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Wrist–Hand Disability in Adolescents with Symptoms Suggestive of Carpal Tunnel Syndrome: Cross-Sectional Study

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Abstract

Background: Carpal Tunnel Syndrome (CTS) is commonly reported in adults; however, symptoms suggestive of CTS are increasingly observed among adolescents. Repetitive wrist movements related to academic activities and prolonged smartphone use may contribute to wrist–hand complaints in this population. Despite this, information regarding wrist–hand disability among adolescents remains limited, particularly in primary healthcare settings.

Objective: This study aimed to describe the demographic characteristics and the level of wrist–hand disability among adolescents presenting with symptoms suggestive of Carpal Tunnel Syndrome.

Methods: This observational study used a descriptive cross-sectional design. Participants were adolescents with wrist or hand complaints suggestive of median nerve compression and were recruited using purposive sampling in the working area of Wonopringgo Primary Health Center. Clinical screening using Tinel's sign and the Phalen test was performed. Wrist–hand disability was assessed using the Wrist Hand Disability Index (WHDI). Data were analyzed descriptively using means, standard deviations, frequencies, and percentages.

Results: A total of 62 adolescents participated. Most respondents were aged 10–14 years (53.5%), followed by 15–17 years (27.4%) and 18–24 years (19.4%). Female participants accounted for 66.1%. The mean WHDI score was 2.39 ± 0.947. Based on WHDI categories, 21.0% reported no disability, 30.6% mild disability, 37.1% moderate disability, and 11.3% severe disability.

Conclusion: Adolescents with symptoms suggestive of CTS were predominantly early adolescents and female. Moderate wrist–hand disability was most common, highlighting the importance of early screening and preventive physiotherapy interventions.

Keywords
Carpal Tunnel Syndrome; Adolescents; Wrist Disorders; Hand Disability; Cross-Sectional Studies

Introduction

Carpal Tunnel Syndrome (CTS) is the most common entrapment neuropathy of the upper extremity and occurs due to compression of the median nerve as it passes through the carpal tunnel in the wrist. This condition is characterized by symptoms such as numbness, tingling, pain, and weakness in the hand, particularly in the distribution of the median nerve. CTS has traditionally been associated with adult populations, especially individuals performing repetitive hand movements or occupational activities involving prolonged wrist positioning.[1]

Epidemiological studies indicate that CTS affects approximately 3–6% of the general adult population and is considered one of the most common peripheral nerve disorders affecting the upper extremity. The condition can significantly impair hand function, reduce grip strength, and interfere with daily activities. As a result, CTS has been extensively studied in adult populations, particularly among workers exposed to repetitive biomechanical stress such as industrial workers, office employees, and manual laborer.[1,2]

Although CTS is typically associated with adults, recent reports suggest that symptoms resembling CTS are increasingly observed among adolescents. This emerging pattern may reflect changes in lifestyle and activity patterns in younger populations. Adolescents today are exposed to prolonged academic activities and frequent use of digital devices, which often involve repetitive wrist movements and sustained hand postures. These behavioral patterns may increase mechanical stress within the carpal tunnel and potentially contribute to symptoms related to median nerve compression.[3,4]

The increasing use of smartphones and other handheld digital devices has introduced new patterns of repetitive hand activity among adolescents. Activities such as texting, scrolling, gaming, and typing require repetitive thumb movements combined with prolonged wrist flexion or extension. From a biomechanical perspective, repetitive wrist motion may increase intracarpal pressure and reduce the available space for the median nerve within the carpal tunnel. Increased intracarpal pressure can impair microcirculation of the nerve and potentially lead to neural irritation or compression over time.[5,6]

In addition to behavioral factors, anatomical variations may also influence susceptibility to CTS symptoms. Structural variations within the carpal tunnel, such as persistent median arteries, anomalous muscles, or bifid median nerves, have been reported in some individuals and may predispose them to nerve compression. These anatomical conditions may reduce the available space in the carpal tunnel, thereby increasing the likelihood of median nerve irritation even during relatively low levels of repetitive activity.[4,7]

Demographic characteristics may also play a role in the occurrence of CTS symptoms. Several studies have reported that females are more likely to experience CTS compared with males. This difference is often attributed to anatomical variations, including smaller carpal tunnel dimensions and differences in connective tissue properties. Hormonal influences have also been suggested as contributing factors. Although these mechanisms have been mainly documented in adult populations, similar anatomical predispositions may influence the occurrence of wrist complaints among adolescents.[8,9]

The functional consequences of CTS extend beyond sensory disturbances. Median nerve compression can impair hand function, resulting in difficulties with gripping, pinching, and performing fine motor tasks. Wrist–hand disability may affect daily activities such as writing, typing, holding objects, or manipulating small items. In adolescents, these functional impairments may interfere with school-related activities and academic performance. Therefore, identifying early signs of wrist–hand disability is important for preventing long-term functional limitations.[10,11]

Clinical screening tests such as Tinel's sign and the Phalen test are commonly used in clinical practice to identify symptoms suggestive of median nerve compression. Although these tests are not definitive diagnostic tools, they provide a practical and non-invasive method for identifying individuals who may be experiencing CTS-related symptoms in primary healthcare settings. Early identification of wrist complaints may allow for preventive interventions, including ergonomic education, activity modification, and physiotherapy management aimed at reducing mechanical stress on the wrist.

Despite increasing awareness of musculoskeletal complaints among adolescents, research specifically examining wrist–hand disability associated with CTS-related symptoms in this population remains limited. Most existing studies focus on adult populations or occupational groups, while evidence regarding adolescents in community healthcare settings is still scarce. Furthermore, limited information is available regarding the demographic characteristics of adolescents presenting with wrist complaints and the extent to which these complaints affect functional hand activities.

Understanding the characteristics and functional impact of wrist complaints among adolescents is important for several reasons. First, it may help healthcare providers identify early indicators of potential nerve compression disorders in younger populations. Second, it may contribute to the development of preventive strategies addressing musculoskeletal risks associated with repetitive hand activities and prolonged digital device use. Third, it may provide evidence supporting the role of physiotherapy in preventing functional impairment of the upper extremity among adolescents. Therefore, this study aimed to describe the demographic characteristics of adolescents presenting with wrist complaints and to evaluate the level of wrist–hand disability associated with symptoms suggestive of Carpal Tunnel Syndrome in the working area of Wonopringgo Primary Health Center.

Methods

This study employed an observational quantitative design using a descriptive cross-sectional approach. The cross-sectional design was selected to describe the demographic characteristics of adolescents presenting with wrist complaints and to assess the level of wrist–hand disability associated with symptoms suggestive of Carpal Tunnel Syndrome (CTS) at a single point in time. The study was conducted in the working area of Wonopringgo Primary Health Center (Puskesmas Wonopringgo), Indonesia, a primary healthcare facility that provides outpatient services to community members including adolescents presenting with musculoskeletal complaints related to school activities, repetitive hand movements, or prolonged digital device use. Data collection was conducted during the study period when eligible adolescents presenting with wrist or hand complaints were identified and invited to participate in the research.

The study population consisted of adolescents presenting with wrist or hand complaints suggestive of median nerve compression. Participants were recruited using purposive sampling to select individuals who met predefined eligibility criteria relevant to the objectives of the study. The inclusion criteria were adolescents experiencing wrist or hand complaints such as pain, numbness, or tingling sensations, the presence of symptoms consistent with sensory disturbances in the distribution of the median nerve, and willingness to participate in the study and complete the assessment procedures. Participants were excluded if they had a history of wrist trauma or fracture that could affect hand function, congenital anatomical abnormalities involving the wrist or hand, or systemic diseases such as inflammatory arthritis or neurological disorders that might influence hand function. In cross-sectional descriptive studies, sample size is often determined based on the availability of eligible participants during the study period. In this study, all adolescents presenting with wrist complaints who met the eligibility criteria during the data collection period were included. A total of 62 participants were considered sufficient to provide preliminary descriptive information regarding wrist–hand disability among adolescents in the study setting.

The variables examined in this study consisted of demographic characteristics and wrist–hand functional disability. The independent variables included age, sex, and body mass index (BMI), while the dependent variable was the level of wrist–hand disability measured using a standardized questionnaire instrument. In this study, symptoms suggestive of Carpal Tunnel Syndrome were operationally defined as wrist or hand complaints accompanied by sensory symptoms in the distribution of the median nerve and supported by positive results on at least one clinical screening test, namely the Phalen test or Tinel's sign. These clinical screening tests were used as preliminary indicators of possible median nerve compression in primary healthcare settings.

Data collection was conducted through a structured process involving questionnaire assessment and basic clinical screening. Participants were first provided with an explanation regarding the objectives and procedures of the study. Adolescents who agreed to participate were asked to complete a self-administered questionnaire collecting demographic information including age, sex, and body mass index. Following questionnaire completion, participants underwent a simple clinical screening examination to identify symptoms consistent with median nerve compression. Tinel's sign was assessed by gently tapping over the median nerve at the level of the carpal tunnel on the volar aspect of the wrist. The test was considered positive when the participant reported tingling or paresthesia radiating along the distribution of the median nerve in the hand. The Phalen test was performed by instructing participants to maintain maximal wrist flexion by pressing the dorsal surfaces of both hands together for approximately 60 seconds. The test was considered positive if the maneuver reproduced symptoms such as numbness, tingling, or discomfort in the median nerve distribution. Participants who demonstrated symptoms suggestive of CTS during clinical screening proceeded to complete the wrist–hand disability assessment questionnaire.

The level of wrist–hand disability was assessed using the Wrist Hand Disability Index (WHDI), a self-reported questionnaire designed to evaluate functional limitations related to wrist and hand conditions. The instrument assesses perceived difficulties during daily activities involving wrist and hand movements and classifies disability into four levels: no complaints, mild complaints, moderate complaints, and severe complaints. Participants were asked to rate their perceived level of difficulty or discomfort during activities involving the wrist and hand, with higher WHDI scores indicating greater levels of functional impairment. Previous studies have reported that the WHDI demonstrates acceptable psychometric properties for evaluating functional limitations in individuals with wrist and hand disorders. The instrument has shown good internal consistency and reliability for assessing patient-reported wrist–hand disability in clinical and research settings. Body Mass Index (BMI) was used as an indicator of participants' nutritional status. BMI values were categorized according to commonly used classifications for adolescents, including underweight, normal weight, and overweight. The BMI data were analyzed descriptively and presented as mean values, standard deviations, and categorical

distributions. Body Mass Index (BMI) was used as an indicator of participants' nutritional status and was calculated as body weight in kilograms divided by the square of height in meters (kg/m²).

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistical analysis was performed to summarize participant characteristics and wrist–hand disability levels. Continuous variables were presented as means and standard deviations, whereas categorical variables were reported as frequencies and percentages. In addition, exploratory bivariate analysis using the chi-square test was performed to examine potential associations between demographic characteristics and wrist–hand disability levels. Statistical significance was determined at a confidence level of 95% (α = 0.05). This study primarily aimed to provide a descriptive overview of wrist–hand disability among adolescents; therefore, the analysis focused mainly on descriptive statistics.

Results

A total of 62 adolescents participated in this study. The analysis focused on describing the demographic characteristics of participants and the level of wrist–hand disability among adolescents presenting with symptoms suggestive of Carpal Tunnel Syndrome. The characteristics examined included age distribution, sex, body mass index (BMI), and wrist–hand disability scores measured using the Wrist Hand Disability Index (WHDI).

The distribution of participants according to age groups is presented in Table 1. The largest proportion of participants belonged to the 10–14 years age group (53.5%), followed by adolescents aged 15–17 years (27.4%) and those aged 18–24 years (19.4%). These findings indicate that wrist and hand complaints were most commonly reported among early adolescents in the study population. Participant recruitment and selection procedures are illustrated in Figure 1.

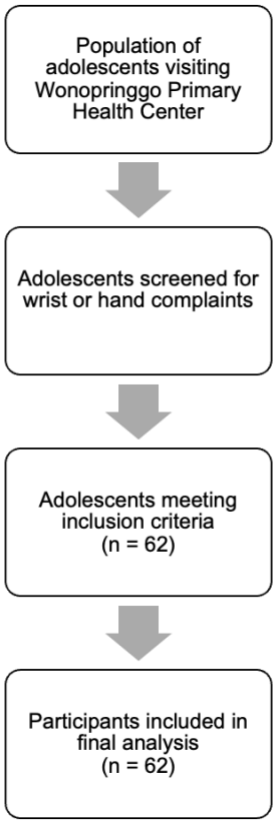

Figure 1. Participant Recruitment Flow Diagram

Table 1. Distribution of Participants by Age Group

Age Group	n	%
10–14 years	33	53.5
15–17 years	17	27.4
18–24 years	12	19.4
Total	62	100

The distribution of participants by sex is presented in Table 2. Female participants accounted for the majority of respondents, representing 66.1% of the sample, while male participants accounted for 33.9%.

Table 2. Distribution of Participants by Sex

Sex	n	%
Male	21	33.9
Female	41	66.1
Total	62	100

Descriptive statistics for Body Mass Index (BMI) are presented in Table 3. The distribution of participants according to BMI categories is presented in Table 3. When categorized according to nutritional status, 45.2% of participants were classified as underweight and 45.2% as having normal body weight, while a smaller proportion (9.7%) were categorized as overweight.

Table 3. Body Mass Index Distribution

Variable	Value	
Standard Deviation	0.665	
Minimum	1	
Maximum	3	
BMI Category	n	%
Underweight	28	45.2
Normal	28	45.2
Overweight	6	9.7
Total	62	100

The level of wrist–hand disability was assessed using the Wrist Hand Disability Index (WHDI), and the results are presented in Table 4. The mean WHDI score was 2.39 ± 0.947, with scores ranging from 1 to 4.

Table 4. Wrist Hand Disability Index Scores

Variable	Value	
Mean	2.39	
Standard Deviation	0.947	
Minimum	1	
Maximum	4	
WHDI Category	n	%
No complaints	13	21.0
Mild complaints	19	30.6
Moderate complaints	23	37.1
Severe complaints	7	11.3
Total	62	100

Based on WHDI classification, the largest proportion of participants experienced moderate wrist–hand disability (37.1%), followed by mild disability (30.6%), no disability (21.0%), and severe disability (11.3%). These findings indicate that most adolescents presenting with wrist complaints experienced some degree of functional limitation in wrist and hand activities.

Overall, the descriptive analysis demonstrates that adolescents presenting with wrist complaints in this study were predominantly early adolescents and female. In addition, moderate levels of wrist–hand disability were the most frequently observed condition among participants.

Discussion

This study aimed to describe the demographic characteristics of adolescents presenting with wrist complaints and to evaluate the level of wrist–hand disability associated with symptoms suggestive of Carpal Tunnel Syndrome (CTS). The findings indicate that wrist complaints suggestive of CTS symptoms were observed among adolescents, with the majority of participants belonging to the early adolescent age group and female sex. In addition, moderate levels of wrist–hand disability were the most commonly reported condition among participants.

One of the notable findings of this study is the age distribution of respondents, where most participants were aged 10–14 years. This finding suggests that wrist and hand complaints may emerge relatively early during adolescence. Although CTS has traditionally been associated with adult populations, several studies have indicated that musculoskeletal complaints involving the upper extremity may also occur in younger individuals. This phenomenon may be associated with increasing exposure to repetitive hand activities during school-related tasks and the use of digital devices.[12,13]

Adolescence is characterized by a transition toward increased academic and technological engagement. Activities such as prolonged writing, typing, drawing, and the use of smartphones require repetitive hand movements and sustained wrist positioning.[14] Repetitive biomechanical loading of the wrist may increase pressure within the carpal tunnel and potentially contribute to median nerve irritation. Over time, such mechanical stress may lead to symptoms resembling CTS, including numbness, tingling, and discomfort in the wrist and hand.[15]

The results of this study also showed that female adolescents represented the majority of participants experiencing wrist complaints. This finding is consistent with several epidemiological studies reporting that CTS occurs more frequently in females than in males. One possible explanation for this difference relates to anatomical characteristics, as females generally have smaller carpal tunnel dimensions compared with males. A narrower carpal tunnel may increase susceptibility to median nerve compression when repetitive wrist movements or increased intracarpal pressure occur.[8]

Hormonal influences and differences in connective tissue properties have also been proposed as contributing factors to the higher prevalence of CTS symptoms among females. Although these mechanisms have been primarily documented in adult populations, similar anatomical and physiological differences may contribute to the distribution observed in adolescent populations.[8]

Another factor that may explain the predominance of female participants in this study is behavioral differences in daily activities. Some studies suggest that females may engage more frequently in activities requiring fine motor skills or prolonged use of digital devices, which may increase exposure to repetitive wrist movements.[16] However, further research is required to better understand the relationship between behavioral factors and the development of CTS symptoms among adolescents.

The distribution of Body Mass Index (BMI) in this study showed that most participants were categorized as underweight or within the normal weight range. Only a small proportion of adolescents were classified as overweight.[17] In adult populations, obesity has been identified as a potential risk factor for CTS because increased adipose tissue may elevate pressure within the carpal tunnel. However, the relationship between BMI and CTS symptoms in adolescents remains less clearly established.

The findings of this study suggest that wrist complaints among adolescents may occur independently of BMI status. This observation may indicate that behavioral factors, such as repetitive hand activities and prolonged use of digital devices, may play a more significant role in the development of wrist complaints in younger populations than metabolic or anthropometric factors.

The assessment of wrist–hand disability using the Wrist Hand Disability Index revealed that moderate functional impairment was the most common level of disability among participants. More than one-third of adolescents reported moderate functional limitations involving wrist and hand activities. Functional complaints commonly reported by adolescents include discomfort during

prolonged writing, difficulty gripping objects, and fatigue during repetitive hand activities. These limitations may interfere with school-related activities that require sustained manual effort and fine motor coordination.[18]

The presence of moderate levels of wrist–hand disability among adolescents suggests that wrist complaints in this population should not be underestimated. Early symptoms such as numbness or mild discomfort may gradually progress and begin to affect functional performance if not addressed. Early identification of wrist–hand disability may therefore play an important role in preventing further functional impairment.[18]

The findings of this study highlight the importance of early screening and preventive strategies for wrist complaints among adolescents. Physiotherapy interventions may play an important role in addressing early musculoskeletal symptoms and preventing the progression of nerve compression disorders. Preventive approaches may include ergonomic education, activity modification, and therapeutic exercises targeting wrist and hand muscles.[19]

Ergonomic education may help adolescents adopt healthier wrist postures during academic activities and digital device use. Encouraging regular breaks during repetitive tasks and promoting appropriate workstation ergonomics may reduce mechanical stress on the wrist. In addition, therapeutic exercises such as tendon gliding and nerve mobilization exercises may help maintain mobility of the median nerve and surrounding structures within the carpal tunnel.[20]

Despite these findings, several limitations should be considered when interpreting the results of this study. First, the cross-sectional design does not allow causal relationships to be established between demographic characteristics and wrist–hand disability. Second, the identification of CTS symptoms in this study was based on clinical screening tests such as Tinel's sign and the Phalen test, which are commonly used in clinical practice but do not provide definitive diagnostic confirmation. Electrophysiological examinations such as nerve conduction studies are considered the gold standard for diagnosing CTS and were not performed in this study. Third, the use of purposive sampling from a single healthcare setting may limit the generalizability of the findings to broader adolescent populations.

Future research is recommended to further investigate wrist and hand complaints among adolescents using larger and more diverse populations. Longitudinal study designs may help clarify the progression of wrist complaints and their relationship with CTS development over time. In addition, future studies may incorporate objective diagnostic assessments such as nerve conduction studies or ultrasonographic examination of the median nerve to improve diagnostic accuracy.

Investigations examining behavioral factors such as smartphone usage duration, typing habits, and ergonomic practices may also provide valuable insights into modifiable risk factors associated with wrist disorders among adolescents.

Overall, the results of this study suggest that wrist complaints suggestive of CTS symptoms are present among adolescents and may already be associated with functional limitations in wrist and hand activities. These findings highlight the importance of early identification and preventive strategies aimed at protecting musculoskeletal health in younger populations.

Conclusion

This study described the demographic characteristics of adolescents presenting with wrist complaints and evaluated the level of wrist–hand disability associated with symptoms suggestive of Carpal Tunnel Syndrome in a primary healthcare setting.

The findings indicate that adolescents experiencing wrist complaints were predominantly in the early adolescent age group and were more frequently female. In addition, moderate levels of wrist–hand disability were the most commonly observed condition among participants, indicating that wrist complaints in adolescents may already affect functional hand activities.

These findings highlight the importance of early identification of wrist and hand complaints among adolescents, particularly in relation to repetitive hand activities and prolonged use of digital devices. Early screening in primary healthcare and school environments may assist in detecting adolescents at risk of developing functional impairment of the wrist and hand.

From a clinical perspective, preventive physiotherapy strategies such as ergonomic education, activity modification, and therapeutic exercises may help reduce mechanical stress on the wrist and improve functional outcomes. Future studies involving larger populations and objective diagnostic assessments are recommended to better understand the risk factors and mechanisms associated with wrist complaints suggestive of Carpal Tunnel Syndrome among adolescents.

Author Contribution

Ardhia Pramesti Amalia: Conceptualization; Methodology; Investigation; Data Curation; Formal Analysis; Writing – Original Draft; Writing – Review & Editing; Visualization; Supervision.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this study.

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Ethics Statement

This study involved minimal-risk observational research using questionnaire-based data collection and non-invasive clinical screening procedures. All participants and their parents or guardians received a full explanation of the study objectives and procedures prior to participation. Written informed consent was obtained before data collection. No personal identifying information was collected, and all data were analyzed anonymously to ensure participant confidentiality.

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