susceptible to reporting bias and placebo effects. Additionally, the relatively short intervention duration and sample size may have reduced the ability to detect significant between-group differences in CVA which shows that postural adaptations may require a longer intervention and follow-up periods.

Conclusion:

This study demonstrated that a structured home-based exercise program might be effective in reducing pain and disability among laboratory technicians with mechanical neck pain. These are safe, cost-effective, and practical interventions that can be implemented in occupational health settings. Moreover, adherence to exercises and its generalisability is a major challenge.

Research Ethical Statement: The study was approved by Institutional Ethics Committee of MM (DU), Mullana, Ambala (Ethical No: IEC-3137). Written Informed consent for the voluntarily participation was taken from all the participants. The study followed National Ethical Guidelines for Biomedical and Health Research Involving Human Participants, 2017 as well as Helsinki Declaration Revised, 2013.

Authors contribution: Conceptualization: Akanksha Saxena and Mandeep Kumar Jangra, Methodology: Akanksha Saxena and Mandeep Kumar Jangra, Investigation: Rashi Mandhan and Lavanya Sachdeva, Writing-Original draft: Rashi Mandhan and Lavanya Sachdeva, Writing-Review and editing: Rashi Mandhan and Lavanya Sachdeva, Resources: Rashi Mandhan and Lavanya Sachdeva, Supervision: Akanksha Saxena and Mandeep Kumar Jangra.

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AI Use Statement: No AI tool was used for writing this manuscript. However, software Grammarly was used for the language refinement.

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Table 1: Home based exercise program for Mechanical neck pain

Sr. No.	Intervention	Procedure	Frequency
1.	Hot Water Fomentation	Soak a towel in hot water (60°-70°C). Wring it and fold. Place this on neck for 10 -15 minutes.	Prior perform exercise. Twice daily
2.	Active Range of Motion Exercise	Patient Position: Upright sitting with back supported	
	a) Neck Flexion	Move your chin downward towards the chest trying to look the floor.	Hold for 5 second. Repeat the exercise for 10 times/twice daily.
	b) Neck Extension	Move your chin upwards trying to look the ceiling.	Hold for 5 second. Repeat the exercise for 10 times/twice daily.
	c) Neck Rotation	Rotate your head towards right until you feel a gentle stretch on left side of the neck and vice-versa.	Hold for 5 second. Repeat the exercise for 10 times/twice daily.

3.	Strengthening Exercise	Patient Position: Upright sitting with back supported	
	a) Neck Flexors	Place your hand over your forehead; try to push head forward against nearly 50 percent resistance of your own hand. Head should remain straight.	Hold for 10 second. Repeat the exercise for 10 times/twice daily
	b) Neck Extensors	Place your hand on the back of your head; push head backward against nearly 50 percent resistance of your own hand. Head should remain straight.	Hold for 10 second. Repeat the exercise for 10 times/twice daily.
	c) Neck Rotator	Place right hand over your right ear; move head toward your right shoulder. Head should remain straight. Repeat the same for left side.	Hold for 10 second. Repeat the exercise for 10 times/twice daily.

4.	Scapular Stability Exercise	Patient Position: Prone (face down) lying on bed/mat on the floor. Place a pillow under your hips and a towel under forehead. Step 1 Hands resting at the side. Lift your hands up to hip level. Step 2 Place hands at shoulder level (airplane). Lift the hands up to 6 inches. Step 3 Place hands above shoulder (overhead) level (superman). Lift the hands up to 6 inches.	Hold for 10 second. Repeat the exercise for 10 times/twice daily. Hold for 10 second. Repeat the exercise for 10 times/twice daily. Hold for 10 second. Repeat the exercise for 10 times/twice daily.
5.	Stretching Exercise a) Trapezius	Patient Position: Sitting or standing. For left side:	Hold for 10 second. Repeat the exercise for 5 times/twice daily.

	b) Levator Scapulae	Place left hand behind the back. Try to touch right ear with the right shoulder. You can use the right hand to hold your head to apply additional stretch. For right side: Place right hand behind the back. Try to touch left ear with the left shoulder. You can use the left hand to hold your head to apply additional stretch. Patient Position: Upright sitting with back supported. For left side: Place left hand on upper back and right hand on back of head. Then rotate your head till 45 degrees towards right side and gently pull it down trying to see towards the floor until you feel a gentle stretch. For right side: Place the right hand on upper back and left hand on back of head. Then rotate your head till 45 degrees towards left side and gently pull it down trying to see towards the floor until you feel a gentle stretch.	Hold for 10 second. Repeat the exercise for 5 times/twice daily. Hold for 10 second. Repeat the exercise for 5 times/twice daily. Hold for 10 second. Repeat the exercise for 5 times/twice daily.

	c) Anterior chest muscles	Patient Position: Standing against the wall in corner. Place both hands at 90 degrees. Place your foot in front of other then bend front knee as to lean forward until a light stretch is felt over chest. Patient Position: Standing against the wall in corner. Place both hands at 90 degrees. Then lean forward trying to reach in the corner until a light stretch is felt over chest.	Hold for 10 second. Repeat the exercise for 5 times/twice daily.

Table 2: Normality of demographics details

Variables	Mean±SD	p- value*
Age (yrs)	35.20±2.69	0.20
Height (cm)	165.57±5.39	0.09
Weight (kg)	65.80±6.46	0.08
Duration of Neck pain (months)	8.23±2.02	0.20
Yrs: Years; cm: centimetre; kg: Kilogram; SD: Standard deviation *: Kolmogorov smirnov test; p>0.05: data is normally distributed; p<0.05: data is not normally distributed		

Table 3: Pre-Post comparison of all outcome measures

Outcomes	Time Point	Experimental group (Mean±SD)	Control group (Mean±SD)	p-value*	Effect size	Power	95 %CI (LL, UL)
VAS	Baseline	6.47±0.819	6.37±0.718	0.617	0.87	91%	-0.298, 0.498
	After 4 weeks	2.57±0.817	3.27±0.785	*0.001*			-1.114, -0.286
P value#		*0.00*	*0.00*				
NDI	Baseline	38.20±6.754	37.67±6.604	0.758	0.58	61%	-2.919, 3.985
	After 4 weeks	18.20±7.053	21.70±4.572	*0.026*			-6.572, -0.428
		0.00	*0.00*				
CVA	Baseline	40.52±5.762	39.63±5.284	0.536	0.30	21%	-1.968, 3.746
	After 4 weeks	43.38±6.121	41.64±5.302	0.246			-1.228, 4.692
		0.00	*0.00*				
VAS: Visual Analogue scale; NDI: Neck Disability Index; CVA: Craniovertebral Angle; SD: Standard deviation *: independent t test; #: paired t test P<0.05: Significant; p>0.05: Not significant							