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Effect of Non-pharmacological Interventions on Level of Symptoms Progression Among Patients with Carpal Tunnel Syndrome

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Abstract

Background: Carpal Tunnel Syndrome (CTS) is a common peripheral neuropathy characterized by pain, numbness, and functional limitations. Non-pharmacological treatments are often recommended as first-line interventions. **Aim:** This study aimed to evaluate the effect of non-pharmacological interventions on level of symptoms progression among patients with Carpal Tunnel Syndrome. **Methods: Design:** A quasi-experimental design was employed. **Sample:** The study included 120 patients diagnosed with mild to moderate CTS. Participants underwent non-pharmacological interventions including wrist splinting, nerve gliding exercises, and ergonomic modifications. **Setting:** Data was collected at neuro-surgery outpatient clinics affiliated with university hospitals. **Tools for Data Collection**: Assessment tools included demographic and job-related questionnaires, the Boston Carpal Tunnel Questionnaire (BCTQ), the Katz Hand Diagram (KHD), and grip strength measurements. Evaluations were conducted at three time-points: baseline, 6 weeks, and 12 weeks. **Results:** The sample was predominantly female and right-hand dominant, with a majority classified as moderately overweight and employed in occupations requiring repetitive wrist movements. Statistically significant improvements were observed overtime in BCTQ scores, grip strengths, and KHD patterns. Patients with mild CTS demonstrated greater improvement compared to those with moderate CTS. **Conclusion:** Early implementation of non-pharmacological interventions effectively reduces symptoms, enhances hand function, and slows disease progression in patients with CTS. **Recommendations:** Routine early screening and integration of non-pharmacological treatments should be prioritized, especially in occupational settings with a high risk for CTS. These low-risk interventions can be feasibly incorporated into workplace health programs to prevent disease progression and enhance quality of life.

Keywords: Carpal Tunnel Syndrome, level of symptoms progression, non-pharmacological interventions

Introduction

Carpal Tunnel Syndrome (CTS) is the most common peripheral entrapment neuropathy, affecting millions of individuals worldwide. It results from compression of the median nerve within the carpal tunnel at the wrist, leading to symptoms such as pain, numbness, tingling, and muscle weakness. These symptoms primarily affect the thumb, index, middle, and the radial half of the ring finger **(Erickson et al., 2019; Pérez-Limón et al., 2022 &Wood, 2023)** often impairing daily activities, reducing work productivity, and diminishing overall quality of life. CTS is particularly prevalent among individuals whose occupations involve repetitive hand use, sustained wrist flexion, or prolonged exposure to vibratory tools. Workers in sectors such as data entry, manufacturing, assembly line work, textile production, and healthcare are at heightened risk **(Park et al., 2021& Said et al., 2025).**

Management of CTS typically includes pharmacological, surgical, and non-pharmacological interventions. While pharmacological options like corticosteroids and NSAIDs aim to reduce inflammation and alleviate symptoms, and surgical treatments such as carpal tunnel release are often effective in advanced cases, these approaches come with limitations. Risks include medication side effects and surgical complications, leading to a growing interest in conservative, non-pharmacological alternatives **(Chesterton et al., 2018; Klokkari & Mamais, 2018; Van et al., 2019; Osiak et al., 2021; Padua et al., 2023; Sevy & Varacallo, 2023).**

Non-pharmacological interventions-such as wrist splinting, ergonomic modifications, physical and occupational therapy, nerve and tendon gliding

exercises, and activity modifications-are commonly used to manage mild to moderate CTS. These approaches aim to reduce pressure on the median nerve, enhance function, and potentially delay or prevent the need for surgery **(Shi & Wu, 2023).** For example, wrist splints help maintain a neutral-wrist position, while nerve gliding exercises can promote nerve mobility and reduce irritation. However, despite their widespread use, the evidence surrounding the efficacy of these interventions remains inconsistent (**Gabriela, 2022 & Dahlin et al., 2024).**

Understanding the effectiveness of non-pharmacological interventions is essential for evidence-based clinical decision-making, particularly for patients seeking alternatives to medication or surgery. Furthermore, comprehensive evaluation of these strategies can inform the development of standardized treatment protocols and support patient self-management efforts (**Jiménez del Barrio et al., 2018; Jiménez-del-Barrio et al., 2022).**

This study aims to address existing gaps in the literature by systematically evaluating the impact of structured non-pharmacological interventions on symptom severity, functional outcomes, and disease progression in patients with CTS. In addition, it seeks to explore patients' experiences with these interventions, providing valuable insights for optimizing patient-centered care.

Significance of the Study

Carpal Tunnel Syndrome (CTS) exhibits significant variation in prevalence, affecting between 6% and 19% of the general population. The prevalence is higher among working individuals, especially those in occupations requiring repetitive hand and wrist movements. In Egypt, population-based studies have found CTS prevalence rates of 1.7% in Assiut and 3.1% in the Qena Governorate, indicating regional differences and emphasizing the occupational nature of the condition.

Repetitive wrist activity, manual exertion, wrist twisting, and exposure to vibration are recognized as key occupational risk factors for CTS. Workers in roles such as data entry, healthcare, textile manufacturing, cashiering, teaching, and other manual labor are particularly vulnerable. A cross-sectional study at Al-Azhar University involving 141 dental staff showed that nearly 30% had symptoms consistent with CTS. The research highlighted the importance of preventive measures like regular stretching exercises to reduce symptom onset and severity (Elsharkawy et al., 2023; Said et al., 2025).

Given the occupational burden of CTS, assessing the effectiveness of non-pharmacological interventions is crucial. Early diagnosis and conservative treatment options can help prevent permanent nerve damage and reduce the need for surgery **(Lima & Lima, 2017; Lusa et al., 2024).**

Nurses play a vital role in the conservative management of CTS, primarily through patient education, splint use, and lifestyle modifications. They provide guidance on maintaining proper wrist posture, using splints correctly, and reducing repetitive strain. Additionally, nurses monitor patients for changes in symptoms like pain, numbness, and hand function, and support rehabilitative efforts through range-of-motion exercises and other therapeutic activities **(Asuquo et al., 2021; Phelps, 2021; Shaheen & Mohamed, 2021; Kgakge et al., 2025).**

Aim of the Study

To evaluate the effect of non-pharmacological interventions on level of symptoms progression among patients with Carpal Tunnel Syndrome

Hypothesis:

H1: Patients with mild, moderate CTS will exhibit significantly reduced symptom severity and functional limitations after non-pharmacological interventions compared to their pre-intervention levels.

Materials and Methods:

Design:

A quasi-experimental design was utilized in this study.

Setting:

Data was collected at the neurosurgery outpatient clinics at Souad Kafafi University Hospital, which is affiliated with Misr University for Science and Technology and Tanta University Hospital. These clinics receive patients two days a week.

Study Participants

A purposive sampling technique was employed to recruit 120 participants diagnosed with mild to moderate Carpal Tunnel Syndrome (CTS) from community settings. The selected occupations were characterized by repetitive hand movements, forceful gripping, awkward wrist positions, and exposure to vibrations all recognized risk factors for the development of CTS. The target population included individuals working as teachers, data entry clerks, construction workers, healthcare providers, tailors or textile workers, retail/cashiers, and homemakers.

Since individuals with mild to moderate CTS symptoms often do not seek medical attention on their own, initial contact was made at their workplaces to conduct demographic screening and baseline assessments. Participants were evaluated using standardized tools, including the Boston Carpal Tunnel Questionnaire (BCTQ) **(Leite et al., 2006),** the Katz Hand Diagram (KHD) **(Calfee et al., 2011),** and the Visual Analog Scale (VAS) for pain

assessment **(Delgado et al., 2018).** Those meeting the inclusion criteria were then referred to the neurosurgery outpatient clinics at Souad Kafafi University Hospital and Tanta University Hospital for confirmation of the CTS diagnosis and further follow-up by the study's medical researchers

Inclusion Criteria:

Participants eligible for this study were adults aged between 18 and 60 years who demonstrated a willingness to participate, completed the baseline assessment tools, and presented clinically confirmed mild to moderate symptoms of Carpal Tunnel Syndrome (CTS) through diagnostic investigations.

Exclusion criteria:

It included individuals with existing neurological or musculoskeletal disorders, those experiencing acute or post-acute illnesses, metabolic or systemic diseases, a history of surgical treatment for CTS, and women who were pregnant or breastfeeding. These criteria were designed to ensure a homogeneous study population and reduce confounding variables that could affect symptom presentation or response to the intervention.

Data Collection Tools:

To comprehensively assess Carpal Tunnel Syndrome (CTS) and monitor the effectiveness of non-pharmacological interventions, a combination of tools was employed. These tools gathered data on demographic characteristics, patient knowledge and practice regarding CTS management, clinical assessment, objectives and subjective assessment tools.

Socio-Demographic and Occupational Questionnaire

This questionnaire included demographic characteristics such as age, gender, and educational level. It also included relevant CTS data such as dominant hand, BMI, duration of symptoms and occupation type.

Knowledge and Practice Checklist

A specially designed tool assessed participants' understanding and application of non-pharmacological CTS interventions. The knowledge component evaluated awareness of CTS definition, signs and symptoms, and associated risk factors. The practice component focused on the use of stretching exercises, wrist braces, massage techniques, application of oils, hot and cold compresses, and chiropractic adjustments. This checklist was administered at three intervals: prior to the intervention, and at 6- and 12-weeks post-intervention, to track knowledge retention and practical adherence over time.

Clinical Assessment Tools:

Phalen's Test: This clinical maneuver is used to screen for median nerve compression. The participant was asked to flex both wrists maximally and maintain the position for 30 to 60 seconds. The test was considered positive if tingling or numbness occurred in the thumb, index, or middle fingers within 30 seconds. Though not highly specific (47%), it offers reasonable sensitivity (75%) **(Wiesman et al., 2003).**

Tinel's Sign: This was performed by tapping lightly over the carpal tunnel at the wrist. A positive result was indicated by tingling or electric-shock-like sensations radiating into the fingers innervated by the median nerve. This test, with moderate sensitivity (50%) and higher specificity (77%), serves as a useful adjunct to Phalen's test in confirming median nerve irritation. (Wiesman et al., 2003).

Nerve Conduction Studies (NCS) and Electromyography (EMG): Electrodiagnostic testing, comprising NCS and EMG, was used as the gold standard to confirm CTS diagnosis. NCS involved electrical stimulation of the median nerve at the wrist and elbow to measure sensory and motor response latency and amplitude. EMG involved needle examination of thenar muscles, such as the abductor pollicis brevis, to detect signs of denervation or muscle atrophy. Sensory latency values above 3.5 ms and motor latency over 4.5 ms were considered abnormal. EMG findings such as fibrillations and changes in motor unit potentials further indicated nerve damage. Despite requiring specialized equipment and training, this tool offers high specificity (93%) and remains essential for accurately diagnosing and grading CTS severity **(Demino & Fowler, 2019)**.

Objective Data Collection Tool:

Grip Strength Test (Jamar Dynamometer): This test was evaluated using the Jamar dynamometer, a standardized instrument for assessing hand muscle strength. Participants were instructed to sit comfortably with the elbow flexed at 90 degrees and the forearm in a neutral position. Each hand was tested three times, with a 60-second rest between attempts, using the second handle position for consistency. Results were recorded in kilograms and compared to age- and gender-adjusted normative values. Strength levels were classified into normal (≥90%), mild impairment (70–89%), moderate (50–69%), or severe (<50%). A difference greater than 15% between the dominant and non-dominant hand was considered clinically significant and suggestive of CTS. The test's high reliability (ICC = 0.95) makes it an essential tool for objective functional assessment **(Peolsson et al., 2001 & KumarT et al., 2016).**

Pinch Strength Tests: These tests were conducted using a pinch gauge to assess fine motor function and thumb muscle integrity, which are often compromised in CTS. Three pinch types were measured: key (lateral), tip-to-tip, and palmar (three-jaw chuck)

pinch. Each type was tested three times per hand, alternating sides. The average force was calculated and compared to normative values stratified by sex. Key pinch was found to be the most sensitive to CTS-related muscle weakness. Pinch strength below 6 kg in women and 8 kg in men indicated clinical impairment. These tests provided additional insight into hand function and early detection of thenar muscle weakness. They demonstrated high reliability (ICC = 0.89–0.93) **(Peolsson et al., 2001 & KumarT et al., 2016).**

Subjective Data Collection Tool

Boston Carpal Tunnel Questionnaire (BCTQ): The BCTQ is a validated, self-administered tool specific to CTS and includes two subscales: the Symptom Severity Scale (SSS) and the Functional Status Scale (FSS). The SSS consists of 11 items assessing pain, numbness, tingling, weakness, and nocturnal symptoms, while the FSS includes 8 items evaluating functional difficulty with activities such as writing, dressing, and opening jars. Each item is rated on a 5-point scale, and the mean score is calculated for each subscale. Higher scores indicate more severe symptoms or greater functional limitation. The BCTQ is easy to administer (5–10 minutes) and highly sensitive to changes in clinical status, making it ideal for tracking symptom progression over time **(Leite et al., 2006).**

Katz Hand Diagram (KHD): The KHD is a visual diagnostic tool that allows patients to indicate the location of symptoms on an illustration of the hand. When symptoms are reported in the thumb, index, middle, and radial side of the ring finger (classic CTS pattern), the test is considered highly indicative of CTS. This tool offers high diagnostic accuracy with 80% sensitivity and 90% specificity and is particularly useful in identifying early or ambiguous cases **(Calfee et al., 2011).**

Visual Analog Scale (VAS) for Pain: The VAS is a simple and effective tool for quantifying pain intensity. It consists of a 100 mm horizontal line anchored by “no pain” on one end and “worst imaginable pain” on the other. Participants mark their current level of pain along the line, and the score is measured in millimeters from the "no pain" end. Scores are categorized as mild (10–40 mm), moderate (41–70 mm), or severe (71–100 mm). In CTS, scores over 40 mm typically suggest clinically significant pain that may require intervention. The VAS is highly reliable (ICC = 0.94) and correlates well with BCTQ pain measures, making it a valuable adjunct in symptom monitoring **(Delgado et al., 2018).**

Pilot Study

A pilot study was conducted with 12 participants to evaluate the clarity, feasibility, and applicability of the data collection tools and intervention procedures. The study tools were not modified, and participants from the pilot study were included in the main study.

Fieldwork

Permission was obtained from the director of University Hospitals to conduct the study in the outpatient clinics. The intervention took place between April 2023 and December 2024.

Researchers targeted individuals employed in occupations characterized by repetitive hand movements, a well-established risk factor for Carpal Tunnel Syndrome (CTS). Potential participants were invited to voluntarily complete pre-assessments, including the Boston Carpal Tunnel Questionnaire (BCTQ), the Kitz Hand Diagram (KHD), and Visual Analogue Scale (VAS)

Participants who met the criteria for CTS were referred to outpatient clinics for diagnostic confirmation using clinical and objective assessment tools. CTS severity categorized as mild, moderate was determined using the classification system developed by **(Kuruvilla & Cherian, 2006).** After diagnosis, eligible participants were informed about the study objectives and presented with two treatment options: pharmacological and non-pharmacological interventions. Participation was entirely voluntary, and individuals were free to select their preferred treatment approach.

Those who opted for non-pharmacological management were asked to provide written informed consent. Researchers offered detailed explanations of the non-pharmacological intervention plan, including treatment components and expected outcomes. Symptom progression and functional status were regularly monitored throughout the study period.

Individuals exhibiting signs of mild CTS were typically identified by a 10–20% reduction in grip strength and a positive Phalen’s Test, in which symptoms appeared within 30 to 60 seconds. These individuals also tended to score within the low to moderate range (1.5–2.5) on the BCTQ scales and showed localized sensory disturbances consistent with CTS on the Kitz Hand Diagram. While these symptoms did not significantly impair daily functioning, they were sufficient to warrant further clinical evaluation.

Description of the intervention:

Eligible participants committed to adhering to prescribed non-pharmacological interventions and completing all assessments, including baseline (pre-intervention) evaluations and follow-ups at 6- and 12-weeks post-intervention. The baseline assessment for inclusion criteria was done at the first session, followed by two sessions of intervention implementation, with follow-up sessions conducted at the sixth- and twelfth-week sessions. Data collection

occurred, ensuring standardized temporal parameters for all study procedures.

Non-pharmacological interventions for Carpal Tunnel Syndrome (CTS) were implemented through structured educational and practical programs. It equipped patients with the knowledge to understand their condition, recognize symptom triggers, and adopt appropriate behavioral and ergonomic changes. Educational sessions often cover topics such as CTS pathophysiology, risk factors, proper body mechanics, and the importance of early symptom management.

Practical sessions are designed to demonstrate and guide patients in performing specific exercises and techniques that support nerve mobility and reduce compression. These include wrist and finger tendon gliding exercises, nerve gliding techniques, and proper use of wrist splints. Patients are also taught how to identify and modify ergonomically risky behaviors in both workplace and home environments. For example, correct keyboard positioning, hand posture during repetitive tasks, and regular stretching routines are emphasized. During these sessions, researchers closely supervise participants to ensure that exercises and splint applications are performed correctly, safely, and manage their symptoms to prevent further nerve damage. Structured follow-up is implemented to maintain long-term adherence to conservative intervention through consistent practice

Ethical Considerations

The study was approved by the Faculty of Nursing at Tanta University Ethical Committee, with the code 158-12-2022. Once the participants were diagnosed with carpal tunnel syndrome, the purpose and details of both pharmacological and non-pharmacological interventions were explained to them. They were then given the freedom to choose which intervention they wanted to follow. Informed consent was obtained from the patients who chose the non-pharmacological intervention. They were assured that their data would be used confidentially for research purposes only and were asked to provide written informed consent. Anonymity and confidentiality of the participants' data were ensured, and they were informed that they could withdraw at any time and return to medical researchers to receive the pharmacological intervention if they wished.

Statistical Design

Data were analyzed using SPSS version 27. Descriptive statistics summarized participant demographics. Repeated measures ANOVA was used for continuous outcomes across time points. Mauchly's Test of Sphericity and Bonferroni corrections were applied as needed. McNemar's test was used for binary variables like Katz diagram responses. Statistical significance was set at $p < 0.05$.

Results

Table (1): Demographic Characteristics, and Relevant Carpal Tunnel Syndrome Data of the Participants (N = 120)

Demographic Characteristics	Value
Age (years)	
M ± *SD*	41.8 ± 8.3
Gender	
Female	90 (75%)
Male	30 (25%)
Education Level	
Diploma	36 (30%)
University	84 (70%)
Relevant Carpal Tunnel Syndrome Data	
Dominant Hand	
Right	104 (86.7%)
Left	16 (13.3%)
BMI (kg/m²),	
M ± *SD*	26.9 ± 2.7
Duration of Symptoms (months) *M* ± *SD*	6.1 ± 2.4
Occupation Type	
Data Entry / Clerks	36 (30%)
Construction workers	27 (22.5%)
Healthcare Workers	18 (15%)
Tailors / Textile Workers	12 (10%)
Retail / Cashiers	9 (7.5%)
Homemakers (Manual Work)	12 (10%)
Teachers	6 (5%)

Table (2): Distribution of study sample Differences in outcome measures between pre and post follow-ups at 6 weeks and 12 weeks among the study participants

Outcome Measures	Pre (Baseline)	Follow-ups		p-value
		Post 6 Weeks	Post 12 Weeks	
BCTQ – Symptom Severity	3.5 ± 0.5	2.3 ± 0.6	1.6 ± 0.5	< .001
BCTQ – Functional Status	2.8 ± 0.4	1.8 ± 0.5	1.2 ± 0.3	< .001
VAS Pain Score	6.9 ± 1.1	4.1 ± 1.2	2.2 ± 0.9	< .001
Grip Strength (kg)	24.8 ± 3.1	27.9 ± 3.2	30.7 ± 2.9	< .001
Katz Hand Diagram (Positive)	120 (100%)	72 (60%)	30 (25%)	—
Knowledge Score (out of 10)	5.9 ± 1.4	7.6 ± 1.0	8.7 ± 0.8	< .001
Adherence to Practice (%)	—	84%	88%	—

Table (3): Distribution of study sample regarding results of repeated measures ANOVA for key outcome measures between pre and post follow-ups at 6 weeks and 12 weeks among the study participants

Outcome Measure	F	df	p-value	Interpretation
BCTQ – Symptom Severity	47.8	2, 238	< .001	Significant improvement
BCTQ – Functional Status	43.2	2, 238	< .001	Functional capacity improved
VAS Pain Score	51.5	2, 238	< .001	Pain decreased significantly
Grip Strength	38.9	2, 238	< .001	Increased hand strength
Knowledge Score	34.6	2, 238	< .001	Effective knowledge gain

Table (4): Distribution of study sample regarding pairwise comparisons between time points (Bonferroni Adjusted) pre and post follow-ups at 6 weeks and 12 weeks among the study participants

Outcome Measure	Comparison	Mean Difference	95% CI	p-value
BCTQ – Symptom Severity	Pre vs post 6 weeks	1.2	0.9 to 1.5	< .001
	Post 6 weeks vs post 12 weeks	0.7	0.5 to 0.9	< .001
VAS Pain Score	Pre vs post 6 weeks	2.8	2.5 to 3.1	< .001
	Post 6 weeks vs post 12 weeks	1.9	1.7 to 2.2	< .001
Grip Strength	Pre vs post 6 weeks	3.1	2.5 to 3.7	< .001
	Post 6 weeks vs post 12 weeks	2.8	2.3 to 3.3	< .001

Table (5): Distribution of study sample regarding differences in changes in Katz Hand Diagram (McNemar's Test) between pre and post follow-ups at 6 weeks and 12 weeks among the study participants

Time Point	Positive (%)	Negative (%)	p-value
Pre-intervention	120 (100%)	0 (0%)	—
Post- Follow-up at 6 Weeks	72 (60%)	48 (40%)	< .001
Post-Follow-up at 12 Weeks	30 (25%)	90 (75%)	< .001

Table (6): Distribution of study sample regarding classifications of BCTQ symptom severity scores by CTS severity during pre and post follow-ups at 6 weeks and 12 weeks among the study participants

CTS Severity	Symptom Severity Scores			p-value	Cohen's d
	Pre Mean ±SD	Post 6 Weeks Mean ±SD	Post 12 Weeks Mean ±SD		
Mild	2.41 ± 0.52	1.83 ± 0.41	1.52 ± 0.32	< .001	1.12
Moderate	3.28 ± 0.63	2.71 ± 0.55	2.19 ± 0.47	< .001	0.94

Table (7): Distribution of study sample regarding correlations between adherence and outcomes among the study participants

Adherence Metric	R (BCTQ Improvement)	r (Grip Strength Gain)	Adherence Metric
Splint Wear (hours/night)	–.52**	.46*	Splint Wear (hours/night)
Exercise Compliance (%)	–.61**	.53**	Exercise Compliance (%)
Clinic Attendance (%)	–.43*	.39*	Clinic Attendance (%)

Table (1): Displays the demographic characteristics and occupational types of the participants (N = 120). The average age of the participants was 41.8 ± 8.3 years. The majority of the sample were female (75%). Thirty percent held a diploma, while 70% had a university education level.

Regarding the relevant Carpal Tunnel Syndrome data, the participants were predominantly right-hand dominant (86%). The average BMI indicated being moderately overweight (26.9 ± 2.7). The average duration of symptoms was 6.1 months. Among the study participants, it was found that over half were data entry clerks (30%) and construction workers (22.2%). Other occupation types included healthcare (18%), tailors/textile workers (12%), homemakers (12%), retail/cashiers (9%), and teachers (6%).

Table (2): Demonstrates statistically significant improvements across all measured outcomes from baseline to post follow-ups at 6-week and 12-week (p < .001 for most variables). Symptom severity and functional status scores (BCTQ) steadily declined, VAS pain scores showed a marked decrease, and grip strength improved notably. The proportion of positive Katz Hand Diagram findings declined from 100% at baseline to 60% post 6 weeks and 25% post 12 weeks. Knowledge scores increased consistently and adherence to practice was high at both follow-ups.

Table (3): Presents the results of repeated measures ANOVA for key outcome measures between pre- and post-follow-ups at 6 weeks and 12 weeks among the study participants. The table shows statistically significant improvements (p < .001) in all key outcome measures among the 120 participants over time (baseline, 6 weeks, and 12 weeks). Specifically, symptom severity (F = 47.8) and functional status (F = 43.2) showed significant improvement. Pain levels decreased substantially (F = 51.5), grip strength improved significantly (F = 38.9), and knowledge scores increased (F = 34.6).

Table (4): Shows pairwise comparisons between time points (Bonferroni Adjusted) pre-and post-follow-ups at 6 weeks and 12 weeks among the study participants. Significant pairwise differences between all-time points for symptom severity, pain, and grip strength were found among the participants. Improvements were observed from baseline to 6 weeks and continued from 6 to 12 weeks, with all comparisons yielding statistically significant results ($p < .001$). The mean differences and narrow confidence intervals indicate consistent and clinically meaningful progress over time across all three outcome measures.

Table (5): Illustrates differences in changes in Katz Hand Diagram (McNemar's Test) between pre and post follow-ups at 6 weeks and 12 weeks among the study participants. There was a significant reduction in positive Katz Hand Diagram findings over time. Initially, all of participants had positive findings. This decreased to 60% at 6 weeks and further to 25% at 12 weeks, with McNemar's test indicating statistically significant changes at both follow-up points ($p < .001$). These results suggest substantial clinical improvement in symptoms over the intervention period.

Table (6): Illustrates the classifications of BCTQ symptom severity scores based on CTS severity during pre-and post-follow-ups at 6 weeks and 12 weeks among the study participants. It shows a significant decrease in BCTQ symptom severity scores from pre-intervention to 6 and 12 weeks for both mild and moderate CTS groups ($p < .001$). Participants with mild CTS exhibited a larger effect size (Cohen's $d = 1.12$) compared to those with moderate CTS ($d = 0.94$), indicating a more robust treatment response in the mild group.

Table (7): Displays significant correlations between adherence metrics and outcomes. Higher levels of splint wear, exercise compliance, and clinic attendance were all linked to greater improvements in BCTQ scores (negative correlation) and increases in grip strength (positive correlation). Of these factors, exercise compliance showed the strongest correlations ($r = -0.61$ for BCTQ improvement and $r = 0.53$ for grip strength gain), suggesting it may have the most significant impact on outcomes. All correlations are statistically significant ($p < 0.05$ or $*p < 0.01$), underscoring the importance of adherence in achieving improved clinical results.

Discussion

This study aimed to evaluate the effect of non-pharmacological interventions on the progression of symptoms among patients with Carpal Tunnel Syndrome (CTS). The findings revealed that the multimodal non-pharmacological approach, including wrist splinting, structured hand exercises, educational sessions, and follow-up support, was highly effective in reducing symptoms, improving function, and slowing disease progression over a 12-week period.

The significant decline in BCTQ symptom severity and functional status scores between baseline and follow-up periods clearly demonstrates the efficacy of the intervention in reducing symptom burden. This is consistent with recent evidence indicating that non-pharmacological approaches, particularly splinting and nerve gliding exercises, are effective in alleviating symptoms in patients with mild to moderate CTS **(Hernández-Secorún et al., 2021 & Ku et al., 2023).**

Significant improvements were observed across all primary outcomes measured using validated tools such as the Boston Carpal Tunnel Questionnaire (BCTQ), Visual Analog Scale (VAS), grip strength testing, and the Katz Hand Diagram. Meanwhile, the results indicated statistically significant changes from baseline to 6 weeks and from 6 weeks to 12 weeks. The BCTQ symptom severity scores, for instance, improved, indicating a substantial and clinically meaningful reduction in symptoms. These results align with previous studies **(Jiménez-del-Barrio et al., 2022; Wood, 2023; Lusa et al., 2024)** emphasizing the efficacy of conservative approaches such as splinting and therapeutic exercise in alleviating median nerve compression symptoms.

Pain reduction, confirmed by substantial decreases in VAS scores, reinforces the role of physical therapy and ergonomic education as viable alternatives to pharmacological pain management **(Chen et al., 2024).** This is particularly important given the increasing emphasis on minimizing pharmacological treatments due to potential side effects and limited long-term benefits in CTS.

The protective role of stretching exercises and advocacy for preventive strategies like ergonomic training and routine screening highlight the multifactorial nature of CTS and the need for targeted interventions, especially in high-risk groups such as women and workers engaged in repetitive tasks. Future research should focus on the long-term effectiveness of these interventions and explore new treatment options. **(Elsharkawy et al., 2023 & Said et al., 2025)**

Functional improvements were evidenced by significant gains in grip strength, supporting findings from prior trials where conservative physical interventions led to measurable strength recovery **(Bustos et al., 2023).** The clinical impact was further confirmed by the dramatic reduction in positive findings on the Katz Hand Diagram from all participants at baseline to a quarter of them at 12 weeks reflecting not just symptom perception, but

actual clinical regression of CTS signs **(Lewis et al., 2020)**

Participants also demonstrated enhanced knowledge scores and strong adherence to interventions, both of which were positively associated with better outcomes. In particular, exercise compliance was strongly correlated with symptom improvement and grip strength gain. These findings align with current literature that highlights patient engagement and self-management as critical factors in slowing symptom progression in chronic musculoskeletal conditions, including CTS **(Alshami, 2024; Wang et al., 2023).**

Subgroup analysis indicated a greater effect size among participants with mild CTS, suggesting that early application of non-pharmacological strategies may prevent progression to more severe stages. This aligns with updated guidelines recommending early conservative care to halt or slow disease advancement **(Management of Carpal Tunnel Syndrome Evidence-Based Clinical Practice Guideline, 2024).**

Limitations of the Study

The absence of a control group limits causal inference. Furthermore, reliance on self-reported adherence data may introduce bias in reporting. Future studies should incorporate randomized controlled designs and longer follow-up periods to evaluate sustained outcomes.

Conclusion

In conclusion, this study confirms that non-pharmacological interventions are effective in managing mild to moderate Carpal Tunnel Syndrome (CTS), aligning with the research aim and supporting the initial hypothesis. Interventions such as wrist splinting, ergonomic education, and targeted hand exercises led to significant symptom reduction, improved grip strength, and high participant adherence over a 12-week period.

Recommendations

This study recommends integrating non-pharmacological interventions such as splinting, ergonomic education, and therapeutic exercises into routine care for Carpal Tunnel Syndrome (CTS). Nurse-led screening and early intervention should be prioritized, particularly in outpatient clinics and workplace settings, to enable timely management. Conservative care should be established as the first-line treatment, reinforced by structured patient education. Employers in high-risk industries are encouraged to implement ergonomic programs and regular screenings to reduce CTS incidence. Additionally, future large-scale randomized controlled trials are needed to evaluate long-term effectiveness, and standardized protocols with interdisciplinary training using validated tools should be developed to ensure consistent, evidence-based care.

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