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ORIGINAL RESEARCH

THE ASSOCIATION BETWEEN BODY MASS INDEX AND CARPAL TUNNEL SYNDROME AMONG MEDICAL STUDENTS OF UNIVERSITAS PELITA HARAPAN: A CROSS-SECTIONAL STUDY

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Abstract

Introduction: Carpal Tunnel Syndrome (CTS) is one of the most common entrapment neuropathies, though its exact cause remains unclear. Obesity has been identified as a potential risk factor, but previous studies have reported inconsistent findings. This study aimed to analyze the association between Body Mass Index (BMI) and CTS among pre-clinical medical students at Universitas Pelita Harapan.

Methods: This cross-sectional study utilized the Boston Carpal Tunnel Syndrome Questionnaire (BCTQ) to assess symptom severity and functional status. Body weight and height were self-reported via questionnaire to calculate BMI. Bivariate analyses are used to examine the association statistically, followed by stratified analyses to assess potential confounding factors.

Results: A total of 201 participants met the inclusion and exclusion criteria for this study. Among them, 7.5% of the subjects presented with symptoms of CTS, and 5.0% experienced functional impairment. The association between BMI and CTS based on the severity of symptoms and functional status impairment was found to be significant (p = 0.004 and 0.049, respectively).

Conclusion Higher BMI was significantly associated with an increased likelihood of CTS symptoms and functional impairment. Gender and a history of diabetes mellitus were identified as potential confounding factors.

Keywords: Carpal Tunnel Syndrome, Body Mass Index, Obesity

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Introduction

Carpal tunnel syndrome (CTS) is a clinical condition characterized by signs and symptoms resulting from compression of the median nerve within the carpal tunnel.[1,2] It is a common peripheral nerve disease worldwide with around 3.8% of the global population, with higher prevalence in women. Typical symptoms are numbness, paresthesia, and pain in areas innervated by the median nerve. Diagnostic provocation maneuvers commonly used are Phalen's test and Tinel's test, in which results are positive if the maneuvers induce the

common symptoms of CTS.[2–4] The exact etiology of CTS is poorly understood. However, there are several identified risk factors of CTS, that are, diabetes mellitus, menopause, obesity, long term repeated use of the wrist, hypothyroid, arthritis, and pregnancy.[2] Obesity, one of the identified risk factors, has drawn research attention due to its prominence in recent epidemiological findings, particularly following the COVID-19 pandemic. Increased adipose tissue deposition around the wrist in individuals with obesity may contribute to greater wrist circumference.[5]

A cross-sectional study in Saudi Arabia by Ahmed et al. (2023) has found that increase of IMT is associated with increase of CTS prevalence in teachers.[6] Callaghan et al. (2018) did a study in China that concludes that obesity is linked to peripheral nerve disease.[7] In Indonesia, a study by Oka et al. (2023) found a significant association between BMI and gender towards the increase of severity of symptoms in patients with CTS. However, Rani et al. (2024) concludes that there are no significant association between BMI and CTS in a cross-sectional study in India.[8]

In Indonesia, particularly within the Banten Province, there is a paucity of research examining the association between BMI and the prevalence of CTS. This gap is even more pronounced in studies involving active university students as participants. Therefore, the present study aims to investigate the relationship between BMI and the prevalence of CTS among students of the Faculty of Medicine, Universitas Pelita Harapan.

Materials and Methods

This cross-sectional study is conducted at Universitas Pelita Harapan. A non-purposive sampling method was employed to recruit participants. The inclusion were active pre-clinical medical students of Universitas Pelita Harapan. Exclusion criteria included a history of trauma or surgery involving the neck or upper extremities, as well as polyneuropathy and/or cervical radiculopathy. Participants with a history of arthritis, current pregnancy, thyroid dysfunction, or malignancy were also excluded After providing informed consent, participants completed an online questionnaire that included the Bahasa Indonesia–translated version of the BCTQ and questions regarding body weight and height. BMI was calculated using standard BMI formulas based on the self-reported weight and height data.

We assessed the respondents' symptoms from the BCTQ with bivariate association analyses and stratification method. This Bahasa Indonesia translated version of BCTQ has been validated by Octaviana et al. (2022), demonstrating strong reliability, with Cronbach's alpha values of 0.876 and 0.874 for the symptom severity scale, and 0.857 and 0.854 for the functional status scale on the first and second measurements, respectively.[9] Thus, confirming the translated version of BCTQ demonstrated adequate reliability. The BCTQ scores are divided into BCTQ-Symptom Severity Score (BCTQ-S) and BCTQ-Functional Status Score (BCTQ-F).[9]

Body BMI was categorized according to the World Health Organization (WHO) classification: underweight (<18.5), normal

(≥18.5–<22.9), overweight (≥23.0–<24.9), and obese (≥25.0). For the BCTQ, a score of ≥3 on the symptom severity scale was interpreted as indicative of possible CTS symptoms, while a score <3 suggested otherwise. Similarly, a score of ≥3 on the functional status scale indicated the possibility of functional impairment related to CTS.

Statistical Analysis

This study used IBM SPSS version 23 for data management and analysis. Descriptive statistics were performed to summarize demographic and clinical characteristics, including gender, age, history of diabetes mellitus, BMI, and BCTQ scores. Bivariate analyses using the Chi-square test and Fisher's Exact method were conducted to examine the association between BMI and BCTQ scores. Results were reported as odds ratios (OR) with 95% confidence intervals (CI), and a p-value < 0.05 was considered statistically significant. Stratified analyses were also performed to adjust for potential confounding factors, and the magnitude of confounding was assessed.

Results

A total of 213 subjects has filled out the informed consent, were given explanation, and agreed to participate in this study. From the 213 subjects, 12 subjects were excluded from the study. 2 Subjects are with history of arthritis, 5 are with history of surgery on upper extremities and/or wrist, 5 subjects are with family history of confirmed CTS. Therefore, a total of 201 participants is included.

Table 1 presents the demographic and characteristics of the participants in this study. Most of the participants are female 115 (57.7%) with age spanning from 17-23 years old. Among the participants, 4 (2%) were presented with history of Diabetes Mellitus. After calculating the BMI, the number of participants within the underweight, normal, overweight, and obese are 27 (13.4%), 79 (39.3%), 40 (19.9%), 55 (27.4%), respectively. After the BCTQ scores are retrieved on both domains, it has been found that 15 (7.5%) subjects scored ≥3 on the symptoms severity scale, and 10 (5.0%) scored ≥3 on the functional status scale.

Table 2 summarizes the bivariate analyses showing significant associations ($p < 0.05$) between BMI and both BCTQ symptom severity and functional status scores, using the Chi-square and Fisher's Exact tests, respectively. Tables 3 and 4 present the bivariate analyses of gender and diabetes mellitus (DM) history as independent variables associated with BCTQ scores. Tables 5 summarize the results of stratified analyses by gender and diabetes mellitus (DM) history.

Table 6 summarizes the analysis of Magnitude of Confounding for gender and history of DM. Skelly et al. (2012), explains that regardless of the analytical method used, an adjusted estimate is obtained to determine the strength of the association between the studied variables after accounting for potential confounding factors.[10] In general, if the adjusted estimate differs from the crude odds ratio (OR) by ≥10%, the factor is considered a confounder.

Table 1. Demographic of Study Subjects (n=201)

Characteristic	Categories	n (%)
Age Group (years)	17	7 (3.5}
	18	51 (25.4)
	19	41 (20.4)
	20	69 (34.3)
	21	24 (11.9)
	22	6 (3.0)
	23	1 (5)
	24	2 (1)
Gender	Female	116 (57.7)
	Male	85 (42.3)
DM History	No	197 (98)
	Yes	4 (2)
BMI	Underweight (< 18,5)	27(13.4)
	Normal (≥18,5 - <22,9)	79(39.3)
	Overweight (≥23,0 - <24,9)	40 (19.9)
	Obese (≥25,0)	55 (27.4)
BCTQ-S	<3	186 (92.5)
	≥3	15 (7.5)
BCTQ-F	<3	191(95)
	≥3	10(5.0)

Table 2. Bivariate Analysis Between BMI and BCTQ Scores

	BMI		OR(CI 95%)	p-value
	(<22.9)	(≥23.0)		
BCTQ-S				
<3	104	82	8.244 (1.809-37.564	0.004
≥3	2	13		
BCTQ-F				
<3	104	87	4.782 (0.989-23.109)	0.049
≥3	2	8		

Table 3. Bivariate Analysis Between Gender and BCTQ Scores

BMI	Gender		OR (CI 95%)	p-value
	Female	Male		
BCTQ symptoms severity				
<3	108	78	1.212 (0.422-3.481)	0.007
≥3	8	7		
BCTQ functional status				
<3	113	78	3.380 (0.848-13.476)	0.100
≥3	3	7		

Table 4. Bivariate Analysis Between DM History and BCTQ Scores

BMI	DM history		OR (CI 95%)	p-value
	No	Yes		
BCTQ symptoms severity				
<3	182	15	0	1.000
≥3	4	0		
BCTQ functional status				
<3	188	3	6.963 (0.657-73.738)	0.186
≥3	9	1		

Table 5. Stratified analysis of confounding factors on BCTQ outcomes

	BCTQ Symptoms Severity OR	BCTQ Functional Status OR
Gender	8.005	4.052
DM History	8.288	4.754

Table 6. Magnitude of Confounding

	Crude OR	Adjusted OR	Magnitude of confounding
BCTQ-S & Gender	1.212	8.005	(1.212-8.005)/1.212=-560%
BCTQ-S & DM	0	8.288	(0-8.288)/0=Undefined
BCTQ-F & Gender	3.380	4.05	(3.380-4.052)/3.380=-19%
BCTQ-F & DM	6.963	4.754	(6.963-4.754)/)/(6.963)=31%

Discussion

A total of 15 (7.5%) out of 201 participants had BCTQ-S of ≥3, while 10 (4.76%) participants had a BCTQ-F of ≥3. According to the literature, the global prevalence of CTS is estimated at 3.8%. The findings of this study indicate a higher prevalence of CTS symptoms among medical students compared to the general population. This is consistent with several previous studies that also reported a higher prevalence of CTS among students and workers engaged in repetitive hand

movements, as well as among healthcare professionals.[11–14]

A statistically significant association was found between participants with a BMI ≥23.0 and the occurrence of CTS symptoms. As shown in Table 2, the bivariate analysis between BMI and BCTQ-S yielded an odds ratio (OR) of 8.244 (95% CI: 1.809–37.564; p = 0.004), indicating that participants with BMI ≥23.0 were 8.2 times more likely to experience severe CTS symptoms compared to those with BMI <22.9. Similarly, the bivariate analysis between BMI and BCTQ-F showed an OR of 4.782 (95% CI: 0.989–23.109; p = 0.049), suggesting that individuals with BMI ≥23.0 were 4.8 times more likely to experience functional impairment. These findings align with previous literature reporting a positive association between higher BMI and CTS prevalence.[6,7] Oka et al. (2023) also reported an increased severity of CTS among individuals with higher BMI, particularly in females.[15] Obesity and metabolic syndrome serve as predisposing factors through fat deposition around nerves and oxidative stress, leading to increased CTS incidence with rising BMI.[15–17] Excess BMI has also been associated with elevated production of advanced glycation end-products (AGEs) via dyslipidemia, hyperglycemia, and the polyol pathway.[15] In contrast, Rani et al. (2024) found only a weak correlation between BMI and CTS, suggesting that differences in BMI distribution between sexes may contribute to variations in this association.[8] Thus, further studies are warranted to clarify the relationship between BMI and CTS.

As shown in the analyses, gender and history of diabetes mellitus were identified as confounding variables in this study. Otelea et al. (2022) reported a higher prevalence of CTS among females, while previous literature also indicates that individuals with diabetes mellitus have an increased risk of developing CTS compared to non-diabetic individuals.[5] Furthermore, the duration of diabetes has been shown to correlate with the duration and severity of CTS.[7,16] However, Hendriks et al. (2014) found that type 2 diabetes did not independently increase CTS risk after stratified analysis. In the present study, bivariate analysis revealed a significant association between gender and the BCTQ-S score, but not with the BCTQ-F score.[18] A higher risk of CTS was also observed among female participants. After stratified analyses, both gender and history of diabetes mellitus remained statistically significant confounders. These findings are consistent with previous studies reporting associations between CTS occurrence or severity and these variables.[7,16] Callaghan et al. (2018) similarly found that the prevalence of peripheral neuropathy increases with worsening glycemic status in a population-based study conducted in China.[7]

Conclusion

This study demonstrated a statistically significant association between higher BMI and the presence and severity of CTS symptoms among medical students. Participants with BMI ≥23.0 were more likely to experience both symptom severity and functional impairment related to CTS. Gender and history of diabetes mellitus were identified as significant confounding variables, consistent with previous evidence

indicating higher CTS prevalence among females and individuals with diabetes. The findings suggest that elevated BMI, female gender, and diabetes mellitus contribute to an increased risk of CTS symptoms, potentially through mechanisms involving fat deposition, oxidative stress, and metabolic dysregulation. Further large-scale studies are warranted to explore these associations in greater depth and to identify preventive strategies for high-risk populations.

Conflict of Interest

The authors declared no conflict of interest.

Acknowledgment

The authors declared no acknowledgment.

Ethical Clearance

This study has passed ethical review by the ethical form committee of Faculty of Medicine, Pelita Harapan University. The number of the ethical approval for this study is 263/K-LKJ/ETIK/XI/2024. All subjects have provided informed consent and thorough explanation of the study purpose that will be conducted prior to participation.

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