ASSOCIATION BETWEEN WRIST RATIO AND CARPAL TUNNEL SYNDROME: EFFECT MODIFICATION BY BODY MASS INDEX

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ABSTRACT: *Introduction:* Previous studies have reported higher wrist ratios (WR) related to carpal tunnel syndrome (CTS) but have not assessed effect modification by obesity and may have inadequately controlled for confounders. *Methods:* Baseline data of a multicenter prospective cohort study were analyzed. CTS was defined by nerve conduction study (NCS) criteria and symptoms. *Results:* Among the 1,206 participants, a square-shaped wrist was associated with CTS after controlling for confounders (prevalence ratio = 2.27; 95% confidence interval [95% CI], 1.33–3.86). Body mass index (BMI) was a strong effect modifier on the relationship between WR and both CTS and abnormal NCS results, with normal weight strata of rectangular versus square wrists = 8.18 (95% CI, 1.63–49.96) and 7.12 (95% CI, 2.19–23.16), respectively. *Discussion:* A square wrist is significantly associated with CTS after controlling for confounders. Effect modification by high BMI masked the eightfold magnitude adjusted relationship seen between WR and CTS among normal weight participants.

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Carpal tunnel syndrome (CTS) is the most commonly diagnosed peripheral entrapment neuropathy.[1,2] Although affected patients typically report intermittent tingling and numbness of the hands, nocturnal paresthesia, and pain,[3,4] many cases of abnormal nerve conduction studies (NCS) consistent with CTS are found among those who are asymptomatic.[5–7] Numerous mechanistic theories have been proposed, including increased carpal tunnel pressure,[8] yet the majority of cases are considered idiopathic and may include intracarpal pressure increases or multiple mechanisms.[9,10] Proposed pathophysiological mechanisms include tendon hypertrophy, tenosynovial hypertrophy, nerve compression based on wrist flexion,[8,11] and retraction of the lumbricals into the canal with phalangeal flexion; however, the exact mechanisms are not well understood.[12–24]

Studies of wrist ratio (WR) dimensions have shown a higher wrist index (wrist depth/wrist width)[25–27] or wrist squareness (wrist thickness to width > 0.70 in most studies)[27,28] in patients with CTS compared with controls. Other studies have shown wrist and hand anthropometrics[29–31] and wrist squareness[32] to be independent factors associated with CTS in women but not in men.

An increase in the WR (more square wrist) is reportedly associated with CTS diagnosed with both symptoms and median nerve latency prolongation.[26,27] However, some studies have shown a positive association between WR and median latencies in persons with CTS,[26,28,29,33] whereas other studies were unable to confirm a significant relationship or showed only a weak association.[32,34] Few studies have assessed the association between WR and CTS with use objective tests for diagnosing CTS on a population basis. In addition, relatively small samples and the lack of adequate control of confounding by meaningful factors such as body mass index (BMI), occupational exposures, and psychosocial factors have limited analyses and power in many studies.[35–37]

This study seeks to quantify the associations between (1) WR and CTS (diagnosed by abnormal NCS results with symptoms) and (2) abnormal NCS results without symptoms after controlling for

Additional supporting information may be found in the online version of this article

Abbreviations: 95% CI, 95% confidence interval; BMI, body mass index; CTS, carpal tunnel syndrome; NCS, nerve conduction study; PR, prevalence ratio; WR, wrist ratio

Key words: carpal tunnel syndrome; effect modification; nerve conduction study; obesity; wrist

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potential confounders. A secondary objective is to evaluate potential effect modification of BMI on the relationship, if one exists.

MATERIALS AND METHODS

Cross-sectional analyses of baseline data from a multicenter longitudinal cohort, the WISTAH Distal Upper Extremity, were analyzed. This study was approved by the institutional review boards of the University of Utah and University of Wisconsin-Milwaukee (03.02.059 and 11889, respectively). Because detailed methods have been published elsewhere,[38] a succinct summary follows.

All participants provided written informed consent. Eligibility criteria included a minimum age of 18 years, no plans to retire within 4 years, ability to speak English or Spanish, and no major limb deformities and/or substantial amputations. Participants were recruited from 17 diverse production facilities covering a spectrum of employment settings including poultry processing, manufacturing and assembly of laboratory testing equipment, small engine manufacturing and assembly, small electric motor manufacturing and assembly, commercial lighting assembly and warehousing, and electrical generator manufacturing and assembly.

Data Collection. Each participant completed a laptop-administered questionnaire that included past medical history, demographics, and potential confounders. Factors included age, sex, feelings of depression, thyroid problems, and diabetes mellitus. Measured weight and height were used to calculate body mass index (BMI, weight/height^2. A computerized structured interview was administered to collect data on symptoms of tingling, numbness, burning, and pain. NCSs were performed on all participants regardless of symptoms and consisted of sensory and motor amplitude and latency measures for both median and ulnar nerves.[38]

Wrist Ratio. The wrist anteroposterior (depth) and mediolateral dimensions (width) were measured bilaterally on all patients at baseline with a digitized caliper to the nearest tenth of a millimeter. Wrist width was measured with the hand in supination at the level of the distal wrist crease just distal to the styloid processes. Wrist depth was similarly measured at the distal wrist crease.

CTS Case Definition. CTS was defined as the presence of symptoms (tingling and/or numbness) in at least 2 median nerve-served digits (thumb, index, middle, and ring fingers) at the time of baseline visit and abnormal NCS results. The NCS was independently interpreted by a physiatrist to determine whether it was consistent with median neuropathy at the wrist. The physiatrist was blinded to participant symptomology, medical history, and job tasks (Supporting Information Table 1).

Confounders and Effect Modifiers Addressed. We assessed and adjusted for confounding by multiple factors of age, sex, BMI, diabetes mellitus, thyroid disorder, feelings of depression and strain index. Sex and BMI were treated as effect modifiers *a priori* and were considered confounders only if analyses found that they were not effect modifiers.

Data Analyses. All analyses were performed in SAS 9.4 (SAS Institute, Cary, NC) and were performed on the right wrist only. Descriptive statistics for continuous variables are presented as mean ± SD. Right WR was calculated by dividing wrist depth by the wrist width. WR was assessed as a continuous variable and was also categorized. Category cut points were chosen to allow for comparison with prior research. The study sample's primary analysis for WR categories stratified participants into WR 0.681 or less (rectangular), those with WR between 0.681 and 0.700 (middle), and those with WR above 0.700 (square). In other words, the higher ratio describes a more square wrist. An estimate for a dichotomized WR (>0.70 and ≤ 0.70) was also assessed for comparisons with the findings of previous studies. Participants with missing wrist depth and wrist width values were excluded ($n = 10$, 0.9%). A subset analysis was used to test an association of 3 levels of BMI with CTS, stratifying the sample into 2 equal size groups by using median values of the WR (≤ 0.696 and >0.696).

The Wilcoxon sign-rank test was used for comparing continuous variables because the data were not normally distributed. Prevalence ratios (PR) and 95% confidence intervals (95% CI) were calculated by using log-binomial regression to analyze univariate and adjusted relationships between WR and right CTS and between WR and NCS results. The *a priori* α level used in all statistical tests, including assessment for selected effect modifiers, was $P = 0.05$. Variables selected as potential confounders were based on the potential risk factors that have been reported in the literature.[21,24]

WR and BMI as continuous variables were centered (subtracting the median value) to be used to assess effect modification. This is tested by adding a term to the final model in which WR continuous (separate effect modification variables) and continuous BMI variables are multiplied together. These measures were included in the main effect model to assess effect modification of BMI on the relationship between WR and CTS. The main effect model was also stratified by sex to test effect modification between WR and BMI in both men and women.

Finally, a cluster variable was used in the analysis to control for employment and corporate culture effects, but this did not prove helpful in this study because it did not have an effect greater than 10% on the outcome. This suggests that the study participants from the 17 different plants were not significantly different from each other. Therefore, using a cluster variable in this study does not yield a meaningful description of the differences between the study participants, so a cluster variable was not used in the final analyses.

RESULTS

Demographics. Among the 1,206 participants, 798 (66.2%) were women and 408 were men (Table 1). A small proportion had been previously diagnosed with diabetes mellitus, and some reported a diagnosis of a thyroid disorder. Among the 1,206 participants, 108 (8.1%) had right CTS (abnormal NCS results plus symptoms) and 202 (16.8%) had abnormal NCS results. Individuals with $WR > 0.70$ (more square) were significantly more likely to have both CTS and an abnormal NCS result than those with $WR < 0.70$ (more rectangular) factors. This statistically significant relationship remained even after controlling for confounders.

Table 1. Descriptive statistics stratified by WR

	Rectangular (D/W < 0.68), mean ± SD, *n* (%)	Middle (0.68 ≤ D/W ≤ 0.70), mean ± SD, *n* (%)	Square (D/W > 0.70), mean ± SD, *n* (%)	Total, mean ± SD, *n* (%)
Demographic variables	*n* = 401	*n* = 245	*n* = 560	*N* = 1,206
WR* (0.01 unit)	0.66 ± 0.02	0.69 ± 0.01	0.74 ± 0.07	0.70 ± 0.06
BMI (per kg/m^2)	28.27 ± 6.30	29.53 ± 6.64	30.42 ± 7.36	29.53 ± 6.94
Age (per year)	42.46 ± 11.48	41.48 ± 10.98	42.22 ± 11.51	42.15 ± 11.39
Right CTS				
No	380 (94.8)	221 (90.2)	497 (88.8)	1098 (91.0)
Yes	21 (5.2)	24 (9.8)	63 (11.2)	108 (8.1)
Sex				
Women	253 (63.1)	147 (60.0)	398 (71.1)	798 (66.2)
Men	148 (36.9)	98 (40.0)	162 (28.9)	408 (33.8)
Median mononeuropathy by NCS criteria				
Abnormal	45 (11.2)	34 (13.9)	123 (21.1)	202 (16.8)
Normal	356 (88.8)	211 (86.1)	437 (78.0)	1004 (83.2)
Diabetes mellitus diagnosis				
No	384 (95.8)	231 (94.3)	529 (94.5)	1144 (94.9)
Yes	17 (4.2)	14 (5.7)	31 (5.5)	62 (5.1)
Tobacco				
Never	180 (44.9)	121 (49.4)	277 (49.5)	578 (47.9)
Smoked in the past	97 (24.2)	63 (25.7)	136 (24.3)	296 (24.5)
Currently	124 (30.9)	61 (24.9)	147 (26.3)	332 (27.5)
Feelings of depression				
Always/often	82 (20.5)	42 (17.1)	106 (18.9)	230 (19.1)
Seldom/never	319 (79.6)	203 (82.9)	454 (81.1)	976 (80.9)
Thyroid disorder diagnosis				
No	372 (92.8)	231 (94.3)	520 (92.9)	1123 (93.1)
Yes	29 (7.2)	14 (5.7)	40 (7.1)	83 (6.9)

BMI, body mass index; CTS, carpal tunnel syndrome; D/W, depth/width; NCS, nerve conduction study; WR, wrist ratio.

**WR = depth divided by width.*

Primary Outcome Measure: Crude and Adjusted Rates for CTS. The simple or crude analyses of right hand CTS revealed that WR is statistically significant when analyzed as a continuous variable or when analyzed by categories (Table 2). Age, sex, BMI, feelings of depression (often/always), diabetes mellitus, and thyroid disorder were found to be associated with CTS. Likewise, age, BMI, feelings of depression, diabetes mellitus, and thyroid disorder were found to be associated with abnormal NCS results (Table 3). The main difference in crude analyses between the 2 outcomes was that sex was statistically significantly associated with CTS but not statistically significant for abnormal NCS results.

The adjusted analysis of right CTS showed that both the square WR category ($WR > 0.70$) and the middle WR ($0.68 \leq WR \leq 0.70$) were statistically associated with CTS after controlling for age, BMI, sex, feelings of depression, diabetes mellitus, and thyroid disorders. (Table 2) WRs for square wrists were statistically associated with both CTS and abnormal NCS results while controlling for confounders. When analyzed continuously, BMI and WR were related to CTS when controlling for confounders (Table 2).

Stratified Analysis by BMI. In the normal weight group, estimated PRs of CTS were not statistically significant for middle WRs. However, PRs were statistically significant with a large magnitude of effect for square WR compared with rectangular WR. WR was not significantly related to CTS among obese participants after controlling for confounders.

Primary Outcome Measure: Crude and Adjusted Rates for NCS. The crude analyses revealed that square WRs were statistically associated with NCS. Age, BMI, depression, and thyroid disorder were also found to be associated with abnormal NCS results (Table 3). Adjusted analysis showed that square WR, feelings of depression, and obesity were statistically associated with NCS after controlling for confounders. When analyzed continuously, BMI and WR were related to abnormal NCS results when controlling for confounders (Table 3).

Stratified Analysis by BMI. WR was not statistically significantly related to abnormal NCS results among obese participants after controlling for other factors. However, normal weight and obese participants ($BMI < 25.33$ and $BMI \geq 30\,kg/m^2$) who reported feelings of depression (often or always) were 3.98 and 2.87 times more likely to have CTS, respectively. Also, those who reported feelings of depression were 2.99 and 1.89 times

Table 2. Adjusted[†] and crude PR and 95% CI for relationship between WR and CTS in the right hand

		Adjusted PR (95% CI)	Adjusted[†] and stratified PR (95% CI)		
			BMI < 25.33	25.33 ≤ BMI < 30	BMI ≥ 30
Variables	Crude PR (95% CI)	*N* = 1,206	(*n* = 362)	(*n* = 362)	(*n* = 482)
WR[‡] (0.01 unit)	1.006 (1.002–1.011)*	1.02 (1.000–1.05)*	–		–
BMI (per kg/m^2)	1.005 (1.003–1.008)***	1.07 (1.04–1.10)***	–		–
Age (per year)	1.039 (1.02–1.06)***	1.04 (1.02–1.06)***	1.08 (1.01–1.15)*	1.03 (0.99–1.072)	1.04 (1.01–1.07)**
WR[‡] categories					
Rectangular (D/W < 0.68)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Middle (0.68 ≤ D/W ≤ 0.70)	1.87 (1.06–4.08)*	2.16 (1.15–4.07)*	1.91 (0.23–15.89)	4.37 (1.10–17.29)*	1.54 (0.68–3.45)
Square (D/W > 0.70)	2.28 (1.34–3.88)**	2.27 (1.33–3.86)**	8.18 (1.63–40.96)*	4.27 (1.19–15.36)*	1.43 (0.74–2.76)
BMI					
Normal	1.00 (Reference)	1.00 (Reference)	–	–	–
Overweight	1.82 (0.96–3.46)	1.53 (0.79–2.97)	–	–	–
Obese	3.54 (1.10–6.32)***	2.67 (1.50–4.85)**	–	–	–
Female gender	1.89 (1.21–2.95)*	1.39 (0.84–2.29)	0.43 (0.12–1.62)	3.02 (0.99–9.25)	1.28 (0.66–2.46)
Often/always feelings of depression	2.12 (1.46–3.08)***	2.30 (1.46–3.62)***	3.98 (1.05–15.05)*	0.84 (0.27–2.62)	2.87 (1.64–5.05)**
Diabetes mellitus	2.52 (1.50–4.25)**	1.61 (0.81–3.20)	9.23 (0.73–116.81)	0.87 (0.10–7.31)	1.61 (0.75–3.48)
Thyroid disorder	1.85 (1.08–3.16)*	1.61 (0.83–3.12)	3.95 (0.86–18.10)	1.06 (0.22–5.09)	1.26 (0.53–2.99)

-, no data; 95% CI, 95% confidence interval; BMI, body mass index; CTS, carpal tunnel syndrome; D/W, depth/width; PR, prevalence ratio; WR, wrist ratio.

[†]Adjusted for all other factors in the table.

[‡]WR = depth divided by width.

**P < 0.05, **P < 0.005, ***P < 0.0001.*

more likely to have abnormal NCS results (Tables (2 and 3)), respectively. This suggests that there may be an effect modification between obesity and depression on CTS and abnormal NCS results. Strain index was initially used in the adjusted analysis but was removed because it resulted in negligible changes (data not reported).

Secondary Outcome Measure: Effect Modification. The strength of meaningful effect modification by continuous BMI was similar for the relationships between all WRs and CTS as well as WRs and abnormal NCS results. However, the results for effect modification for continuous BMI were not significant for the relationship between WR as a continuous measure and CTS.

The effect modification by continuous BMI on the relationship between categorical WR and CTS was not statistically significant for women ($P = 0.40$) or men ($P = 0.50$). Similarly, the effect modification by continuous BMI on the relationship between categorical WR and abnormal NCS results was not statistically significant for women ($P = 0.77$) or men ($P = 0.08$).

DISCUSSION

In this study, individuals with a square WR who were not obese (BMI < 30.0 kg/m^2) had an eightfold increase in the likelihood of being a prevalent case of CTS after controlling for confounders. Similar results were found when analyzing for abnormal NCS results alone, with a significantly increased PR of 7.12. This suggests that differential reporting of symptoms is not responsible for these relationships with CTS. The large magnitude of this combined effect of square WR and low BMI suggests a biologically meaningful association and impact. One unifying theory of CTS includes increased intracarpal pressure by any mechanism. Perhaps obesity increases intracarpal pressure in all participants regardless of their WR, therefore masking any relationship between WR and CTS. Careful studies quantifying the adipose cells in and near the carpal canal could help support such a mechanism.[39] Another possible explanation is that obesity, and possibly other cardiovascular risk factors,[40] overpower the relationship between WR and CTS due to decreased vascularization. This has been suggested as a potential mechanism for the relationship seen between diabetes and CTS.[40]

Previous research has shown that individuals with a WR > 0.70 have a greater tendency to develop CTS,[27,41] in line with the results of this study. Recent meta-analysis has also suggested that a square-shaped wrist (WR > 0.70) is a risk factor for CTS.[42] Our findings support prior findings that a WR > 0.70 is associated with both CTS and abnormal NCS results. Furthermore, these data demonstrate that, among those with a WR < 0.70, the more square wrist (0. 681 ≤ WR ≤ 0.70) has a significantly increased likelihood of both CTS and abnormal NCS results after adjustment for confounders and stratification by BMI. The findings of this study also confirm that age, BMI, depression, diabetes mellitus, and thyroid disorder are

Table 3. Adjusted[†] and crude PRs and 95% CIs for relationship between WR and abnormal NCS results in the right hand

			Adjusted[†] and stratified abnormal NCS: PR (95% CI)		
	Crude PR	Adjusted PR	BMI < 25.33	25.33 ≤ BMI < 30	BMI ≥ 30
Variables	(95% CI)	$N = 1{,}206$	($n = 362$)	($n = 362$)	($n = 482$)
WR[‡] (0.01 unit)	1.010 (1.005–1.016)***	1.03 (1.003–1.05)*	–		–
BMI (per kg/m^2)	1.008 (1.005–1.011)***	1.09 (1.07–1.12)***	–		–
Age (per year)	1.04 (1.03–1.05)***	1.05 (1.03–1.07)***	1.09 (1.04–1.14)**	1.04 (1.01–1.08)*	1.05 (1.02–1.07)***
WR[‡] categories					
Rectangular (D/W < 0.68)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Middle (0.68 ≤ D/W ≤ 0.70)	1.24 (0.82–1.87)	1.30 (0.80–2.15)	1.43 (0.28–7.28)	2.56 (0.96–6.84)	0.89 (0.46–1.71)
Square (D/W > 0.70)	1.96 (1.43–2.69)***	2.17 (1.47–3.21)***	7.12 (2.19–23.16)**	3.14 (1.34–7.33)*	1.45 (0.88–2.38)
BMI					
Normal	1.00 (Reference)	1.00 (Reference)	–	–	–
Overweight	1.80 (1.12–2.89)*	1.60 (0.98–2.83)	–	–	–
Obese	3.89 (2.56–5.93)***	3.68 (2.32–5.84)***	–	–	–
Female gender	1.30 (0.98–1.72)	0.93 (0.64–1.33)	0.42 (0.15–1.16)	1.19 (0.58–2.43)	0.92 (0.57–1.49)
Often/always feelings of depression	1.43 (1.08–1.90)*	1.52 (1.04–2.24)*	2.99 (1.02–8.81)*	0.49 (0.16–1.46)	1.89 (1.18–3.02)*
Diabetes mellitus	2.37 (1.67–3.37)***	1.68 (0.94–2.99)	4.58 (0.38–54.63)	2.37 (0.66–8.53)	1.50 (0.78–2.91)
Thyroid disorder	1.49 (0.99–2.23)*	1.36 (0.77–2.40)	2.70 (0.74–9.89)	1.63 (0.49–5.45)	1.00 (0.47–2.10)

-, no data; 95% CI, 95% confidence interval; BMI, body mass index; D/W, depth/width; NCS, nerve conduction study; PR, prevalence ratio; WR, wrist ratio.

[†]Adjusted for all other factors in the table.

[‡]WR = depth divided by width.

**P < 0.05, **P < 0.005, ***P < 0.0001.*

independently associated factors for CTS, in line with findings of other studies.[35,37,43]

WR mean values were similar for normal, overweight, and obese participants (0.694, 0.705, and 0.707, respectively). In this study, obesity was the strongest independent risk factor for CTS or abnormal NCS results alone, in line with most other studies.[43–46] Also, female gender was an independent risk factor for CTS, but this association completely disappeared in the adjusted models for CTS and in all the analyses for abnormal NCS results. In a study with a predominantly female population, hand and wrist anthropometrics were found to be an independent risk factor for CTS in women,[35] in line with another study of mostly female workers.[43] Some research suggests that women may be more likely to report CTS syndromes. If this is true, the prevalence of CTS may be underestimated in men[47] and may explain the sex similarity in electrodiagnostic and clinical studies. Also, after removing WR from the adjusted model, sex remained statistically insignificant for CTS and for abnormal NCS results. This suggests that sex is not a risk factor but that it is associated with other factors that may be true risk factors.

The absence of an association between job physical factors (including strain index and threshold limit value for hand–arm vibration) and CTS in this study contrasts with other studies that have found a combination of physical factors associated with CTS. This suggests that the wrist anthropometrics and BMI are the primary risk factors. In this study, feelings of depression changed the main effect for both CTS and abnormal NCS results. Normal weight and obese participants who reported being often or always depressed were 3.98 and 2.87 times more likely to have CTS, respectively. Additionally, they were 2.99 and 1.89 times more likely to have abnormal NCS results, respectively. This suggests that there may be effect modification between obesity and depression on CTS and abnormal NCS results. Those who feel depressed may be more likely to report symptoms of CTS. Effect modification by continuous BMI measure and categorical depression measure after controlling for confounders were similar ($P = 0.02$) to CTS and the continuous BMI and categorical depression ($P = 0.01$) for NCS. However, an effect modification by categorical BMI and depression was not statistically significant. The association between psychological factors related to abnormal NCS results in this study is in line with a prior study that found patients with neurophysiological abnormality had poor mental health[48] and that depression predicted electrodiagnostic test results 82% of the time.[49] However, the mechanisms by which feelings of depression are related to CTS are unknown.

Study strengths include the large number of participants from multiple occupational settings and standardized data collection methods, including anthropometric measures. A trained team of researchers gathered data and preformed exams in strict compliance with the study protocol,

increasing the external validity of the results. Computerization of structured interviews aided in reducing both missing data and errors in coding responses and data entry. An independent analysis of NCS results alone, regardless of symptoms, helped to provide a second set of analyses in support of, and in contrast with, the diagnosis of CTS in this group of participants. Quantified job physical factors are another relatively unique strength.

This study has some limitations. The cross-sectional study design limits assessment of risk factors, although an increased WR cannot be a consequence of CTS. Because some data were self-reported, there is a possibility of recall bias. Categorizing WRs into 3 groups showed statistical significance with CTS, but this leads to modest loss of information while allowing better reporting of a dose-response relationship. Because the strain index did not meaningfully alter the risk estimates, it was removed from the final models. Lack of associations between job physical factors and CTS could be explained by the wrist anthropometrics and BMI overwhelming any effect of job physical factors.

This is not a diagnostic study, and square-shaped wrist does not have clear diagnostic utility to identify individuals with impaired median nerve function. Additional studies are required for further assessment of the relationship of the square-shaped wrist and CTS, especially as it relates to BMI. Such research can more definitively identify the corresponding pathophysiological mechanisms.

In conclusion, CTS and abnormal NCS results were both associated with a square WR, even when controlling for age, BMI, sex, feelings of depression, and thyroid disorders. Furthermore, there was strong effect modification by BMI on the relationship between WR and both CTS and abnormal NCS results, such that the relationship between WR and both CTS and abnormal NCS results was relatively strong among normal weight and overweight participants but was not seen among obese participants.

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