

## Effect of Nursing Instructional Program on Neurophysiologic Parameters of Carpal Tunnel Syndrome among Pregnant Women

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### Abstract

**Background:** Carpal tunnel syndrome has a great impact on the pregnant woman's daily life. Several non-pharmacological techniques have been used to alleviate these symptoms. **Aim:** The present study aimed to examine the effect of nursing instructional program on neurophysiologic parameters of carpal tunnel syndrome among pregnant women. **Methods:** A quasi-experimental research design was adopted. A convenient sample of 100 pregnant women with carpal tunnel syndrome was enrolled. This study was carried out at the obstetric and gynecological outpatient clinic of Kafrelsheikh general hospital, Kafrelsheikh governorate, Egypt. Three tools were used to collect data: A structured interviewing Questionnaire, Numeric Pain Rating Scale, and Boston Carpal Tunnel Syndrome Questionnaire. **Results:** The mean wrist pain scores at baseline assessment didn't show a significant difference between the control and intervention groups ( $p>0.05$ ). However, post-intervention, the difference in mean wrist pain scores between the two groups was highly statistically significant ( $p<0.001$ ). When comparing the symptom severity scale and functional status scale between the two groups, the differences weren't statistically significant at baseline assessment ( $p>0.05$ ). Post-intervention, the difference in symptom severity scale was highly statistically significant ( $p<0.001$ ) between both groups while the functional status scale did not show a significant difference ( $p>0.05$ ). **Conclusion:** The nursing instructional program was successful in improving the neurophysiologic parameters of carpal tunnel syndrome among pregnant women. **Recommendation:** Applying such nursing instructional program should be enforced to decrease suffering among pregnant women with carpal tunnel syndrome.

**Keywords:** Nursing instructional program, neurophysiologic parameters, carpal tunnel syndrome, pregnant women.

electrophysiological techniques, primarily median nerve conduction velocity (Dabbagh et al., 2020).

### Introduction

Carpal tunnel syndrome (CTS) is the most common peripheral nerve entrapment, caused by compression neuropathy of the median nerve at the level of the carpal tunnel (Obuchowicz, Kruszyńska, & Strzelecki, 2021). The median nerve permits sensory innervation to the fingers as well as innervation to the tiny muscles of the hand, which essentially control the grip of the hand (Urits et al., 2019). The estimated prevalence of CTS in adults is 2.7-5.8%; it is more frequent in the age range between 25 and 64 years (Radiopaedia, 2023). Women are 3.6 times more likely to have the condition than men (Hamid et al., 2020). Every year, the high incidence rate increases the pathology-related factors that drive up healthcare and socioeconomic expenses (Erickson et al., 2022; Subandi et al., 2020; Zhuang et al., 2020).

The symptoms of CTS are recognized by nocturnal pain, a gradual loss of sensation accompanied by weakening and numbness, weaker muscles due to severe axonal degeneration, and tingling in the hand's median nerve division (Genova et al., 2020). Symptoms can extend from mild to extremely upsetting affecting one or two hands (Setyawan, 2017). Diagnosis of CTS depends on taking history, clinical assessments, and tests such as diagnostic

Carpal tunnel syndrome is determined by sex, age, genetics, pregnancy, diabetes mellitus, hormonal changes, obesity, amyloidosis, autoimmune diseases such as rheumatoid arthritis, renal illness, trauma, and thyroid illness (Hernández-Secorún et al., 2021; Lampainen et al., 2022). It can occur also due to chronic frequent forceful jobs including vibration and/or excessive postures of the wrist, typing, or repetitive wrist motion (Moradi et al., 2020; Schmid et al., 2020).

Pregnancy can result in complications including carpal tunnel syndrome, with a reported 62% increase in occurrence. It can occur during the first trimester but is most frequently seen during the third trimester (Kamel et al., 2017). The body goes through many physical and hormonal changes that might cause swelling during pregnancy. The median nerve is compressed when extra fluid in the wrist bulges, causing tingling and a lack of sensation in the hands and fingers (Afshar & Tabrizi, 2021). Sixty out of every one hundred pregnant women may suffer CTS symptoms. The pain also related to CTS may be more likely to impact the woman's daily life routines (Cazares-Manríquez et al., 2020; Padua et al., 2016).

Early treatment of CTS is important to avoid permanent damage to the median nerve. There are many

management choices including conservative and surgical treatment. Conservative includes stopping daily activities which aggravate the condition, taking frequent rests between tasks, resting the hand, and applying cool packs as well as Nonsteroidal anti-inflammatory drugs (NSAIDs) such as aspirin, ibuprofen, and other nonprescription pain relievers may provide some short-term relief from discomfort but haven't been shown to treat CTS (Karjalainen, Raatikainen, Jaatinen, & Lusa, 2022). Moreover, surgical treatment is inappropriate during pregnancy and is exceedingly expensive compared to conservative care (Klokkari & Mamais, 2018).

Nurses play an important role in providing interventions that decrease CTS symptoms and increase functional status. The nurse should instruct the women on practicing hand exercises that can minimize CTS symptoms and apply mild heat on the hands before practicing them. The nurse also should advise them with the night wrist splint to support and immobilize the wrist at night (Abdel Maksoud & Ramadan, 2021). Earlier studies assessed the impact of the educational intervention on CTS and concluded that the intervention was effective in decreasing symptoms severity and improving functional status (Abd Elmoniem et al., 2018; Hamzeh et al., 2021). This stimulates the current study to examine the effect of nursing instructional program on neurophysiologic parameters of carpal tunnel syndrome among pregnant women.

### Significance of the study

The pregnancy period is characterized by a morphophysiological variation that directly affects the musculoskeletal system in pregnant women (Lewis et al., 2020). The dynamic normal variation associated with pregnancy can cause musculoskeletal system growth disorders. Carpal tunnel syndrome is one of the most frequent complaints during pregnancy (Oliveira et al., 2019). Untreated CTS has a negative impact on pregnant women's quality of life. It can cause persistent pain, disturbed sleep, difficulties with daily activities, and ineffective work because of damage to the median nerve (Wolska et al., 2018).

Women's health and midwifery nurses should at least be able to recognize, inform, and provide conservative measures to pregnant women with CTS to improve their quality of life. Minimal research has been done on CTS using wrist splints and hand exercises during pregnancy. Therefore, more nursing research is required to confirm whether wrist splints and hand exercises are more effective management options. In addition to the standard treatment for carpal tunnel syndrome, this study was conducted to examine the effect of nursing instructional program on neurophysiologic parameters of carpal tunnel syndrome among pregnant women. As a result, this study will be useful in the management of mild to moderate carpal tunnel syndrome.

### Aim of the study

The present study aimed to examine the effect of nursing instructional program on neurophysiologic

parameters of carpal tunnel syndrome among pregnant women.

### Operational definitions

**Neurophysiologic parameters of carpal tunnel syndrome:** refer to symptom severity, functional status (measured by Boston Carpal Tunnel Syndrome Questionnaire), and wrist pain intensity (measured by Numeric Pain Rating Scale).

**Nursing instructional program** includes the educational session containing practicing hand exercises (such as wrist flexor stretches, wrist extensor stretches, medial nerve glide, and tendon gliding exercises) and night splint application.

### Research hypotheses

- H.1. Pregnant women with carpal tunnel syndrome who receive the nursing instructional program have a lower level of pain than controls.
- H.2. Pregnant women with carpal tunnel syndrome who receive the nursing instructional program have a lower mean score of symptom severity than controls.
- H.3. Pregnant women with carpal tunnel syndrome who receive the nursing instructional program have a higher mean score of functional status than controls.

### Subjects and method

#### Research design

The hypotheses were tested using a quasi-experimental approach with a non-equivalent control group pre-and post-test. Women were divided into an intervention group and a control group. All women underwent the baseline assessments of the dependent variables. Only women in the intervention group attended the instructional program. Then, all women underwent a post-test to evaluate the difference in the dependent variables (LoBiondo-Wood & Haber, 2018).

#### Setting

This study was carried out at the obstetric and gynecological outpatient clinic of Kafrelsheikh general hospital, Kafrelsheikh governorate, Egypt. It is located on the first floor and has three sub-clinics. The first one is intended for history taking and diagnosis. The second is equipped with ultrasound for obstetrical and gynecological examination while the third clinic is dedicated to gynecological examination and surgical dressing. The official working hours begin at 9 am and end at 1 pm. The outpatient clinic receives about 2000 pregnant women every year.

## Sample

A convenient sample of 100 pregnant women with carpal tunnel syndrome between the ages of 18 and 35 years was enrolled.

## Sample size calculation

Based on data from the literature (Abd Elmoniem et al., 2018), considering a level of significance of 5%, and power of study of 80%, the sample size can be calculated using the following formula:

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \times 2(SD)^2}{d^2}$$

where, SD = standard deviation obtained from the previous study;  $Z_{\alpha/2}$ , for 5% this is 1.96;  $Z_{\beta}$ , for 80% this is 0.84 and d, for the expected difference. Therefore,

$$n = \frac{(1.96 + 0.84)^2 \times 2(4.95)^2}{(2.78)^2} = 49.7$$

Based on the above formula, the sample size required is 50 in each group.

## Data collection tools:

The data was collected using three tools:

### Tool 1: A structured interviewing questionnaire

It was developed by the researchers after reviewing the related literatures (Abd Elmoniem et al., 2018; Afshar & Tabrizi, 2021; Oliveira et al., 2019). It included three parts: **Part I: Socio-demographic data of the studied pregnant women:** such as age, education, residence, occupation, and telephone number; **Part II: Obstetric history:** such as gravida, para, mode of the previous deliveries, and gestational age. **Part III: Wrist pain characteristics:** this part included questions related to the presence and the site of wrist pain (Right, left, or bilateral).

### Tool 2: Numeric Pain Rating Scale (NPRS)

It is a self-report pain scale, that was used to determine the severity of wrist pain (McCaffery & Beebe, 1989). It is a horizontal line with a number from zero to ten that represents the respondents' level of pain. On a scale from 0, "no pain," to 10, "severe pain," women were asked to choose a whole number that best describes the level of pain they experience. **A scoring system:** The NPRS has 3 main sections: the first section reflects mild pain and is listed from

1-3 cm, the second section is listed from 4-7 cm for moderate pain, and the third one is listed from 8-10 cm for severe pain. Higher scores indicate the worst pain.

### Tool 3: Boston Carpal Tunnel Syndrome Questionnaire (BCTQ)

It is a self-administered questionnaire adopted from Beaton et al., (2000) to measure the symptom severity and functional status of CTS. It consisted of 2 scales: the symptom severity scale includes 11 items to evaluate various symptoms like pain, weakness, paresthesia, nocturnal symptoms, and difficulties grasping and the functional status scale includes 8 items to measure functional deficiencies: writing, holding a book, gripping a telephone, opening jars, carrying grocery bags, buttoning clothing, conducting household tasks, bathing, and dressing. **A scoring system:** Each item of the symptom severity scale is graded on a Likert scale with 5 possible points, ranging from 1 (no symptoms) to 5 (the worst symptoms). Each response to the functional status scale is graded on a 5-point Likert scale, with 1 (easiest) and 5 (most difficult) performing the activity.

### Validity and reliability of the tools

The content validity of the tools was tested and confirmed by three specialists in the field of maternity nursing. The tools were validated for the accuracy, applicability, and completeness of their contents. Accordingly, no modifications were made. The Cronbach's alpha coefficient test was used to assess the reliability of the suggested instruments. Cronbach's alpha of 0.89 for the structured interview questionnaire indicated a good positive correlation between the tool's elements, reliability for Numeric Pain Rating Scale was 0.96 whereas the BCTQ's test-retest reliability was 0.95.

### Ethical consideration

Ethical approval to conduct the study was attained from the Faculty of Medicine ethical committee of Kafrelsheikh University (MKSU 23-3-7). Official permission to carry out the study was attained from the director of the previously mentioned setting. The researcher explained to pregnant women the aim and advantages of the study. The researcher told them that their participation is completely voluntary, and they have the right to quit at any time, for any reason, without having an impact on their care. The pregnant women were also told that there were no health risks or dangers from this study. Women were given the assurance that the data would only be utilized for the purposes of the study, and precautions were taken to ensure anonymity in data coding. Each pregnant woman who accepted to participate in the study and met the eligibility requirements was asked for her signed agreement.

### Pilot study

It was conducted on 10 pregnant women who fulfilled the selection criteria to evaluate the clarity, application, and relevance of the study tools. Based on its

findings, no modifications were made to the tools and no issues that might hinder the data collection were found. The pilot study sample was included in the study.

### Research procedure

Data were collected within nine months from April 2022 to December 2022. The researcher attended the predetermined setting two days a week from 9:00 am to 1:00 pm. This study was carried out through preparation, interview and assessment, implementation, and evaluation.

**Preparation for the study:** To develop data-gathering tools and apply the instructional program, a thorough evaluation of the related literature has been carried out.

**Interview and assessment:** Following recruitment, the researcher conducted a one-on-one interview with each pregnant woman to collect her socio-demographic data and obstetrical history using a predefined interviewing questionnaire. The researcher recorded the responses after asking the questions in Arabic. To get a baseline evaluation, the pregnant women were also asked to rate the intensity of their symptoms, their functional status, and their wrist pain using the BCTQ and NPRS, respectively. All pregnant women in the intervention and control groups underwent an interview and evaluation. Each pregnant woman's assessment took approximately 20 to 30 minutes to complete.

**Implementation:** Routine care was provided to pregnant women in the control group in accordance with the hospital's standard of care. Whereas the pregnant women in the intervention group attended one session of the nursing instructional program in addition to receiving routine care. The session lasted nearly 30 to 45 minutes. Its goal was addressed using a variety of instructional techniques, including discussion, demonstration, and re-demonstration. A computerized PowerPoint presentation was displayed to present the provided information. Arabic pamphlets with summaries of the session content and additional colored images were provided following the conclusion of the session.

**Educational session:** It was designed to inform pregnant women about the meaning, danger signs, symptoms, and treatment of CTS. Wrist splints were distributed among pregnant women (Figure 1). Women were advised to wear it at night to support the wrist while holding it firm and still immobilizing it. It also showed them how to perform wrist flexor and wrist extensor stretches. Stretching the wrist flexors involves straightening the arm, palm down, and bending the wrist so that the fingers point downward. Use the other hand to gently bring the hand towards the body until feeling a stretch on the outside of the forearm (Figure 2). By straightening the arm and bending the wrist back, one can do a wrist extensor stretch. Then, using the other hand, gently press across the palm and bring it back until feeling a stretch on the inside of the forearm (Figure 3). The pregnant women were told to hold each stretch for 15 seconds during the two exercises.

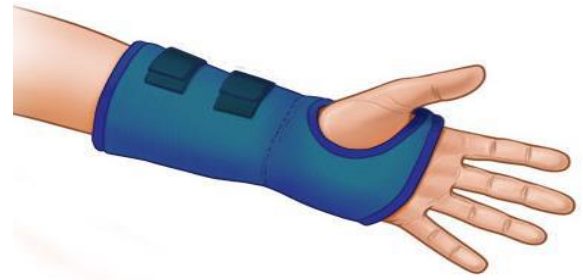


Figure 1. Wrist splint

Adopted from: **Healthwise Staff. (2022).** Wrist splint. Available at: <https://www.northshore.org/healthresources/encyclopedia/encyclopedia.aspx?DocumentHwid=zm6001>

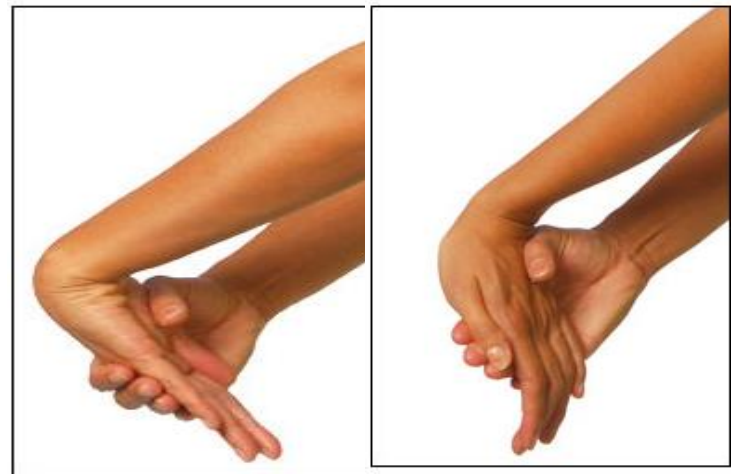


Figure 2. Wrist flexor stretch

Figure 3. Wrist extensor stretch

Adopted from: **Healthwise Staff. (2022).** Carpal Tunnel Syndrome: Exercises. Available at: <https://myhealth.alberta.ca/Health/aftercareinformation/pages/conditions.aspx?hwid=ad1506&>

The researcher also trained pregnant women on performing medial nerve glide and tendon gliding exercises. Each pregnant woman was instructed to apply mild heat to her hand for 15 minutes prior to practicing the exercises and maintain the neck and shoulder in a neutral position during the exercises. For three to seven seconds, maintain each position. Use a bag of crushed ice for 20 minutes after the workouts are finished to reduce inflammation. The workouts are done for 5–10 repetitions each, 5–10 times daily.

Six alternative hand and wrist positions are used in the medial nerve glide technique to mobilize the medial nerve: 1) A fist is formed by placing the thumb outside the fingers, 2) extending the fingers, and keeping the thumb close to the side of the hand; 3) Moreover, the wrist is extended and the fingers are kept straight. 4) Hold fingers and wrist in place while extending thumb; 5) Keep fingers extended while turning forearm palm up; and 6) Keep fingers extended while using the other hand to gently stretch thumb (Figure 4).

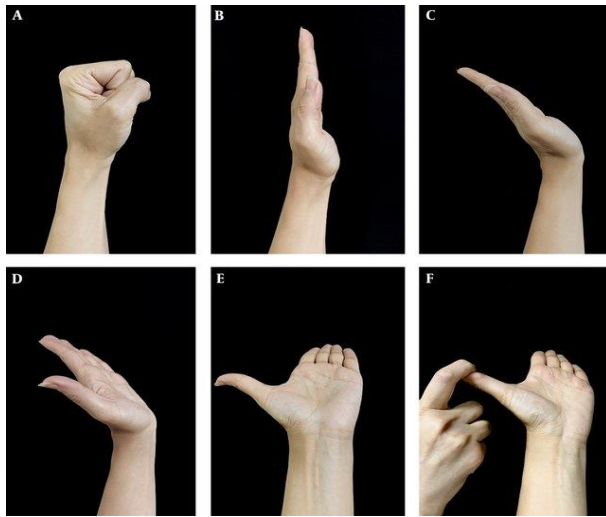


Figure 4. Totten and Hunter nerve gliding exercises (11) (A-F): "(A) wrist in neutral, fingers and thumb in flexion; (B) wrist in neutral, fingers and thumb extended; (C) wrist and fingers extended, thumb in neutral; (D) wrist, fingers, and thumbs extended; (E) as in (D) with the forearm in supination; (F) as in (E) with a gentle stretch of thumb".

Adopted from: **Nazarieh et al. (2020)**. Non-surgical management and post-surgical rehabilitation of carpal tunnel syndrome: An algorithmic approach and practical guideline. *Asian Journal of Sports Medicine*, 11(3).

Tendon gliding exercise is a mobilization technique in which the fingers should be moved through the following five distinct postures to slide the hand's flexor tendons: 1) Hand, wrist, and finger straight; 2) Tips of fingers bent into the "hook" position; 3) Making a tight fist with the thumb over the fingers, 4) Bend the fingers at the bottom knuckle while maintaining them straight, and 5) Touch the palm with the middle joint of the fingers (Figure 5).

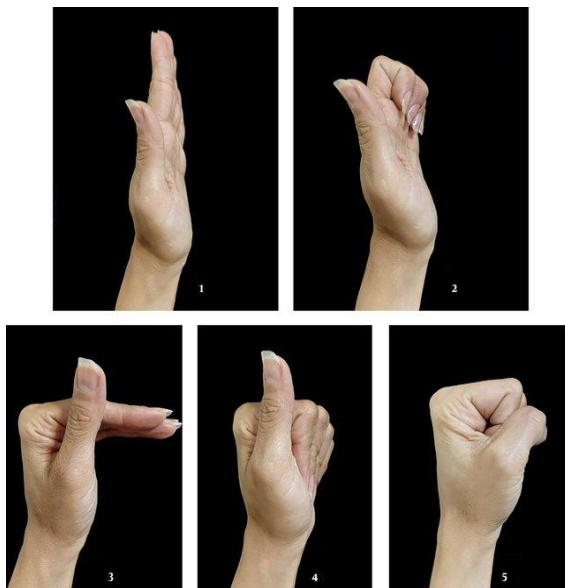


Figure 5. (1-5) Tendon gliding exercises. (1) straight; (2) straight fist; (3) table top; (4) fist; (5) hook.

Adopted from: **Nazarieh et al. (2020)**. Non-surgical management and post-surgical rehabilitation of carpal tunnel syndrome: An algorithmic approach and practical guideline. *Asian Journal of Sports Medicine*, 11(3).

**Evaluation:** One month after implementing the suggested intervention, results were evaluated to determine the intensity of symptoms and functional status using the NPRS, as well as wrist discomfort using BCTQ. This evaluation was performed for both intervention and control groups through an interview during the follow-up visit.

### Statistical analysis

The collected data were arranged, coded, and statistically analyzed using the statistical package for social science version 26.0 (SPSS, Chicago, IL). For quantitative variables, the arithmetic mean and standard deviation were employed to define the central tendency of observations and quantify the dispersion of results around the mean. The one-way analysis of variance (ANOVA) test was used for comparison among more than two variables with continuous quantitative data, whereas the student's t-test was used for comparison between two variables with continuous quantitative data. To compare the variables with categorical data, the Chi-square [X<sup>2</sup>] test was applied. The cutoff for statistical significance was  $p < 0.05$ .

## Results

The current study's findings are organized into four primary sections: socio-demographic data, obstetrical history, wrist pain characteristics, and neurophysiologic parameters of carpal tunnel syndrome.

### a. Socio-demographic data

While there were no statistically significant differences between the two groups in terms of age, educational level, residence, and occupation ( $p > 0.05$ ), the results of the current study demonstrated homogeneity of the pregnant women and matching between the control and intervention groups. According to Table (1), 44.0% of the intervention group and 40.0% of the control group were both under the age of 25. In terms of education, 34.0% of the intervention group and 38.0% of the control group had finished their preparatory education. In terms of residence, 72.0% of the intervention group and 76.0% of the control group both came from urban areas. In terms of occupation, housewives made up the majority of women in both groups.

### b. Obstetrical history

It was revealed that the pregnant women in both groups were homogeneous with regard to prior obstetrical history because there were no statistically significant differences between the two groups in terms of gravidity, parity, mode of prior delivery, or complications from prior pregnancies ( $p > 0.05$ ). In terms of gestation, the control and intervention groups' respective gravidity rates were 72.0% and 74.0%. In

terms of parity, 70.0% of the intervention group and 72.0% of the control group were both primiparas. In terms of prior delivery mode, 67.5% of the intervention group and 70.7% of the control group both underwent cesarean sections. The findings showed that difficulties during their prior pregnancies occurred in 24.4% of the control group and 12.5% of the intervention group (Table 2). In terms of gestational age, the findings showed that 86.0% of the intervention group and 90.0% of the control group were in the third trimester of pregnancy (Figure 6).

### c. Wrist pain characteristics

As shown in Table (3), all the control and intervention groups suffered from hand pain pre-intervention. While post-intervention, 84.0% of the control group and 50.0% of the intervention group suffered from hand pain. The difference between the two groups was statistically significant ( $p < 0.001$ ). Pain severity showed that pre-intervention, 40.0% of the control group had severe pain as compared to 30.0% of the intervention group with no

statistically significant difference between the levels of pain among the two groups ( $p = 0.574$ ). When comparing levels of pain post-intervention, Table (4) showed that 47.6% of the control group had severe pain in comparison to no one in the intervention group. This difference was highly statistically significant ( $p < 0.001$ ).

### d. Neurophysiologic parameters of carpal tunnel syndrome

It was found that there was no statistically significant difference between the mean scores of the control group and the intervention group prior to the intervention for the symptom severity scale ( $p = 0.494$ ). There was a statistically significant difference in the mean scores post-intervention ( $p = 0.013$ ). The functional status scale results showed that neither pre-intervention ( $p = 0.758$ ) nor post-intervention ( $p = 0.118$ ) differences in mean scores were found. There was no statistically significant difference in the overall mean BCTQ scores between the control group and the intervention group prior to the intervention ( $p = 0.802$ ). After the intervention, there was a statistically significant difference ( $p = 0.032$ ) in the overall mean scores of both groups.

**Table 1. Socio-demographic characteristics of the studied pregnant women**

Variables	Control group (N=50)		Intervention group (N=50)		Chi-Square	
	Freq.	%	Freq.	%	X <sup>2</sup>	P
<b>Age (Years)</b>						
< 25	20	40.0	22	44.0		
25 – 30	14	28.0	18	36.0		
> 30	16	32.0	10	20.0	1.980	0.372
<b>Mean ±SD</b>	27.1 ±4.5		25.9 ±3.9		1.378	0.171
<b>Level of education</b>						
Read and write	4	8.0	3	6.0		
Primary education	5	10.0	4	8.0		
Preparatory education	19	38.0	17	34.0		
Secondary education	14	28.0	19	38.0		
Higher education	8	16.0	7	14.0	1.189	0.880
<b>Residence</b>						
Rural	12	24.0	14	28.0		
Urban	38	76.0	36	72.0	0.208	0.648
<b>Occupation</b>						
Housewife	39	78.0	32	64.0		
Working	11	22.0	18	36.0	2.380	0.123

Table 2. Obstetric history of the studied pregnant women

Items	Control group (N=50)		Intervention group (N=50)		Chi-Square	
	Freq.	%	Freq.	%	X <sup>2</sup>	P
<b>Gravidity</b>						
1	7	14.0	7	14.0		
2	36	72.0	37	74.0		
3 or more	7	14.0	6	12.0	0.091	0.956
<b>Parity</b>						
Nullipara	9	18.0	10	20.0		
1	36	72.0	35	70.0		
2	5	10.0	5	10.0	0.067	0.967
<b>Mode of prior delivery</b>	<b>(n=41)</b>		<b>(n=40)</b>			
VD	12	29.3	13	32.5		
CS	29	70.7	27	67.5	0.099	0.753
<b>Prior pregnancy complications</b>	<b>(n=41)</b>		<b>(n=40)</b>			
Yes	10	24.4	5	12.5		
No	31	75.6	35	87.5	1.897	0.168
<b>If yes, what were they?</b>	<b>(n=10)</b>		<b>(n=5)</b>			
Abortion	6	60.0	0	0.0		
PROM	1	10.0	2	40.0		
Placenta Previa	2	20.0	2	40.0		
Polyhydramnios	1	10.0	1	20.0	5.250	0.263

Figure 6. Gestational age of the studied pregnant women

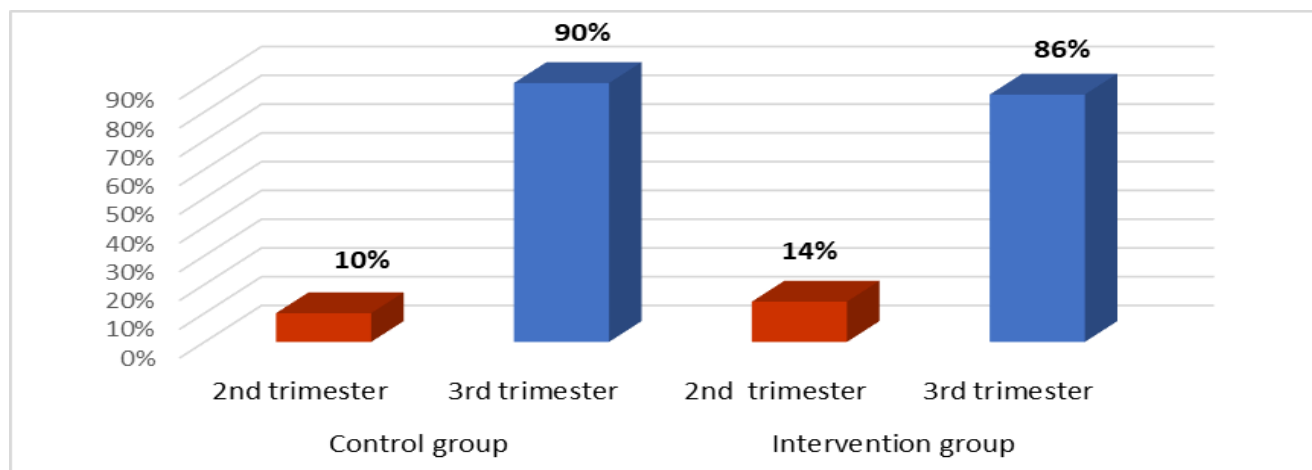


Table 3. Comparison of wrist pain characteristics among both groups pre-intervention

Variables	Control group (N=50)		Intervention group (N=50)		Chi-Square	
	Freq.	%	Freq.	%	X <sup>2</sup>	P
<b>Presence of wrist pain</b>						
Absent	0	0.0	0	0.0		
Present	50	100.0	50	100.0	0.000	1.000
<b>Site of wrist pain</b>						
Bilateral	11	22.0	10	20.0		
Right	22	44.0	24	48.0		
Left	17	34.0	16	32.0	0.165	0.921
<b>Intensity of wrist pain</b>						
Mild	4	8.0	5	10.0		
Moderate	26	52.0	30	60.0		
Severe	20	40.0	15	30.0	1.111	0.574

Table 4. Comparison of wrist pain characteristics among both groups post-intervention

	Control group (N=50)		Intervention group (N=50)		Chi-Square	
	Freq.	%	Freq.	%	X <sup>2</sup>	P
<b>Presence of wrist pain</b>						
Absent	8	16.0	25	50.0		
Present	42	84.0	25	50.0	13.071	<0.001**
<b>Site of wrist pain</b>	(n=42)		(n=25)			
Bilateral	3	7.1	3	12.0		
Right	22	52.4	9	36.0		
Left	17	40.5	13	52.0	1.787	0.409
<b>Intensity of wrist pain</b>	(n=42)		(n=25)			
Mild	3	7.1	19	76.0		
Moderate	19	45.2	6	24.0		
Severe	20	47.6	0	0.0	36.428	<0.001**

Table 5. Comparison of the Boston Carpal Tunnel Syndrome mean score among both groups pre-intervention

	Control group		Intervention group		Student's T-Test	
	Mean ±SD		Mean ±SD		T	P
<b>Symptom severity scale</b>	2.9 ±0.4		2.8 ±0.4		0.687	0.494
<b>Functional status scale</b>	3.2 ±0.5		3.2 ±0.5		0.308	0.758
<b>Total BCTQ Score</b>	3.0 ±0.4		3.0 ±0.3		0.251	0.802

Table 6. Comparison of the Boston Carpal Tunnel Syndrome mean score among both groups post-intervention

	Control group		Intervention group		Student's T-Test	
	Mean ±SD		Mean ±SD		T	P
<b>Symptom severity scale</b>	2.3 ±1.0		1.9 ±0.3		2.520	0.013*
<b>Functional status scale</b>	2.3 ±1.2		2.1 ±0.3		1.579	0.118
<b>Total BCTQ Score</b>	2.3 ±1.0		2.0 ±0.2		2.180	0.032*



## Discussion

This study aimed at examining the effect of nursing instructional program on neurophysiologic parameters of carpal tunnel syndrome among pregnant women. It was found that most pregnant women with CTS were in their third trimester of pregnancy. This is similar to an epidemiological study done by **Ajrout et al. (2020)** who studied carpal tunnel syndrome among pregnant women at Al-Wahda hospital Derna and observed that the majority of the women were in their 3<sup>rd</sup> trimester. It is vindicated by the actuality that there is raise in water retention which leads to edema, and most pregnant women are present in the last trimester.

The study aim was attained through the study findings which revealed that there was no statistically significant difference between the intervention and control groups concerning pain severity at baseline assessment while after the intervention, there is a significant decline in pain severity among both groups. These findings supported the first study hypothesis " Pregnant women with carpal tunnel syndrome who receive nursing instructional program have a lower level of pain than controls".

Similarly, **Naeiji et al. (2021)** analyzed the effect of the Persian manual on patients with mild and moderate carpal tunnel syndrome. They showed that pain improved in the experimental group significantly than in the monitoring group. This finding is also supported by a study done by **Wolny & Line, (2019)** titled: Is the treatment of carpal tunnel syndrome with manual therapy based on neurodynamic approaches effective? a controlled, random experiment. They declared that there is a significant change in hand pain severity in the intervention group compared to the monitoring group.

In the same line, **Ahmed & Khatab (2020)** conducted a study designed to find out if hand exercises and night splinting had any influence on CTS patients' symptoms. They reported that after the intervention, there was a significant reduction in hand pain severity among the studied group compared to the control group. This finding announced that hand exercises and night splints are effective methods of relieving hand pain. The effectiveness may improve symptoms of CTS by prohibiting or extending the cohesions through the median nerve and tendons, lowering tenosynovial edema, recovering venous return, and decreasing the median nerve strain. As a result, the hands' blood circulation improved.

In addition, the night splint helped the joint in a balanced posture. When women slept at night, the symptoms became worse because the hands are more probable to bend. The night splint blocks these from occurring. It's also significant; on the day pregnant women should normally move their hands to save the muscles from weakness and stiffness.

The results of the current study showed that there was no statistically significant difference in the mean scores among the control and intervention groups pre-intervention

for any of the items on the symptom severity scale of the Boston Carpal Tunnel Syndrome Questionnaire. While there was a statistically significant difference in the mean scores post-intervention. Thus, the second study hypothesis: "Pregnant women with carpal tunnel syndrome who receive nursing instructional program have a lower mean score of symptom severity than controls" was also validated.

These findings are appropriate with the findings of a study done by **Naeiji et al. (2021)** stated that there was a significant refinement in the study group regarding the BCTQ symptom severity scale compared to the monitoring group after the intervention. Similarly, **Keskin et al. (2020)** examined effectiveness of home exercise in pregnant women with carpal tunnel syndrome. They assessed BCTQ symptom severity scale items pre-and post-intervention. Pre-intervention, there was no statistically significant difference between the mean scores among the control and study groups while post-intervention, there was a statistically significant difference between the mean scores. This result is identical to **Wolny & Line (2019)** who mentioned significant changes in pain and symptom severity in the experimental group after the intervention.

Concerning the functional status scale, it was shown that there was no statistically significant difference between the mean scores among the control and intervention groups either pre-intervention or post-intervention. Thus, the third study hypothesis: "Pregnant women with carpal tunnel syndrome who receive nursing instructional program have a higher mean score of functional status than controls" was unsupported. This finding is inappropriate with the finding of a study done by **Naeiji et al. (2021)** stated that there was a significant perfection in the experimental group with regard to the BCTQ functional status scale compared to the monitoring group. A randomized controlled Turkish study conducted by **Keskin et al. (2020)** partially agreed with the present study's findings; it revealed no statistically significant difference between the mean scores among the control and intervention groups regarding BCTQ functional status scale pre-intervention while post-intervention, there was a statistically significant difference between the mean scores.

In contrast with the current study, the results of **Ahmed & Khatab, (2020)** reported that the highest proportion of the study group had moderate difficulty with their activities on the functional status scale pre-intervention. Post-intervention, it improved and significantly correlated with Boston carpal tunnel syndrome. This result conflict with **Wolny & Line (2019)** who found statistically significant changes in the functional status in the intervention group after the intervention. Perhaps, the reported differences in the functional status scale between this study and other studies might be due to the sample of study being pregnant women and most of them were in 3<sup>rd</sup> trimester which led to an increase in the severity of CTS.

Regarding the total BCTQ mean score, there was no statistically significant difference between the total mean scores of the control and intervention groups pre-intervention while post-intervention, the difference between the total

mean scores of both groups was statistically significant. Similarly, **Ajrout, et al. (2020)** concluded that home physiotherapy can be used as a conservative treatment during pregnancy to improve CTS symptoms. In the same line, **Atroshi et al. (2019)** in a randomized placebo-controlled trial study examined the treatment of CTS with wrist splinting and found that splint treatment can be used as conservative management which revealed evidence concerning the efficacy of hand splinting in patients had CTS.

As well likeness with **Unver & Akyolcu (2018)** in their research to decrease the CTS symptoms in patients under hemodialysis using hand exercise, they mentioned that most of the studied group with mild CTS symptoms improved by the ball exercise, so this exercise had a lot of advantages such as effective, handy and faint cost to use as an alternative treatment in CTS. This finding is appropriate to the findings of a study done by **Abd Elmoniem et al. (2018)** examined how an educational program regarding carpal tunnel syndrome affected pregnant women's knowledge, the intensity of their symptoms, and their functional status came to the conclusion that using a night splint and exercising during pregnancy helped the women's symptoms become less severe.

From the present study findings, the nursing instructional program is an effective intervention that improves the neurophysiologic parameters of carpal tunnel syndrome among pregnant women. It should be provided by nurses at antenatal care units.

## Conclusion

It can be concluded that the nursing instructional program was successful in the improvement of the neurophysiologic parameters of carpal tunnel syndrome among pregnant women, according to the study's findings.

## Recommendations

According to the study's conclusion, the following are suggested:

- Apply such nursing instructional program could be imposed to decrease suffering among pregnant women with CTS.
- Design an educational program to increase maternity nurses' knowledge regarding hand exercises and splinting for CTS.
- Provide pregnant women with adequate evidence-based knowledge about strategies that improve the neurophysiologic parameters of CTS.
- Include hand exercises and splinting for CTS among pregnant women in the nursing curriculum.
- Replicate the current work on a bigger probability sample in various settings as a future study.

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## Conflicts of interest

The researchers declare no conflict of interest.

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