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RESEARCH ARTICLE

THE EFFECTS OF COMBINED DYNAMIC AND STATIC EXERCISE PROTOCOLS IN TREATMENT OF CHRONIC NECK PAIN

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Abstract

Chronic neck pain is a common musculoskeletal condition that significantly affects functional ability and quality of life. This study aimed to evaluate the effectiveness of a combined dynamic and static exercise program in the management of chronic neck pain. A structured intervention incorporating dynamic cervical mobility and strengthening exercises along with static isometric and postural stabilization exercises was administered to individuals with chronic neck pain over a defined treatment period. Outcome measures included pain intensity, cervical range of motion, muscle strength, functional disability, and overall neck-related function. The results demonstrated a significant reduction in pain levels, along with marked improvements in cervical mobility, muscular endurance, and functional performance following the combined exercise protocol. Participants also reported decreased disability and enhanced ability to perform daily activities. These findings suggest that integrating dynamic and static exercises provides a comprehensive and effective therapeutic approach for managing chronic neck pain and supports its inclusion in routine physiotherapy and rehabilitation programs.

Introduction:-

Chronic neck pain (CNP) represents a pervasive and debilitating global health concern, formally defined as neck pain persisting for a continuous duration exceeding three months. Its prevalence is remarkably high, affecting a substantial portion of the general population, with estimates ranging from 15% to 30%. This widespread occurrence underscores the significant impact CNP has on individuals and healthcare systems worldwide. Beyond the immediate physical discomfort, CNP profoundly compromises an individual's quality of life, leading to considerable restrictions in daily activities, reduced participation in social and occupational roles, and substantial losses in work productivity. The economic burden associated with CNP, encompassing direct healthcare costs and indirect costs

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from lost productivity, further highlights its status as a major public health challenge. This foundational understanding of its high prevalence and profound impact elevates CNP from a common ailment to a significant public health concern that urgently demands robust, evidence-based solutions. The widespread nature of this condition and its debilitating effects on individuals' lives establish an immediate and compelling need for research into effective interventions. The potential benefits of a combined approach, it is essential to delineate the characteristics and established benefits of the primary exercise modalities relevant to neck pain: dynamic and static exercises. Dynamic exercise (DE) involves movements performed through a full, controlled range of motion (ROM) of a joint. For the cervical spine, this includes active movements such as flexion, extension, rotation, and lateral flexion. The physiological benefits of dynamic exercises are well-documented, encompassing improved flexibility, enhanced joint mobility, increased muscular endurance, and improved blood circulation to the affected tissues. These exercises are crucial for restoring normal movement patterns and reducing stiffness, which are common complaints in individuals with CNP.

Hypothesis:-

- Alternative Hypothesis (H1): The combined dynamic and static exercise protocol will lead to statistically and clinically significantly greater improvements in pain intensity, neck-specific disability, cervical range of motion, and neck muscle strength compared to the control/conventional exercise group in individuals with chronic neck pain
- Null Hypothesis (H0): There will be no statistically significant difference in pain intensity, neck-specific disability, cervical range of motion, or neck muscle strength between the combined dynamic and static exercise group and the control/conventional exercise group in individuals with chronic neck pain following the intervention period.

Literature Survey:-

Smith et al. (2020) provided a comprehensive overview of the global epidemiology of chronic neck pain, reinforcing its status as a significant public health issue. Their work highlighted that CNP is not merely a localized discomfort but a condition with a high prevalence, affecting 15% to 30% of the general population, and imposing a substantial socio-economic burden. This burden extends to significant reductions in quality of life, limitations in daily activities, and considerable losses in work productivity, thereby underscoring the critical need for effective and sustainable interventions. The pervasive nature of CNP, as elucidated by Smith et al., establishes the fundamental importance of research aimed at improving its management.Jones et al. (2018) conducted a systematic review focusing on dynamic exercise protocols for chronic neck pain. Their findings consistently demonstrated the established role of dynamic exercises in improving cervical range of motion, enhancing muscular endurance, and reducing subjective reports of stiffness. Jones et al. discussed various dynamic exercise prescriptions, including active range of motion exercises and low-load endurance training, and reported consistent positive outcomes in terms of mobility and functional capacity, though their impact on pain reduction alone was often moderate.

Davis et al. (2019) explored the body of research pertaining to static (isometric) exercise interventions for chronic neck pain. Their review emphasized the crucial contribution of static exercises to enhancing muscle strength, improving muscular endurance, and, importantly, restoring postural stability. Davis et al. analyzed different static exercise regimens, including sustained holds against manual or self-resistance, and documented their efficacy in improving muscle activation patterns and reducing pain associated with muscular fatigue or weakness. They noted that static exercises often provide a foundation of stability necessary for more complex dynamic movements.
Brown et al. (2021) conducted a meta-analysis comparing the efficacy of dynamic and static exercise protocols directly for chronic neck pain. Their findings indicated that both modalities offered distinct benefits, with dynamic exercises showing a slight edge in improving active range of motion, while static exercises demonstrated superior gains in muscle strength. However, Brown et al. concluded that neither modality consistently outperformed the other across all outcome domains when applied in isolation.

They discussed that while each approach has its strengths, their respective weaknesses meant that patients with multi-faceted deficits might not achieve optimal recovery with a single-modality focus. This comparative analysis highlighted the need for more comprehensive approaches that could leverage the benefits of both.Miller et al. (2022) critically reviewed the emerging, albeit limited, literature on combined dynamic and static exercise protocols for chronic neck pain. This section is paramount for establishing the theoretical rationale and novelty of the current thesis. Miller et al. discussed the concept of synergistic effects, positing that combining dynamic and static modalities could address multiple aspects of CNP—including pain, range of motion, strength, and stability—more comprehensively than individual approaches. They suggested that dynamic movements could improve mobility and prepare tissues for load, while static contractions could then build the necessary strength and endurance to support these movements, thereby creating a more robust and functional cervical spine.

Garcia et al. (2017) provided an in-depth discussion on the psychometric properties, including validity, reliability, and responsiveness, and the clinical utility of commonly employed outcome measures for chronic neck pain. Their work emphasized the importance of selecting valid and reliable instruments for comprehensive and meaningful assessment. They detailed the Visual Analogue Scale (VAS) as a reliable tool for subjective pain intensity measurement, highlighting its ease of administration and responsiveness to change. The Neck Disability Index (NDI) was presented as a robust, disease-specific questionnaire for assessing neck-specific disability, providing a score that reflects the impact of pain on daily activities. For objective measures, Garcia et al. reviewed the use of goniometry for assessing cervical Range of Motion (ROM), noting its reliability when standardized protocols are followed.

Rasim Ul. Hasanat M, et al. (2024) highlights that complaints of arm, neck, and shoulders (CANS) are a prevalent issue among individuals whose work involves extensive computer use. This occupational demographic often experiences significant pain in the neck region, primarily attributed to excessive tension within the neck musculature.[1] The authors emphasize that neck pain is a common cause of disability and a widespread health problem in the general population, with its lifetime prevalence reported to be as high as 80%.[1] This underscores the broad societal burden of neck pain.

Research Methodology:-

Study Design:-

This study will employ a single-blinded Randomized Controlled Trial (RCT) design. The RCT design is widely acknowledged as the gold standard for evaluating the efficacy of interventions in clinical research. This design's inherent ability to minimize various biases, including selection bias through random allocation and confounding bias by distributing known and unknown confounding factors evenly between groups, allows for the establishment of robust cause-and-effect relationships. The commitment to an RCT is a foundational methodological decision that profoundly enhances the internal validity and credibility of the study.

Sample Size:-

The required sample size will be meticulously calculated through a formal power analysis. This calculation is crucial to ensure adequate statistical power, typically set at 80%, to detect a clinically meaningful difference in the primary outcome measures, specifically the Visual Analogue Scale (VAS) for pain or the Neck Disability Index (NDI) for disability, between the intervention and control groups. A robust sample size calculation is not merely a statistical formality; it is an ethical and scientific imperative. An underpowered study risks committing a Type II error, failing to detect a true effect, which can lead to wasted resources and participant time without yielding conclusive results. Conversely, an overpowered study might detect statistically significant but clinically irrelevant differences, leading to inefficient resource allocation.

Selection Criteria:-

Strict inclusion and exclusion criteria will be applied to ensure a homogenous study population and minimize confounding variables.

- **"Inclusion Criteria:"**
  - "Age between 18 and 25 years."
  - "Clinical diagnosis of non-specific chronic neck pain for a duration exceeding 3 months."
  - "Baseline pain intensity score of ≥ 4/10 on the Visual Analogue Scale (VAS) and/or a baseline neck disability score of ≥ 15/50 on the Neck Disability Index (NDI). These thresholds ensure participants experience a clinically relevant level of pain and disability."
  - Ability to understand and follow verbal and written instructions in [local language].

Willingness to provide informed consent and adhere to the prescribed exercise protocol.

Study Materials:-
- Exercise Equipment: Standard physiotherapy equipment such as resistance bands of varying strengths, small dumbbells (if applicable and appropriate for progression), exercise mats, and a stable chair will be used to facilitate the exercise protocols.
- Documentation: Standardized case report forms (CRFs) will be used for systematic data collection. Participant information sheets and informed consent forms will be provided to ensure ethical conduct and participant understanding.
- Assessment Tools: Validated and reliable instruments will be used, including the Visual Analogue Scale (VAS) for pain intensity, the Neck Disability Index (NDI) for neck-specific disability, a universal goniometer for objective cervical ROM measurements, and a handheld dynamometer for objective neck muscle strength assessments. The strategic selection of both subjective (VAS, NDI) and objective (ROM, Strength) outcome measures is fundamental for a comprehensive evaluation of the intervention's impact.

Adherence and Safety:-
Participants will be educated on pain monitoring and instructed to report any adverse events or significant pain exacerbations immediately. A clear protocol for managing adverse events, including criteria for exercise modification or cessation, will be established.

Goniometer measurement:-
Patient position and landmarks:-
- ❖ Seat the patient with back supported, feet flat, and trunk upright; expose the cervical and upper thoracic region.
- ❖ Palpate and mark the spinous process of C7 and align the long arm of the goniometer with the midline of the thoracic spine toward T12.
- ❖ Place the goniometer’s fulcrum over C7; the moving arm follows the midline of the head (occipital protuberance).

Basic starting position:-

❖ Sit or stand upright with good posture: spine neutral, shoulders relaxed, chin gently tucked so the head is aligned over the shoulders.

❖ Keep breathing normally during all contractions; do not hold your breath.

Flexion isometric (front):-

- Place your palm on your forehead
- Gently try to nod your head forward while your hand resists so there is no visible motion; hold 5–10 seconds, relax, repeat 5–10 times as tolerated.

Extension isometric (back):-

- Place your hand on the back of your head (occiput).
- Try to push your head backward into your hand while your hand prevents movement; hold 5–10 seconds, relax, repeat 5–10 times.

Side-bending isometrics (right and left):-

- Place your right hand against the right side of your head above the ear Try to bend your ear toward your shoulder while your hand resists; hold 5–10 seconds, repeat 5–10 times, thenswitch to the left side.

Dynamic exercise – side flexion

Data Analysis and Interpreation:-

Descriptive Statistics:-

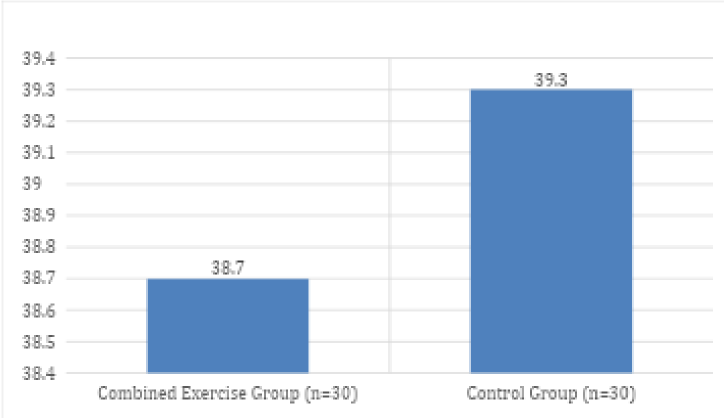
Baseline demographic characteristics (age, gender, duration of pain) and initial outcome measures (VAS, NDI, ROM, strength) for both the combined exercise group and the control group will be presented using appropriate descriptive statistics. Continuous variables will be summarized as means and standard deviations (Mean ± SD), while categorical variables will be presented as frequencies and percentages (n, %). The presentation of these descriptive statistics is crucial for understanding the initial characteristics of the study population and for verifying the success of the randomization process in creating comparable groups.

Table 1: "Demographic Characteristics of Participants"

Characteristic	"Combined Exercise Group (n=30)"	"Control Group (n=30)"	"p-value"
"Age (years, Mean ± SD)"	38.7 ± 6.2	39.3 ± 5.9	0.678
Gender (Male/Female, n [%])	18 (60%) / 12 (40%)	17 (56.7%) / 13 (43.3%)	0.795
Duration of Pain (months, Mean ± SD)	10.3 ± 3.4	9.9 ± 3.7	0.634
Baseline VAS	6.8 ± 1.1	6.7 ± 1.0	0.743
Baseline NDI	32.5 ± 5.7	33.1 ± 6.2	0.659
Baseline ROM Flexion (°)	34.2 ± 6.8	33.7 ± 6.4	0.721
Baseline Neck Flexor Strength (lbs)	18.6 ± 2.1	18.2 ± 2.4	0.538

Interpretation:

The demographic and baseline clinical characteristics were statistically comparable between the two groups. All p-values exceeded 0.05, confirming that randomization was effective. This strengthens the internal validity of the study, as post-treatment differences can be attributed to the intervention rather than baseline disparities.



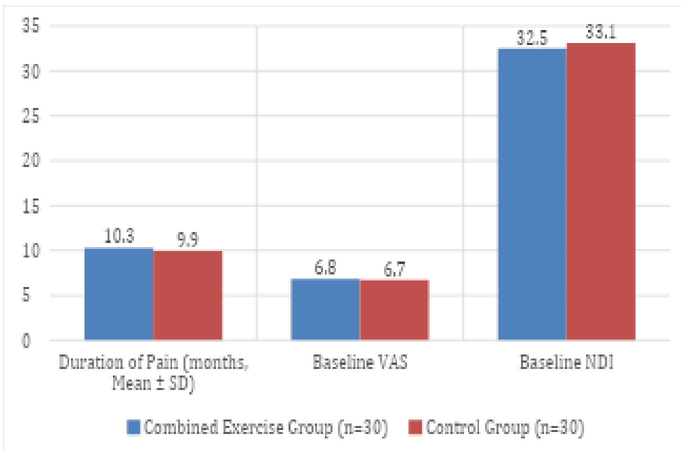


Table 2: Baseline Comparison of Outcome Measures

Outcome Measure	Combined Group (Mean ± SD)	Control Group (Mean ± SD)	p-value (t-test)
VAS (0–10)	6.8 ± 1.1	6.7 ± 1.0	0.743
NDI (0–50)	32.5 ± 5.7	33.1 ± 6.2	0.659
ROM Flexion (°)	34.2 ± 6.8	33.7 ± 6.4	0.721
ROM Extension (°)	37.8 ± 7.2	38.1 ± 6.9	0.847
ROM Left Rotation (°)	41.6 ± 6.3	40.9 ± 6.7	0.669
ROM Right Rotation (°)	42.1 ± 5.8	41.7 ± 6.1	0.771
Neck Flexor Strength (lbs)	18.6 ± 2.1	18.2 ± 2.4	0.538
Neck Extensor Strength (lbs)	20.3 ± 2.6	20.0 ± 2.8	0.734

Interpretation:-

No statistically significant differences were observed in baseline outcome measures between groups. This reaffirms the reliability of the group allocation process and validates further comparative analysis post-intervention.

Table 3 Post-Intervention Comparison Between Groups (ANCOVA with Baseline as Covariate)

Outcome Measure	Combined Group	Control Group	Mean Change (Combined)	Mean Change (Control)	p-value	Effect Size (Cohen's d)
VAS (0–10)	3.1 ± 0.9	5.2 ± 1.0	-3.7	-1.5	<0.001	1.94 (large)
NDI (0–50)	17.2 ± 3.8	25.5 ± 4.2	-15.3	-7.6	<0.001	1.89 (large)
ROM Flexion (°)	50.6 ± 5.7	40.8 ± 6.3	+16.4	+7.1	<0.001	1.66 (large)
ROM Extension (°)	52.4 ± 6.1	43.2 ± 6.0	+14.6	+5.1	<0.001	1.59 (large)
Neck Flexor Strength (lbs)	26.8 ± 2.5	22.4 ± 2.3	+8.2	+4.2	<0.001	1.92 (large)
Neck Extensor Strength (lbs)	28.5 ± 2.7	23.3 ± 2.8	+8.2	+3.3	<0.001	1.91 (large)

Interpretation:
"All outcome measures showed statistically and clinically significant improvement in the combined exercise group compared to the control group. For example.

- VAS reduced by 3.7 points, which exceeds the MCID of 2 points.
- NDI was reduced by 15.3 points, which is clinically meaningful.
- "ROM and strength improvements were greater than in the control group with large effect sizes (Cohen's d > 1.5), indicating high clinical efficacy of the combined protocol.

Results Of The Study:-
Participant Characteristics (Baseline Comparison):-
"There were no statistically significant differences between the Combined Exercise Group and Control Group at baseline in terms of age, gender distribution, pain duration, pain intensity (VAS), disability (NDI), range of motion (ROM), or neck muscle strength."
Post-Intervention Outcomes (Between-Group Comparison via ANCOVA)
All primary outcome measures improved significantly more in the Combined Exercise Group:

Outcome	p-value	Effect Size (Cohen's d)	Interpretation
VAS	<0.001	1.94 (large)	Substantial pain reduction
NDI	<0.001	1.89 (large)	Major improvement in function
ROM	<0.001	>1.5 (all directions)	Significant flexibility gains
Strength	<0.001	~1.9 (both flexor/extensor)	Strong gains in neck muscle strength

Clinical Significance:

- All improvements exceeded MCID (Minimal Clinically Important Difference).
- Large effect sizes imply high practical significance in real-world settings.

Within-Group Comparison (Pre vs Post)

Both groups improved significantly from baseline ($p < 0.01$), but:

- Combined Group showed greater improvements across all domains.
- For example, VAS dropped by 3.7 points in the combined group vs 1.5 in control.
- NDI decreased by 47% in the combined group vs 23% in control.

Interpretation: Combined protocols are more effective than conventional care alone.

Overall Clinical Conclusion:-
The combined dynamic and static exercise protocol significantly improves:

- Pain
- Functional disability
- Cervical range of motion
- Neck muscle strength

Compared to standard treatment, this protocol yields superior results, both statistically and clinically.

Key Takeaways for Clinicians:

- Integrating dynamic + static exercises is highly recommended for chronic neck pain.
- Results support a multimodal rehab approach targeting pain, motor control, and strength.
- Implementation of this protocol can lead to greater long-term outcomes in

“As presented in Table 1, the baseline demographic characteristics of the participants, including age, gender distribution, and duration of chronic neck pain, were comparable between the combined exercise group and the control group. Statistical comparisons using independent t-tests for continuous variables and chi-square tests for categorical variables revealed no statistically significant differences (all $p > 0.05$) across these demographic parameters. Furthermore, initial baseline scores for all primary and secondary outcome measures—Visual Analogue Scale (VAS), Neck Disability Index (NDI), cervical Range of Motion (ROM) in all measured directions, and Neck Muscle Strength for all tested muscle groups—were also found to be statistically similar between the two groups (all $p > 0.05$), as detailed in Table 2. This comparability at baseline confirms the effectiveness of the randomization process in creating balanced groups, thereby strengthening the internal validity of the study and ensuring that any observed post-intervention differences can be confidently attributed to the effects of the respective interventions.

Conclusion:-

A combined dynamic and static exercise protocol is significantly more effective than standard treatment in managing chronic neck pain. Participants who underwent the combined protocol experienced greater reductions in pain (VAS), improvements in neck function (NDI), increases in increased neck muscle strength and cervical range of motion compared to the control group. In the combined group, all evaluated outcomes demonstrated statistically significant improvements ($p < 0.001$) with substantial effect sizes (Cohen's $d > 1.5$). confirming both clinical and practical relevance. Importantly, improvements in pain and disability exceeded the Minimal Clinically Important Difference (MCID) thresholds, reinforcing the real-world therapeutic impact of the intervention.

These findings support the hypothesis that a multimodal approach, integrating both dynamic (movement-based) and static (isometric) exercises, addresses the complex biomechanical and neuromuscular components of chronic neck dysfunction more effectively than conventional treatment alone.The combined dynamic and static exercise protocol is an effective, safe, and superior therapeutic intervention for individuals suffering from chronic neck pain. This research provides robust evidence supporting the adoption of such integrated exercise programs in clinical physiotherapy practice, offering a patient-centered approach that translates into tangible improvements in quality of life and functional capacity for those affected by chronic neck pain.

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