

**DENTIST: WRIST POSITION, HANDGRIP STRENGTH, AND BODY MASS INDEX  
ASSOCIATED WITH CARPAL TUNNEL SYNDROME IN DAILY PRACTICE****Annisaa Putri Ariyani<sup>1\*</sup>, Wita Anggraini<sup>2</sup>, Boedi Oetomo Roeslan<sup>3</sup>, Indrani  
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Carpal tunnel syndrome (CTS) is one of the most common musculoskeletal disorders affecting dentists and their ability to work. Prolonged work with repetitive flexion and extension of the wrist position and high force may increase the risk of CTS. Exposure to various individual factors (gender, age, work duration, work experience, body mass index), wrist position, and handgrip strength during daily practice may also trigger CTS. To determine whether individual factors, wrist position, and handgrip strength were associated with CTS incidence in dentists. A case-control study in the population of the epidemiological study area. Dentists practicing at the community health center in Tangerang, Banten, agreed to complete the informed consent form. The total population of this present study in the forty-four community health centers in Tangerang was sixty-seven participants. Two participants were excluded due to a history of arthritis and diabetes mellitus. Therefore, only sixty-five participants who met the inclusion criteria were included. The assessment included observation of wrist position, handgrip strength, body mass index, and individual questionnaires (gender, age, work duration, and work experience). The association between these variables and CTS was then analyzed using the chi-squared test. The distribution of CTS among dentists showed that eighteen participants complained of CTS, while forty-seven participants did not. In a case group, the majority of participants complaining of work-related CTS symptoms were female (94.40%). We found that CTS sufferers were over 35 years of age (61.10%), had more than 9 years of work experience (61.10%), and had less than 6 hours of work duration (61.60%). Whereas, 100% of the participants performed wrist position at risk for CTS, 77.80% had weak handgrip strength, and 50% were obese based on body mass index compared to the control group at 80.90%, 4.30%, and 2.10%, respectively. The Chi-square test showed a significant level of wrist position, handgrip strength, and BMI against CTS. CTS is a disease associated with a dentist's wrist position, handgrip strength, and body mass index during dental practice.

**Keywords:** Dentist, Carpal Tunnel Syndrome, Wrist Position, Handgrip Strength, Body Mass Index

## INTRODUCTION

The dental profession is at a high risk of developing diseases related to posture at work, especially musculoskeletal disorders (MSDs) (Hagberg & Hagberg, 2020; Thorat et al., 2022; Veeresh et al., 2015). Musculoskeletal disorders (MSDs) are also stated as a cause of ill health retirement among dentists (Brown et al., 2010; Gupta et al., 2014), and the majority of them thought that their ill health was work-related (Anggraini et al., 2024; Brown et al., 2010).

MSDs are a group of work-related conditions, such as overexertion, prolonged static and awkward postures, repetitive movements combined with heavy force (Anggraini et al., 2024; Chenna et al., 2022; Thorat et al., 2022), that can cause disorders of the musculoskeletal system, including nerves, tendons, muscles, and intervertebral discs (Alshouibi et al., 2020; Ariyani et al., 2022). A previous study (Veeresh et al., 2015), reported that the prevalence of MSDs among dentists was 34.71%, characterized by pain and dysfunction. In their daily practice, dentists often spend long hours bending over their patients with their arms raised to get a good view of the patient's oral cavity. Unsupported pressure is imposed on the dentist's lower back, neck, and shoulder muscles. Unfortunately, dentists tend to think that the pain they feel from fatigue is normal. When occasional pain from awkward postures becomes a regular occurrence, cumulative damage can result in work-related musculoskeletal disorders (MSDs) (Anggraini et al., 2024; Dabholkar et al., 2015).

This was in line with a previous study (Veeresh et al., 2015) reporting that the most common complaint was lower back pain, with

a percentage of 71.42%, followed by upper back pain (28.57%), shoulder pain (44%), and hand and wrist pain (43%). Another study (Alshouibi et al., 2020) also revealed that 68% of the muscle pain suffered by dentists occurred after a dental procedure. Back pain was the most commonly reported area (53.9%), followed by wrist pain (7.4%). One of the MSDs that occurs in the hands and wrists is carpal tunnel syndrome (CTS) (Gupta et al., 2014).

Carpal Tunnel Syndrome (CTS) is an idiopathic syndrome that occurs due to the compression at the median nerve. However, there are some risk factors, such as systemic diseases and conditions, that have been associated with the occurrence of CTS. Obesity, diabetes mellitus, hypothyroidism, and renal failure have been reported to increase the risk of CTS. The development of CTS has also been found in pregnancy, the menopausal period, and the use of oral contraceptives (Annisa et al., 2021; Deger et al., 2022; Genova et al., 2020).

The prevalence of oral health diseases such as dental caries and periodontal disease in Indonesia, based on data from the Ministry of Health in 2018, was 88.8% and 74.1%, respectively (Badan Penelitian dan Pengembangan Kesehatan, 2018). These issues contribute to increasing the working hours of dentists in the Community health center to meet the needs and demands of dental services, thus potentially increasing CTS among dentists.

## LITERATURE OVERVIEW

CTS occurs when the median nerve becomes compressed by inflammation or a thickening structure as it passes through the carpal tunnel in the wrist. (Genova et al., 2020; Sevy JO; et al., 2024)

Normally, the pressure in the carpal tunnel is between 2 and 10 mmHg. The movement of flexion or extension of the wrist increases the pressure 8-10 times (Sevy JO; et al., 2024).

Compression of the median nerve often causes patients to complain of pain, tingling, and paresthesia in the area innervated by the median nerve, including the thumb, index finger, middle finger, and half of the ring finger. (Alhusain et al., 2019; Annisa et al., 2021; Larasati et al., 2022; Newington et al., 2015) Symptoms may get worse at night (Larasati et al., 2022; Newington et al., 2015) and in the early morning (Newington et al., 2015) and progress to thenar muscle weakness, resulting in weakened pinch grip (Newington et al., 2015) and hand function (Alhusain et al., 2019). CTS has been reported as a work-related disease and is significantly higher in workers with hand-held instruments, especially those that require repetitive movement, heavy pressure, and vibration effects, such as dentists (Alhusain et al., 2019; Annisa et al., 2021; Larasati et al., 2022; You et al., 2014). The prolonged duration of work with repetitive flexion and extension of the wrist leads to increased pressure on the carpal tunnel, resulting in median nerve injury, thus increasing the risk of CTS (Annisa et al., 2021; You et al., 2014).

Risk factors that contribute to the development of CTS include gender (Hidayati et al., 2022; Sassi & Giddins, 2016), menopausal women (Mohammadi et al., 2016; Sevy JO; et al., 2024; Tang et al., 2022), women on hormone replacement therapy (HRT) (Tang et al., 2022), obesity (Anton et al., 2002; Becker et al., 2002; Chen et al., 2023; Sevy JO; et al., 2024), age (Becker et al., 2002; Hidayati et al., 2022), long

work duration and experience (Haghighi et al., 2013; Larasati et al., 2022), and wrist position including flexion and extension (Dabholkar et al., 2015). The contribution of those risk factors may cause grip weakness (Becker et al., 2002; Sasaki et al., 2020).

Based on those backgrounds, we conducted the study to observe the incidence of CTS among dentists practicing at the community health center in Tangerang, Banten. We also aimed to determine whether individual factors such as gender, age, work duration, work experience, and BMI; wrist position; and handgrip strength were associated with the incidence of CTS in dentists.

## METHOD

The study design used in the present study was an observational-analytic study with a case-control design. A simple random sampling technique, which involves sampling based on certain considerations or criteria, was used to calculate the sample size. The procedures carried out in this study were approved by the Ethics Committee of the Faculty of Dentistry, Universitas Trisakti, with the number 251/S2/KEPK/FKG/4/2019, and received permission from the Head of District Health Office Tangerang with the letter code 4235/1359-Dinkes.

This study was conducted on dentists who work in community health centers in Tangerang and have more than one year of work experience. However, dentists who had a history of neurological problems, previous musculoskeletal pathology or trauma, diabetes mellitus, thyroid gland disease, or steroid therapy were excluded from the study. All dentists participating

in the present study agreed to complete a consent form.

67 dentists practicing at the community health center in Tangerang participated in this study. However, two participants were excluded from the present study due to a history of arthritis and diabetes mellitus. Therefore, only 65 participants who met the inclusion criteria were included in the study, distributed among 44 community health centers. We observed CTS symptoms and confirmed them with the Phalen test. We then found 18 participants who were identified as having CTS. These participants were then grouped into a case group. The control group consisted of dentists who had no complaints related to CTS. Both groups worked for the same duration and intensity.

Initially, participants were asked to complete individual questionnaires about their gender, age, work duration, work experience, and BMI. The independent variables in the present study were the above individual factors, wrist position, and handgrip strength. The dependent variable was carpal tunnel syndrome (CTS).

#### **Carpal Tunnel Syndrome (CTS) Assessment**

The symptoms of CTS experienced by the participants were characterized by one or more of the following: pain, heat, numbness, swelling, stiffness, and soreness. Phalen's test (Genova et al., 2020) was also used to confirm symptoms. The result was then mentioned in the individual questionnaire.

#### **Body Mass Index (BMI) Calculation**

BMI was calculated by dividing body weight (kilograms) by twice of height (meters). The body scales and the microtoise were used to measure

body weight and height, respectively.

#### **Handgrip strength Assessment**

Handgrip strength was also observed since CTS contributes to the median nerve compression, leading to weak handgrip strength. Participants were positioned based on the American Society of Hand Therapists's recommendation (Mathiowetz et al., 1984). A *Jamar hand dynamometer* was used to measure the grip strength of the left and right hands.

#### **Wrist Position Assessment**

The wrist position was observed while the participant was performing a dental procedure. A 14-megapixel camera was mounted on the tripod and placed 1.5 meters from the dental chair, parallel to the floor (Dabholkar et al., 2015). It was placed to capture the lateral and anterior views of the participant's upper body. The observed wrist positions, such as flexion and extension accompanied by abduction and/or adduction, were transferred to *AutoCAD software* to analyze the deviation angle.

The wrist position was characterized by neutral and CTS risk groups. Neutral wrist position was defined when the wrist was moved parallel to the floor or flexed/extended at  $0^{\circ}$ - $15^{\circ}$ . Whereas if the wrist flexion and extension movement was more than  $15^{\circ}$  accompanied by abduction or adduction, it was considered to be in the CTS risk group. (McAtamney & Nigel Corlett, 1993)

#### **Statistical Analysis**

Data were initially analyzed using descriptive statistical test analysis to provide an overview of the characteristics of a data set. A Chi-Square test was performed further to test the hypothesis using

SPSS. A significance value of 0.05 was determined to indicate that the independent variable influenced the dependent variable.

## RESULT

A total of 65 dentists spread across 44 community health centers met the inclusion criteria and agreed to participate in the present study. We found that among these participants, some had CTS complaints and some did not.

**Table 1. Distribution of participants with and without CTS complaints at the Community Health Center, Tangerang, Banten.**

	With Complaint		Without Complaint	
	n	%	n	%
CTS	18	27.70	47	72.30

Based on Table 1, it can be seen that the CTS complaint in participants practicing at the Community Health Center,

Tangerang District, Banten, was found in 27.70% of participants, while it was not found in 72.30% of respondents.

**Table 2. Distribution of participants according to Carpal Tunnel Syndrome (CTS) to dentists at the Community Health Centre, Tangerang, Banten.**

		Participant	
		n	%
Gender	Male	6	9.23
	Female	59	90.77
Age (years)	18-35 y.o	23	35.38
	>35 y.o	42	64.62
Work Duration (hour per day)	< 6 h	30	46.15
	≥ 6 h	35	53.85
Work Experience (years)	1-9 y	32	49.23
	>9 y	33	50.77
Body Mass Index (BMI)	Normal ≤ 25 (kg/m <sup>2</sup> )	55	84.62
	Obesity > 25 (kg/m <sup>2</sup> )	10	15.38
Wrist Position	Neutral	9	13.85
	CTS risk	56	86.15
Handgrip Strength	Normal	49	75.38
	Weak	16	24.62
Total		65	100

Based on Table 2, it shows that the participants in the present study were distributed differently according to gender, age, work duration, work experience, BMI, wrist position, and handgrip strength. 90.77% of participants

were female and more than 35 years old (64.62%). 53.85% of participants spent more than 6 hours in their daily practice, and 50.77% had experience in their profession for more than 9 years. The majority of participants also had a normal BMI

(84.62%) and handgrip strength (75.38%). However, 86.15% performed wrist motion with a deviation angle of more than 15° referred to as the CTS risk group.

**Table 3. Bivariate Analysis with Chi-Square in Carpal Tunnel Syndrome (CTS).**

		With Complaints CTS		Without Complaints CTS		P value	
		n	%	n	%		
<b>Gender</b>	Male	1	5.60	5	10.60	1.000	
	Female	17	94.40	42	89.40		
<b>Age (years)</b>	18-35 y.o	7	38.90	16	34.00	0.776	
	>35 y.o	11	61.10	31	66.00		
<b>Work Duration (hour per day)</b>	< 6 h	11	61.10	19	40.40	0.170	
	≥ 6 h	7	38.90	28	59.60		
<b>Work Experience (years)</b>	1-9 y	7	38.90	25	53.20	0.408	
	>9 y	11	61.10	22	46.80		
<b>Body Mass Index (BMI)</b>	Normal ≤ 25 (kg/m <sup>2</sup> )	9	50.00	46	46.00	0.000*	
	Obesity > 25 (kg/m <sup>2</sup> )	9	50.00	1	2.10		
<b>Wrist Position</b>	Neutral	0	0.00	9	19.10	0.050*	
	CTS risk	18	100	38	80.90		
<b>Handgrip Strength</b>	Normal	4	22.20	45	95.70	0.000*	
	Weak	14	77.80	2	4.30		
<b>Total</b>		<b>18</b>	<b>27.70</b>	<b>47</b>	<b>72.30</b>		

\*Significant at  $p < 0.05$

Based on Table 3, CTS complaints were found in distributed differently according to gender, age, work duration, work experience, BMI, wrist position, and handgrip strength. In the case group, the majority of female participants (94.40%) complained of work-related CTS symptoms. 61.10% of CTS sufferers were over 35 years of age; 61.60% had less than 6 hours of work duration; 61.10% had more than 9 years of work experience; 50.00%

were obese according to BMI; 100% had performed wrist position at the risk of CTS; and 77.80% had weak handgrip strength.

Bivariate analysis using the Chi-Square test showed a significant value for BMI, wrist position, and handgrip strength against CTS. These indicated that CTS was associated with the dentist's BMI, wrist position, and handgrip strength while practicing in the Community Health Center, Tangerang, Banten.



## DISCUSSION

This case-control study was conducted on 67 dental practitioners employed at the Community health center in Tangerang. Two participants were excluded from the present study due to a history of arthritis and diabetes mellitus. Therefore, only 65 participants who met the inclusion criteria were included in the study, which was distributed across 44 Community health centers. By observing the presence of CTS symptoms and subsequently confirming them through the Phalen test, 18 participants were identified as having CTS. Subsequently, the aforementioned participants were then grouped into a case group. The control group consisted of dentists who did not have any complaints related to CTS. Both groups have the same work duration and intensity.

Most participants with CTS were female (94.40%). It was corroborated by a review (Hidayati et al., 2022) stated that females have a 3.6-fold greater risk for CTS based on the reported manifestations. A previous study (Sassi & Giddins, 2016) found that females have disproportionately smaller carpal tunnels than males, which increases the possibility of median nerve compression (Omole et al., 2023). Estrogen level has an association with CTS in the menopause period. That is because estrogens have an anti-inflammatory effect, and their decreased level induces the expression of inflammatory cytokines such as interleukin 1 (IL-1), IL-6, and tumor necrosis factor-alpha, which leads to the development of CTS (Mohammadi et al., 2016; Tang et al., 2022). However, hormone replacement therapy (HRT) to treat menopausal women might induce the upregulation of estrogen receptors in the transverse carpal

ligament, resulting in increased fluid accumulation and thus inducing CTS (Tang et al., 2022). The HRT was associated with CTS development (Tang et al., 2022). However, other studies (Manosroi et al., 2023; Mohammadi et al., 2016) found no significantly increased CTS risk in women using HRT.

61.10% of the participants who complained of CTS were older than 35 years old. This finding was consistent with a review (Hidayati et al., 2022) which stated that females have a 3.6 times higher risk of CTS than males in the age range of 25-64 years old. However, a higher incidence of CTS was found in the age range of 25-34 years old. On the other hand, a previous study (Becker et al., 2002) in agreement with our findings, found that the age group of 41-60 years was at higher risk for the syndrome. With age, the amount of a protein called amyloid in the carpal tunnel increases. Its accumulation in the tendons and surrounding tissue of the carpal tunnel reduces its space, leading to compression of the median nerve (Omole et al., 2023).

The present study found that dentists with more than 9 years of work experience have complained with CTS (61.10%). The incidence of CTS is often associated with work-related diseases because certain occupations involving the use of hand instruments may generate repetitive motion, vibration, and hand force, thus increasing the risk of CTS. (Haghighi et al., 2013; Larasati et al., 2022) Longer working hours will lead to lower quality and work results and may also lead to a tendency toward work fatigue and health problems such as CTS (Hamid et al., 2020; Ranggaini et al., 2024). This was also consistent with a previous study reporting that dentists with more years of work

experience were at high risk of CTS (Haghighi et al., 2013).

50.00% of participants complaining of CTS have a BMI greater than 25 (kg/m<sup>2</sup>), which indicates overweight. Statistically, we found that BMI correlates with CTS, with a p-value of 0.000. Previous studies (Anton et al., 2002; Becker et al., 2002; Chen et al., 2023) have shown a positive correlation between BMI and CTS. A BMI greater than 25 (kg/m<sup>2</sup>) showed an increase in the incidence of CTS (Becker et al., 2002). The accumulation of adipose tissue inside the carpal tunnel can compress the median nerve (Becker et al., 2002; Chen et al., 2023), which is the first sensory nerve to be affected (Chen et al., 2023). The compression can also cause damage to the myelin sheath around the node of Ranvier of the median nerve. When CTS becomes severe, the motor nerve is also affected, and the damage to the motor nerve is greater than that to the sensory nerve (Chen et al., 2023).

We also observed that all participants with CTS (100%) experienced wrist flexion and extension with abduction or adduction while performing a dental procedure. There was a positive correlation between wrist position and CTS with a p-value of 0.05. Participants often perform repetitive movements and work in awkward positions such as excessive posture or flexion in the upper body during daily practice (Phedy & Gatam, 2016). In the normal range of wrist movement, the width of the carpal tunnel decreases constantly with the movement of the carpal bones toward the tunnel wall (Genova et al., 2020). Wrist flexion, extension, and forearm rotation were constantly changed during dental procedures (Dabholkar et al., 2015). Flexion and extension during

this movement also cause an increase in carpal tunnel pressure. Moreover, the extreme extension causes the lunate bones to crinkle the passage as they are being pushed toward the interior part of the carpal tunnel. (Genova et al., 2020) Compression in the carpal tunnel impinges on the median nerve, generating the disturbed sensation and causing sensory dysfunction and weakness of the thenar muscles (Newington et al., 2015).

In addition, 77.80% of participants with CTS had weak handgrip strength. Handgrip strength is often used to assess muscle strength and evaluate hand function. There was a positive correlation between handgrip strength and CTS with a p-value of 0.000. The decreased handgrip strength has been commonly found in CTS (Baker et al., 2013; Sasaki et al., 2020). This could be caused by the loss of muscle tension related to grip and pinch strength, resulting in the loss of flexion strength of the metacarpophalangeal (MCP) joint (Baker et al., 2013). Damage to the sensory nerve in CTS may also cause decreased handgrip strength (Baker et al., 2013; Chen et al., 2023). A previous study (Sasaki et al., 2020) that measured the grip strength of each finger innervated by the median nerve (Newington et al., 2015) reported that in the CTS group, the grip strength of the index, middle, and ring fingers was lost early after reaching maximum compared with the little finger. Therefore, it was suggested that people suffering from CTS tend to release the middle and ring fingers early and then rely on the little finger for gripping.

## CONCLUSION

Based on the description in the previous chapter, the present study



showed that individual factors (gender, age, work duration, work experience, BMI), wrist position, and handgrip strength were associated with the incidence of CTS in dentists practicing in the Community Health Centre, Tangerang District, Banten.

Further investigation as to whether these three factors play a role in the cause of CTS may need to be taken into consideration for future research. Thus, precautions can be taken to increase the work productivity of dentists. The expanded sample size could be considered in a future study so that the data could represent the population of dentists in terms of the incidence of CTS.

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