



The Correlation Between Occupational Factors and the Severity Level of Carpal Tunnel Syndrome (CTS) Among Dentists

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ABSTRACT

Carpal Tunnel Syndrome (CTS) is common condition that causes pain and functional disturbances in the hands and wrist, resulting from injury to the median nerve. This study aims to analyze the relationship between occupational factors and the severity of Carpal Tunnel Syndrome (CTS) among dentists, along with potential preventive strategies. In Indonesia, data on CTS prevalence remain limited. The research method utilized the Boston Carpal Tunnel Questionnaire (BCTQ) to assessed the severity of CTS among dentists and the statistical tests are used to test the correlation between occupational factors with the severity of CTS. Correlation analysis revealed that occupational factors such as daily working hours, excessive force application, age, years of professional experience, and regular medication usage significantly affect CTS severity and symptoms like tingling. The findings revealed that these factors significantly influence the severity of CTS. These results provide a foundation for developing more effective preventive strategies to improve the occupational health of dentists.

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1. INTRODUCTION

The significance of health has increasingly become a focal point of public concern, heightening awareness about the necessity of maintaining well-being across various sectors. This awareness underscores the need for protective measures to safeguard workers from occupational health risks. Health is broadly defined as a state of physical and mental well-being that profoundly influences an individual's daily functioning and overall quality of life. (Rahmaningrum et al., 2022). Carpal Tunnel Syndrome (CTS) is a condition characterized by pain and functional impairment in the hands,

caused by compression or injury to the median nerve within the carpal tunnel located in the wrist. Individuals with CTS often report symptoms such as pain, numbness, tingling, and a burning sensation along the distribution of the median nerve in the hand (Cazares-Manriquez et al., 2020). Certain professions, including cashiers, department store employees, violinists, carpenters, and dentists, are identified as having an elevated risk of developing CTS due to the nature of their occupational activities (Elsharkawy et al., 2023). In dental practice, dentists often perform treatments while maintaining static and

awkward postures. Furthermore, the use of precision medical instruments, which demands intense concentration, can heighten the risk of developing CTS. Prolonged exposure to vibrations from dental tools may also contribute to tingling sensations, thereby increasing the likelihood of CTS among dentists (Rahmaningrum et al., 2022).

A study conducted among dental health professionals in the United States reported that the prevalence of CTS symptoms was as high as 56% (Alhusain et al., 2019). In Australia, the prevalence of CTS among dentists was reported at 17% (Alhusain et al., 2019). Dentists also experience pain in their fingers at a rate exceeding 29% (Bhatia et al., 2023). Unfortunately, data on the prevalence of CTS in developing countries remains unclear (Alhusain et al., 2019).

In Indonesia, the prevalence of Musculoskeletal Disorders (MSDs) and CTS among dentists has not been thoroughly documented or well-established. However, approximately 55–93% of dentists suffer from MSDs, with the highest risk observed in women and older individuals (Pratamawari et al., 2020). Recognizing that the prevalence of CTS in Indonesia is poorly documented and data remains scarce, it becomes crucial to advance further research in this field.

Dentists are developing CTS at a high rate due to the repetitive movements, vibrations, and tool usage required in their profession. CTS poses a significant threat to dentists as their work relies heavily on the full range of motion of their hands (Devi et al., 2022). Pain experienced by dentists is often overlooked and rarely receives the attention it deserves. If left untreated, this pain can lead to long-term health complications (Shetty et al., 2021). Occupational factors such as tool-generated vibrations and repetitive motions are among the primary risk factors for CTS in dentists (Maghsoudipour et al., 2021).

Based on a preliminary study on 7 dentists in Padang City using the Boston Carpal Tunnel Questionnaire (BCTQ), there are 19 questions which are divided into 2 parts, namely, symptom severity, and functional disorders in

daily life. The recapitulation of symptoms revealed that the prevalence of CTS among dentists was categorized as 32% with mild symptoms, 46% with moderate symptoms, and 23% with severe symptoms. Regarding functional impairments in daily activities, 71% of the dentists reported experiencing mild difficulties, while 29% reported moderate difficulties.

Occupational factors contributing to CTS in dentists include the use of vibrating tools with frequencies exceeding 20,000 Hz (Cristina, 2023). One such tool commonly used by dentists is the KaVo MASTERtorque LUX M8900L, a dental drill operating at a speed of 400,000 rpm. The use of such handheld tools is considered a risk factor for CTS in dentists (Sugiantini, 2020). Additionally, other occupational factors associated with CTS include prolonged tool usage, increased daily patient contact time, repetitive movements, and the dentist's years of service (Mehmood et al., 2022; Cazares-Manriquez et al., 2020; Matur et al., 2023; Zubair et al., 2022).

Prolonged use of vibrating tools can increase pressure on the hands and wrists (Finsen et al., 2022). Extended contact time with patients raises the risk of musculoskeletal injuries due to non-ergonomic body positions during patient care (Osborne & Smith, 2021). Repetitive movements and long years of service are also associated with CTS, as they cause muscle strain in the wrists and the median nerve. Additionally, excessive force applied when using work tools increases the risk of CTS (Linton et al., 2020; Kim et al., 2019; Aljunaid et al., 2021).

The high prevalence of Carpal Tunnel Syndrome (CTS) among dentists is caused by occupational factors such as static working posture, repetitive movements, and ergonomic pressure on the wrist. Additionally, there is a lack of risk control strategies to mitigate CTS, relying solely on individual interventions without a systematic approach to reducing risk. CTS is often considered a common complaint without adequate preventive measures, which can ultimately reduce dentists' quality of life and long-term productivity.

The increase in CTS may also be influenced by age, likely due to cumulative exposure to pressure on the wrists (Javed et al., 2023). Research on the correlation between occupational factors and the severity of CTS is essential, given that dental work involves repetitive movements and other non-ergonomic factors that can exacerbate CTS. Such conditions adversely impact the quality of life and work performance of dentists. This study aims to contribute to the body of knowledge in this field and provide a basis for developing preventive strategies to address CTS among dentists in Indonesia, with a particular focus on Padang, West Sumatra.

2. LITERATURE REVIEW

A. Ergonomics

Ergonomics is a science and its application aimed at harmonizing work and the environment with human capabilities to achieve optimal productivity and efficiency through the effective utilization of human resources (Nadila & Suryadi, 2024). The International Ergonomics Association (IEA) defines ergonomics as the scientific study of interactions between humans and system elements, applying principles, theories, information, and design practices to enhance overall workforce well-being and performance (Ispãsoiu et al., 2021).

Ergonomics encompasses three primary specializations: (1) Physical Ergonomics: This area focuses on human anatomy, biomechanical characteristics, physiology, and biology in relation to physical activities, addressing issues such as posture, repetitive motions, and workplace safety. (2) Cognitive Ergonomics: This specialization pertains to mental processes, including perception, memory, and decision-making, which affect how individuals interact with their work environment and perform tasks. (3) Organizational Ergonomics: This category emphasizes optimizing environmental systems, such as organizational structure, work processes, and communication, to enhance efficiency and improve worker well-being. By integrating these dimensions, ergonomics contributes to creating systems that prioritize both productivity and human health.

B. Musculoskeletal Disorders (MSDs)

Musculoskeletal Disorders (MSDs) are

disorders affecting muscles, tendons, joints, ligaments, nerves, bones, and the circulatory system, caused by the effects of the work environment (Nadila & Suryadi, 2024). MSDs can result from overly heavy work or incorrect work practices. Factors that can contribute to MSDs include physically demanding tasks, repetitive movements, awkward body postures, exposure to high-frequency vibrations that cause muscle contractions, an imbalance in the amount of force exerted when lifting objects, and demographic factors (Graveling, 2019). When muscles are affected during work activities, it can disrupt daily routines, as muscles are essential for the body's range of motion (Jabbar & Suryadi, 2024).

According to Graveling (2019), MSDs are categorized into several types, as follows: (1) CTS is a condition characterized by irritation or discomfort in the hand or wrist, resulting from the compression of the median nerve as it passes through the carpal tunnel in the wrist. (2) Back pain caused by muscle strain and awkward posture while working. (3) Thoracic Outlet Syndrome is pain that affects the shoulders, arms, and hands, characterized by fatigue and numbness in the affected area. (4) Low Back Pain is pain in the lower back caused by excessive activities such as lifting, sitting, and uncomfortable positions while working. (5) Neck pain is characterized by tension and stiffness in the neck.

C. Carpal Tunnel Syndrome (CTS)

CTS is a neuropathy syndrome related to the median nerve passing through the carpal tunnel, beneath the transverse carpal ligament (Hidayati, 2023). CTS is caused by chronic, forced repetitive movements involving vibrations, non-ergonomic postures, or a combination of both (Hidayati, 2023). CTS is commonly found in occupations associated with repetitive movements and forced, non-ergonomic postures. This condition affects both men and women, although some studies indicate that women are more sensitive and vulnerable to developing CTS compared to men (Utamy et al., 2021).

The initial diagnosis of CTS is primarily based on the presence of classic symptoms, including pain, numbness, tingling, and a burning

sensation along the area served by the median nerve in the hand (Utamy et al., 2021). Certain systemic diseases contribute to the development of CTS, including diabetes, thyroid disorders, alcoholism, and various rheumatic conditions. These conditions can cause peripheral neuropathy, thereby increasing the susceptibility to nerve compression (Graveling, 2019). Additionally, other factors that can lead to CTS include age, pregnancy, osteoarthritis, and Body Mass Index (BMI).

In addition, CTS can be triggered by repetitive tasks and a combination of other contributing factors. These include excessive force, repeated movements, and the impact of vibration, which is often generated by the use of high-powered tools or equipment. The use of hand tools that produce vibration is considered a significant risk factor for the development of CTS.

Many studies highlight CTS risk factors but don't quantitatively analyze how occupational factors influence the severity of CTS symptoms, minimal focus on ergonomic and preventive measure, and while CTS recognized as a work-related condition, there is limited research on how CTS affect the productivity, efficiency, and overall quality of life dentist in Indonesia

3. RESEARCH METHOD

This study employs a quantitative research design, utilizing numerical data analysis to investigate CTS among dentists. The research was conducted between September and October 2024, involving 39 dentists in Padang City. The sampling method used was purposive sampling, selecting participants based on specific characteristics aligned with the study's objectives. Dentists with a minimum of one year of professional experience were included as participants.

The primary data collected focused on the severity of CTS among dentists, assessed using the Boston Carpal Tunnel Questionnaire (BCTQ). Occupational factors affecting dentists were identified through an extensive literature review of relevant books, journals, and databases. Table 1 summarizes the occupational factors identified in the literature review. The severity of CTS tested for

correlation with occupational factors that affect the occurrence of CTS in dentists. The software used for the correlation test is the Statistical Package for Social Sciences (SPSS) version 22.

Table 1. Occupational factors

Variable	Occupational Factors
X1	Working hours/ day
X2	Hand Dominance
X3	Repetitive motion
X4	Use of Force
X5	Duration using Vibration Tools
X6	Age
X7	Experience
X8	Gender
X9	Body Mass Index (BMI)
X10	History of Diseases (Tumors, Arthritis, Hand Injuries, and Diabetes Mellitus)
X11	Medicine Consumption
X12	Alcohol Consumption
X13	Nerve Injury

4. RESULT AND DISCUSSION

Observations among dentists in Padang City revealed that the participants' average age was 30 years, with the oldest being 48 years and the youngest 24 years. The sample predominantly consisted of female dentists, with working hours ranging from 9:00 AM to 10:00 PM. Table 2 presents the detailed characteristics of the study sample.

The Boston Carpal Tunnel Questionnaire (BCTQ) used in this study consists of two sections: the Symptoms Severity Scale (SSS), which assesses CTS symptoms, and the Functional Severity Scale (FSS), which evaluates the functional impact of CTS on daily activities. The questionnaire comprises 19 items, with 11 questions in the SSS and 8 in the FSS.

The SSS assessment revealed the following results related to hand/wrist pain:

1. Nighttime Pain: 8 participants (20.5%) were in normal condition, 14 (35.9%) reported mild symptoms, 16 (41%) had moderate symptoms, and 1 (2.6%) experienced severe symptoms.
2. Daytime Pain: 4 participants (10.3%) were in normal condition, 16 (41%) reported mild symptoms, 15 (38.5%) had moderate symptoms, and 4 (10.3%)

experienced severe symptoms.

Table 2. Sample characteristics

No	Sample	Gender	Age	Working Hours / Day	Experience/ Years
1	RM	F	30	8	5
2	YD	F	44	7	10
3	M	F	33	4	9
4	TF	F	29	6	6
5	HZ	M	29	6	5
6	DSD	F	27	6	4
7	RB	M	27	7	4
8	AGF	F	27	5	3
9	AI	M	30	6	5
10	DS	M	39	8	9
11	DM	M	34	6	5
12	DSS	F	48	8	15
13	RFN	F	34	6	4
14	YK	F	27	5	2
15	MFH	M	26	6	1,5
16	SC	F	27	6	2
17	MDF	F	31	10	6
18	AK	F	27	6	2
19	RM	F	26	7	1
20	AT	F	27	7	1
21	RAC	M	36	12	7
22	RKS	F	29	8	5
23	TR	F	32	8	7
24	AYF	F	26	6	3
25	MS	F	30	8	6
26	DS	F	29	8	4
27	JS	F	27	5	3
28	NS	F	39	10	9
29	NRF	F	29	7	3
30	MA	F	27	10	4
31	EFD	F	30	7	5
32	HKA	F	24	6	3
33	SF	F	25	4	2
34	NKN	F	26	6	1
35	RW	F	31	7	5
36	HD	F	28	5	3
37	FAR	M	26	5	2
38	MI	M	28	5	3
39	BSM	M	29	6	4

For numbness, the findings were 3 participants (7.7%) were in normal condition, 18 (46.2%) reported mild numbness, 13 (33.3%) had moderate numbness, and 5 (12.8%) experienced severe numbness. Regarding hand weakness, 7 participants (17.9%) reported normal conditions, 17 (43.6%) experienced mild weakness, 9 (23.1%) reported moderate weakness, and 6 (15.4%) experienced severe weakness. For tingling sensations, the results showed 3 participants (7.7%) were in normal condition, 11 (28.2%) reported mild tingling, 16 (41%) experienced moderate tingling, and 9 (23.1%) reported severe tingling. These findings highlight the prevalence and severity of CTS symptoms among dentists, underscoring the need for targeted interventions.

Dentists also experienced different levels of

numbness and tingling at night; 7 (17.9%) reported light symptoms, 18 (46.2%) reported moderate symptoms, 10 (25.6%) reported serious symptoms, and 4 (10.3%) reported severe symptoms. Lastly, 27 people (62.2%) with normal conditions, 9 people (23%) with mild symptoms, only one person (2.6%) with moderate conditions, and 2 people (5.1%) with severe conditions reported having trouble handling small things.

The frequency of pain felt during the day by 16 people (41%) was normal, 10 people (25.6%) felt pain 1-2 times, 12 people (30.8%) 3-5 times, and 1 person (2.6%) experienced pain >5 times. Meanwhile, the average frequency of waking up at night over the past 2 weeks was 12.8% normal, 60.3% felt 1-2 times, 23.1% felt 3-5 times, and 3.8% felt more than 5 times. The average duration of pain felt during the day was 5 people (12.8%) in normal duration, 23 people (61.5%) for 1-2 times, 9 people (21.8%) for 3-5 times, and 1 person (2.6%) for more than 5 times. Overall, the frequency of pain in the hands/wrists felt by dentists was 22.2% in normal conditions, 49.1% in mild conditions, 25.6% in moderate conditions, and in severe conditions as much as 3%.

The Functional Status Scale (FSS), which measures dentists' functional status, revealed that some dentists had no trouble writing (35.9%), buttoning clothing (64.1%), handling books (33.3%), carrying shopping bags (82.1%), or showering and dressing (94.9%). In contrast, the dentists in this study experienced severe difficulty opening the jar (46.2%) and moderate trouble grasping the phone handle (35.9%). According to the functional state of dentists, 46.5% of them had no issues performing their everyday tasks. In performing their activities, 24% encountered mild difficulties, 16.7% encountered considerable difficulties, and 12.8% encountered severe difficulties.

Table 3 shows the severity of CTS based on the interpretation of the average results of SSS and FSS scores. The results showed that as many as 5 dentists experienced severe CTS, 19 people experienced moderate CTS, and 15 people had mild conditions.

Table 3. CTS Severity in Dentists

No	Name	Result Interpretation	Interpretation Score
1	RM	2,83	Intermediate
2	YD	2,72	Intermediate
3	L	2,51	Intermediate
4	TF	2,37	Intermediate
5	HZ	2,47	Intermediate
6	DSD	2,43	Intermediate
7	RB	2,64	Intermediate
8	AGP	2,26	Intermediate
9	AI	1,81	Low
10	DS	3,02	High
11	DM	3,04	High
12	DSS	3,44	High
13	RPN	2,20	Intermediate
14	YK	1,74	Low
15	MFH	2,17	Intermediate
16	SC	2,34	Intermediate
17	MDP	1,18	Low
18	AK	1,00	Low
19	RM	1,05	Low
20	AT	1,14	Low
21	RAC	1,88	Low
22	RKS	1,51	Low
23	TR	2,49	Intermediate
24	AYP	1,72	Low
25	MS	2,50	Intermediate
26	DS	1,99	Low
27	JS	1,52	Low
28	NS	2,03	Intermediate
29	NRP	2,38	Intermediate
30	MA	1,97	Low
31	EFD	3,00	High
32	HKA	1,24	Low
33	SF	1,97	Low
34	NKN	1,58	Low
35	RW	3,76	High
36	HD	2,29	Intermediate
37	FAR	2,03	Intermediate
38	MI	2,77	Intermediate
39	BSM	2,35	Intermediate

Table 4 presents the results of the recapitulation regarding the relationship between occupational factors and the severity CTS, as well as the tingling symptoms experienced by dentists. Working hours/day ($p = 0.021$), excessive use of force ($p = 0.00$), age ($p = 0.00$), working period ($p = 0.00$), and routine medicine consumption ($p = 0.00$) were the occupational factors that significantly impacted the severity of CTS and tingling symptoms, according to the results of the Spearman Correlation Test and Chi-Square Test used to correlate occupational factors with the severity of CTS.

The results of this study align with the findings of Maghsoudipour et al. (2021), which indicated that working hours are not directly related to the severity of CTS, although tingling

symptoms may serve as early indicators of the condition. Additionally, the study on working hours/days in relation to CTS severity yielded varying results across different studies, suggesting that the relationship between these factors may be inconsistent or influenced by other variables. The main reason is the difference in work intensity and the type of work that is more important when compared to the duration of the work time (Matur et al, 2023). However, there are studies that mention that working hours have a significant relationship with the tingling symptoms felt by dentists. The first indication of CTS symptoms in dentists is tingling. This is particularly evident among dentists with long working hours, who may experience an increased likelihood of developing symptoms such as tingling, which can serve as an early indicator of CTS.

In the study by Al Shahrani et al. (2021), it was found that working more than 8 hours per day was significantly associated with tingling symptoms in dentists. This may be attributed to stress caused by poor ergonomic posture, which can negatively impact blood circulation to the hands and wrists, thereby contributing to the development of symptoms such as tingling. Hand dominance, repetitive motion, and excessive use of force were also measured as one of the occupational factors related to CTS. In this study, it was found that hand dominance did not have a significant relationship with the severity of CTS and the tingling felt by dentists. This was explained by Farhan (2018) that the initial complaint of CTS was sensory disturbances only, and there was a feeling of pain or numbness in the hands or arms to the shaking of the hands felt at night or at work.

Repetitive motion showed an insignificant relationship with the severity of CTS and tingling symptoms. However, excessive force used in grasping or holding work tools demonstrated a significant association with tingling symptoms experienced by dentists. This aligns with findings from Maghsoudipour (2021), which also reported no significant relationship between repetitive movements, excessive force, and CTS.

Table 4. Recapitulation of Occupational Factor Correlation Test with CTS Severity and Tingling Symptoms

Occupational Factors	CTS Severity				Tingling			
	Sig. (chi-Square test)	Spearman's Rho (ρ)	Sig.	Status	Sig. (chi-Square test)	Spearman's Rho (ρ)	Sig.	Status
Working Hours/Day	-	0,075	0,651	Insignificant	-	0,368	0,021	Significant
Hand dominance	0,731	-	-	Insignificant	0,777	-	-	Insignificant
Repetitive motion	-	-	-	Insignificant	0	-	-	Tidak signifikan
Excessive Force	-	-	0,083	Insignificant	-	-	0	Significant
Duration of Vibrator Tools	-	-0,215	0,188	Insignificant	-	0,085	0,607	Insignificant
Age	-	0,556	0,000	Significant	-	0,753	0,000	Significant
Experience	-	0,546	0,000	Significant	-	0,775	0,000	Significant
Gender	0,353	-	-	Insignificant	0,636	-	-	Insignificant
Body Mass Index (BMI)	-	-0,095	0,569	Insignificant	-	-0,131	0,432	Insignificant
Disease History (Tumors, Arthritis, Diabetes Mellitus, and Wrist Surgery)	-	-	-	Insignificant	-	-	-	Insignificant
Consumption of Medicine	0,000	-	-	Significant	0,674	-	-	Insignificant
Alcohol Consumption	-	-	-	Insignificant	-	-	-	Insignificant
Nerve Injury	0,063	-	-	Insignificant	0,215	-	-	Insignificant

Contrarily, research by Cristina (2023) highlighted that repetitive and prolonged wrist flexion or extension, particularly when combined with a strong grip, can significantly increase the risk of CTS. These contrasting findings suggest that while repetitive motion alone may not directly contribute to CTS severity, its interaction with other factors such as excessive force could elevate the risk.

The duration of use of vibratory devices in dentists showed an insignificant association with the severity of CTS and tingling symptoms. In this study, dentists were exposed to vibration for an average of 5 hours per day, which aligns with findings from Maghsoudipour (2021), who noted that using vibrators for more than 2 hours per day could increase the risk of CTS and had a significant relationship with its severity. Additionally, Vihlborg et al. (2022), in their cohort study, found that exposure to Hand-Arm Vibration (HAV) significantly raised the risk of developing CTS but specifically did not report a direct association between vibrating device use and CTS severity and tingling symptoms.

Based on the Spearman correlation test, the relationship between age and the severity of CTS was positively correlated, indicating that as a dentist's age increases, the risk and severity of CTS also tend to increase. The p-value confirmed a significant correlation between age and CTS severity, suggesting that age is an important factor in the development and progression of CTS within the studied population.

This is related to tissue degeneration, where dentists over the age of 35 are more prone to CTS due to decreased tissue elasticity and slower nerve regeneration (Devi et al., 2022). Aging leads to physiological changes that make the body more susceptible to chronic conditions and disorders, including CTS. The combination of reduced tissue elasticity, slow nerve regeneration, and age-related medical conditions can also increase susceptibility to CTS in dentists (Sevy et al., 2023; Kostares et al., 2023; Kotwal & Thakur, 2020).

In relation to work experience, the correlation

test revealed a significant relationship between the duration of the dentist's work experience and the severity of CTS. The results showed that as a dentist's work experience increases, the severity of CTS also tends to rise. This is caused by repetitive work positions or activities, as well as the continuous use of tools with high pressure, which can lead to cumulative injuries to the median nerve. Furthermore, chronic fatigue resulting from prolonged work experience also causes muscle exhaustion, thereby increasing the risk of CTS (Aljunaid et al, 2021; Alhusain et al, 2019; Cazares-Manríquez, 2020). Additionally, tingling symptoms were significantly associated with the dentist's years of practice. However, this finding contrasts with the study by Elsharkawy (2022), which reported that work duration was not related to CTS symptoms. The average working hours for dentists in this study were 7 hours per day with daily work schedules, consistent with the results of Elsharkawy (2022).

The severity of CTS in dentists in Padang City was not significantly correlated with sex, according to the findings of the chi-square tests. This outcome is corroborated by studies carried out by According to the Tonga & Bahadir study (2022), individuals with moderate and severe degrees of CTS did not experience any change in their condition. Maghsoudipour et al. also reported that there was no significant correlation between the severity of CTS and sex in industrial workers. In the research conducted by Wei Ta Huang (2023), the cumulative incidence rate of Carpal Tunnel Syndrome (CTS) in dentists over the previous five years of follow-up was 0.5%. The study found that the risk of developing CTS was 0.4% for male dentists and 0.75% for female dentists.

Body Mass Index (BMI) is a measure used to assess an individual's weight status, classifying individuals as underweight, normal weight, overweight, or obese. Based on the data collected, it was found that 33% (13 individuals) of dentists were underweight, 64% (25 individuals) had a normal weight, and 3% (1 individual) were overweight. Based on the results of the spearman correlation test, there is an insignificant relationship between BMI and CTS severity. BMI also does not have a

significant association with the tingling symptoms felt by dentists. However, the results of the research Cristina et al (2023) stated that being overweight (obesity) is at high risk of CTS. However, in a study by Mondelli et al (in Tonga & Bahadir, 2022) it was found that BMI was not related to the severity of CTS, but was related to the prevalence of CTS in the last study.

The history of diseases such as tumors, arthritis, diabetes mellitus, and previous wrist surgeries was examined for its relationship with the severity of Carpal Tunnel Syndrome (CTS). However, no significant relationship was found, as the dentists in this study were generally in good health and did not have a history of conditions like tumors, arthritis, or diabetes mellitus. As a result, the statistical values remained constant. In contrast, Al Shahrani et al. (2021) identified common clinical conditions, including diabetes mellitus, hypertension, thyroid disease, and arthritis, as being frequently associated with CTS, with more significant p-values observed in those groups.

Other literature studies suggest that factors such as diabetes, pregnancy, arthritis, tumors (tumor-like lesions), and a history of fractures or injuries to the hand or wrist may increase the severity of CTS (Sugiantini, 2023). Diabetes mellitus, in particular, is considered a significant factor influencing the occurrence of CTS, with a prevalence of 15-25% among diabetic patients (Cristina, 2023). A meta-analysis has noted that while diabetes may raise the risk of CTS, the direct relationship with its severity is not always consistent, potentially due to variations in populations and research methodologies. These factors are caused by nerve damage due to high blood glucose levels, which can worsen CTS. Additionally, hormonal changes during pregnancy can affect tissue flexibility, thereby increasing pressure on the median nerve (Galiero et al., 2023).

A study conducted by Mitake (2019) investigated the prevalence of comorbidities in CTS patients, paying attention to gender. There are significant differences between the male and female groups. In particular, the prevalence of diabetes mellitus, heart disease, and

hypertension was significantly higher in the male group than in the female group.

Some dentists in this study reported taking routine medications, including stomach medications, pain relievers, and hypertension drugs. The chi-square test revealed a significant relationship between routine drug consumption and the severity of CTS. However, the direct effects of the medications used in this study could not be conclusively determined (Hernández-Secorún et al., 2021).

The use of routine medications can cause fluid retention in the body, worsening median nerve compression and CTS symptoms such as tingling and pain (Devi et al., 2020). Additionally, certain medications can cause peripheral neuropathy as a side effect. Nonsteroidal anti-inflammatory drugs (NSAIDs), commonly used for pain relief in CTS, can affect gastrointestinal health and lead to other issues that coincidentally worsen the body's condition. Long-term use of these medications increases the tendency for swelling or inflammation, ultimately contributing to CTS (Alhusain et al., 2019; Javed et al., 2023; Teo et al., 2022).

Based on the data analysis, preventive measures for CTS in dentists in Padang City include implementing breaks during the use of vibrating devices such as scalers and dental drills. These breaks are recommended for each session and during patient handling practices, with the goal of reducing tingling sensations experienced by dentists both during the day and at night. Specifically, if vibrating tools are used for more than 2 hours a day, with each session lasting 30-60 minutes, it is advisable to incorporate a 5-minute break to reduce the risk of tingling.

A study by Elsharkhawy et al. (2023) found that dentists who regularly practice stretching exercises during or after each session can reduce the risk of CTS. This approach is considered a clinical application of ergonomics, which can mitigate the risk of both CTS and MSDs. Working hours and experience also significantly impact the occurrence of CTS. The average working hours for dentists in this study were between 6 to 7 hours a day, with some working up to 10 hours. According to Devi et

al. (2022), the longer the contact between a dentist and their patient, the higher the risk of developing CTS. This risk increases further when working hours exceed 8 hours per day. Additionally, dentists with more than 3 years of work experience have been reported to have a higher severity of CTS (Alhusain et al., 2019). The tingling sensation felt by the dentist can also be an indicator of the severity of CTS. In the research of Devi et al (2022). Conducted on dentists in India and Malaysia, it was found that tingling and numbness in the first 3 fingers were critical factors of CTS. Providing break time of using the tools that generate vibrations can reduce vibrations in the hands/wrists, so that the symptoms of tingling and numbness in dentists can be overcome. Another suggestion is to add or replace existing devices with lower vibrations below 25,000 hz.

The dentist age who participating in this study was 30 - 48 years old, with the maximum age being 48 years old. With some sources stating the age range at risk of developing CTS, the division of duties can be given to younger dentists, in addition, there are work shifts that consider dentists to work at certain hours when there are not too many patients in line, to reduce CTS in elderly dentists. This was also suggested by Sugiantini (2023) in his research using dentists in DKI Jakarta. Recommended interventions include taking 10–15-minute breaks during service sessions, performing stretching exercises, reducing daily working hours, and using protective hand or wrist tools. This study is confirming previously known risk factors (age, working hours, excessive force), challenges some assumptions (repetitive motion, BMI, vibration tool use), and this study suggest practical, specific ergonomics intervention for reducing CTS severity in dentists.

5. CONCLUSION

The findings of this study demonstrate a significant association between occupational factors and the severity of Carpal Tunnel Syndrome (CTS) among dentists. Key occupational factors influencing CTS severity and symptoms, such as tingling, include daily working hours, excessive force application, age, years of professional experience, and regular medication use. These factors significantly contribute to the development and progression

of CTS symptoms in dentists. The proposed preventive measures include implementing rest breaks between patient sessions to alleviate muscle strain, performing light exercises after work, consulting healthcare professionals for therapy in moderate to severe CTS cases, using wrist braces, and adjusting working hours. Given the limitations of this study, further research is recommended to explore additional factors such as environmental influences and the role of repetitive motions in the onset and progression of CTS among dentists. Longitudinal follow-up over 6 to 12 months is also suggested to monitor the progression of CTS cases. Advanced analytical studies could provide a deeper understanding of the long-term effects and progression of CTS, serving as a basis for effective medium-term interventions.

The limitation of this study on Carpal Tunnel Syndrome (CTS) among dentist in Padang City are this research was conducted as a cross-sectional study, meaning data was collected at a single point in time. This design limits the ability to determine causal relationship between occupational factors and the severity of CTS. Also, this study primarily focused in work-related factors such as working hours, force exertion, and tool usage. However, it didn't comprehensively analyze non-occupational factors such as lifestyle, which can also influence the severity of CTS.

Further research is needed to explore non-occupational factors contributing to CTS among dentists and to conduct follow-up evaluations of CTS cases every 6–12 months, and explore the impact of CTS on productivity and quality of life, conducted longitudinal studies.

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