

The Associated Risk Factors for Entrapment Neuropathy in the Upper Extremity: The Locomotive Syndrome and Health Outcome in Aizu Cohort Study (LOHAS)

Kenichi Otoshi^{1*}, Shinichi Kikuchi², Nobuyuki Sasaki², Miho Sekiguchi², Koji Otani², Tsukasa Kamitani³, Shingo Fukuma³, Shunichi Fukuhara³, Shinichi Konno²

¹Department of Sports Medicine, School of Medicine, Fukushima Medical University, Fukushima, Japan

²Department of Orthopaedic Surgery, School of Medicine, Fukushima Medical University, Fukushima, Japan

³Department of Healthcare Epidemiology, Graduate School of Medicine and Faculty of Medicine, Kyoto University, Kyoto, Japan
Email: *kenichiotoshi@email.plala.or.jp

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Abstract

Purpose: Although carpal tunnel syndrome (CTS) and cubital tunnel syndrome (CuTS) are the most common neuropathies in the upper extremities, there have been few studies describing the etiology and associated factors in the general population. The purpose of this study was to investigate and clarify the etiology and associated factors for CTS and CuTS in the Japanese general population. **Methods:** A total of 1875 participants, who participated in health checkups conducted in rural areas in Japan in 2010, were enrolled. The prevalence of CTS and CuTS was investigated. Logistic regression models were performed to examine the relationship between CTS and CuTS and correlated factors such as occupational status, smoking and alcohol preferences, and medical characteristics. **Results:** The overall prevalence of CTS and CuTS was 2.0% and 2.2%, respectively. With regards to CTS, female subjects showed 7.33-times higher risk of CTS compared with male subjects. In addition, hypertension was also at high risk of CTS (5.56-times higher in borderline and 4.55-times higher in definite hypertension compared with normal blood pressure). However, there were no significant associations between CuTS and age, gender, occupation, smoking and alcohol preferences, or metabolic factors. **Conclusions:** CTS was associated with female gender and hypertension, whereas there was no obvious risk factor contributing to the onset of CuTS.

Keywords

Risk Factor, Carpal Tunnel Syndrome, Cubital Tunnel Syndrome, Metabolic Factor, Prevalence

1. Introduction

It has been reported that peripheral nerve entrapment syndromes involve chronic irritation and compression where the nerves pass through anatomical stenotic lesions and fibro-osseous canals. In the upper extremities, various peripheral nerve neuropathies have been reported, and carpal tunnel syndrome (CTS) and cubital tunnel syndrome (CuTS) have been reported as the most common peripheral nerve disorders [1] [2].

There have been several reports describing the etiology of CTS and CuTS. The results of almost all those studies suggest that CTS occurs more commonly in women, with an annual incidence of 1.5 per 1000 compared to 0.5 per 1000 for men [3]. Recently, a CTS prevalence of 2.3% to 4.3% has been reported in two large cohorts of French workers [4].

On the other hand, male gender predisposes to CuTS with an incidence of 24.7 per 100,000 people per year in the general population [5], and, depending on the case definition, prevalence rates in the general population have been estimated at between 7% - 19% [6].

Several studies have demonstrated the associated risk factors of CTS and CuTS. Diabetes, thyroid dysfunction, fluid retention from pregnancy or menopause, high blood pressure, autoimmune disorders such as rheumatoid arthritis, and fractures or trauma to the wrist have also been considered as risk factors of CTS [7] [8] [9] [10] [11].

As with CuTS, fractures around the elbow joint [12] [13] [14], smoking [15], holding a tool in the same position [16], and education [12] have been found to be risk factors.

However, since most of the reported risk factors were investigated using a hospital-based case control study or epidemiologic study of the working population, little is currently known about the relative contributions of associated factors to CTS and CuTS in the general population, and a large population-based research is needed to clarify the associated factors influencing the onset of these neuropathies.

The aim of the current study, a large epidemiologic study, was to clarify the prevalence of CTS and CuTS in the Japanese general population and investigate the associated risk factors using cross-sectional data from the Locomotive Syndrome and Health Outcome in Aizu Cohort Study (LOHAS) [17].

2. Materials and Methods

The LOHAS is an ongoing prospective cohort study of locomotive disorders and health outcomes in Japanese subjects aged 40 - 74 years [17]. The subjects were National Health Insurance (NHI) beneficiaries receiving annual health check-ups conducted by local governments in the towns of Minami-Aizu and Tadamiin Fukushima Prefecture, Japan. Inclusion criteria included subjects who had participated in annual health checkups conducted in 2010. Written informed consent was obtained from all subjects, and the institutional ethics

committee approved the study protocol.

2.1. Sociodemographic Characteristics

We collected sociodemographic data including sex, age, occupation, and personal medical, smoking, and alcohol history, as measured via self-completed questionnaire, and body mass index (BMI), as measured by local nurse practitioners or clinicians. Regarding occupation, the subject's current or longest-lasting former occupation was classified four categories as follows: manual, non-manual, service, and other. Manual work included agriculture, transportation, and manufacturing, non-manual work included office work, administration, and professional, and service work included sales and the service industry. The population of unemployed subjects was categorized as having no occupation [17]. As for smoking status, there were three groups: current smoker, former smoker, and never smoker [18]. With regard to alcohol consumption, there were four groups into which the subjects were categorized: every day, sometimes, rarely, and never [18]. We defined as "overweight" when a BMI was ≥ 25 kg/m² based on the criteria of the Japan Society for the Study of Obesity [19].

2.2. Clinical Characteristics

We also assessed clinical characteristics as systolic blood pressure (SBP), diastolic blood pressure (DBP), glycated hemoglobin (HbA1c), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and triglyceride (TG) serum levels. According to the Japanese Society of Hypertension Guidelines for the Management of Hypertension [20], the subjects were categorized into three groups based on their SBP and DBP: normal (SBP < 130 mmHg and DBP < 85 mmHg), definite (SBP ≥ 140 mmHg or DBP ≥ 90 mmHg), and borderline. The criteria recommended by the Japan Diabetes Society (2010) are used to define chronic hyperglycemia. Three groups were made based on HbA1c: favorable control (HbA1c < 5.5), suspected (HbA1c, 5.6 - 6.4), and definite (HbA1c ≥ 6.5) [21]. The hyperlipidemic was defined if at least one of the following three criteria was satisfied: fasting serum LDL-C level is >140 mg/dL, TG level is >150 mg/dL, or HDL-C level is <40 mg/dL, which are recommended by the Japan Atherosclerosis Society [22]. The criteria from the Examination Committee of Criteria for Metabolic Syndrome in Japan (2005) The metabolic syndrome was defined if the waist circumference was ≥ 85 cm for men and ≥ 90 cm for women and at least two of the following three criteria were satisfied: TG is ≥ 150 mg/dL, HDL-C level is ≤ 40 mg/dL, or receiving lipid-lowering therapy; have a SBP of ≥ 130 mmHg, a DBP of ≥ 85 mmHg, or be receiving antihypertensive therapy; and at least one of the following two criteria was satisfied: a fasting plasma glucose level is ≥ 110 mg/dL or receiving antihyperglycemic therapy [23].

2.3. Clinical Symptom and Health-Related Quality of Life

The upper extremity disability was assessed using the Japanese version of the shortened Disabilities of the Arm, Shoulder and Hand (The Quick DASH) [24].

The general health-related quality of life (HRQOL) was assessed using the Medical Outcome Study Short Form 12-Item Health Survey (SF-12) [25]. We calculated the scores for a mental component summary (MCS) and physical component summary (PCS).

2.4. Assessment of CTS and CuTS

CTS and CuTS diagnoses were based on the symptoms presented and clinical signs observed via a standardized physical examination. The diagnostic criteria of CTS were subjective neurological symptoms around the median nerve area, and either a positive Tinel's sign at the carpal tunnel or a positive carpal tunnel compression test [26] [27]. The CuTS diagnostic criteria were subjective neurological symptoms around the ulnar nerve area, and either a positive Tinel's sign at the cubital tunnel or a positive elbow flexion test [28].

2.5. Statistical Analysis

We described the characteristics of all subjects (analyzed and excluded) as appropriate indices by presence of CTS or CuTS. The Chi squared test for categorical variables, and Student's t test for continuous variables were used to compare the each characteristics between the subjects with and without CTS or CuTS. To explore the associated factors for CTS or CuTS, separated logistic regression analysis were performed. All tests of statistical significance were two-tailed, and P values of less than 0.05 were considered statistically significant. All analyses were conducted using JMP version 10.0.2 (SAS Institute Inc, Cary, NC).

3. Results

3.1. Study Subject and Characteristics

Of the 2505 participants in the LOHAS baseline survey, 80 participants who did not receive special health check exam or physical exam and 550 participants who had at least one missing value were excluded. This left 1875 subjects to be ultimately enrolled in the present study for analysis (**Figure 1**). The characteristics of the study population are described in **Table 1**. The subjects included in this study were more likely to be older, male, smokers, and have a higher prevalence of hypertension history.

3.2. Prevalence of CTS and CuTS

The prevalence of CTS and CuTS are described in **Table 2**. The overall prevalence of CTS and CuTS was 2.0% and 2.2%, respectively. In addition, the prevalence of CTS was significantly higher in female compared with male subjects (3.0% in females vs 0.6% in males), whereas no significant difference was observed between the male and female subjects regarding CuTS. In both CTS and CuTS, there were no significant differences among the age groups in both the male and female subjects.

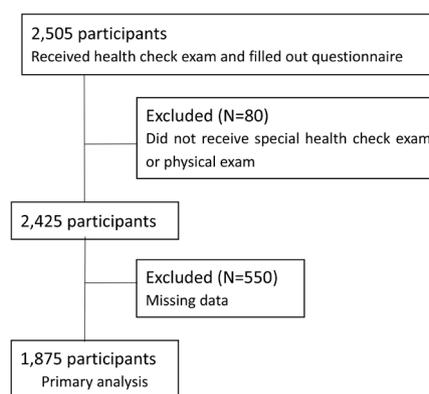


Figure 1. Study flow chart.

Table 1. Baseline characteristics of analyzed population.

	All subjects (N = 2425)	Excluded subjects (N = 550)	Analyzed subjects (N = 1875)	P-value
Age				
≤59	368 (15.2%)	100 (18.5%)	268 (14.3%)	0.029
60 - 69	843 (34.9%)	170 (31.4%)	673 (35.9%)	
≥70	1205 (49.9%)	271 (50.1%)	934 (49.8%)	
Gender				
Male	983 (40.7%)	161 (29.8%)	822 (43.8%)	<0.001
Female	1433 (59.3%)	380 (70.2%)	1053 (56.2%)	
Smoking history				
No	1571 (65.1%)	403 (75.1%)	1168 (62.3%)	<0.001
Yes	841 (34.9%)	134 (24.9%)	707 (37.7%)	
Alcohol consumption				
Never	768 (32.1%)	171 (33.0%)	597 (31.8%)	0.632
Current	1626 (67.9%)	348 (67.0%)	1278 (68.2%)	
Obesity				
Normal (BMI < 25)	1344 (63.3%)	156 (62.7%)	1188 (63.4%)	0.827
Overweight (BMI ≥ 25)	780 (36.7%)	93 (37.3%)	687 (36.6%)	
Past medical history				
Hypertension	No	1234 (51.7%)	290 (56.6%)	0.012
	Yes	1153 (48.3%)	222 (43.4%)	
Cerebrovascular disease	No	2272 (95.4%)	486 (95.5%)	0.904
	Yes	110 (4.6%)	23 (4.5%)	
Cardiac disease	No	2181 (91.5%)	470 (92.2%)	0.518
	Yes	204 (8.5%)	40 (7.8%)	
Hyperlipidemia	No	1652 (69.4%)	357 (70.4%)	0.559
	Yes	730 (30.6%)	150 (29.6%)	
Diabetic disease	No	2186 (91.9%)	467 (92.5%)	0.562
	Yes	194 (8.1%)	38 (7.5%)	

BMI, body mass index

Table 2. The prevalence of CTS and CuTS.

		Total	CTS		CuTS	
		N	N	Prevalence (%)	N	Prevalence (%)
Male	≤59	117	1	0.9	3	2.6
	60 - 69	296	2	0.7	8	2.7
	≥70	409	2	0.2	11	2.7
	All	822	5	0.6	22	2.7
Female	≤59	151	6	4.0	3	2.0
	60 - 69	377	10	2.7	8	2.1
	≥70	525	16	3.1	8	1.5
	All	1053	32	3.0	19	1.8
Total		1875	37	2.0	41	2.2

3.3. Comparison of Characteristics between Subjects with and without CTS

Among the female subjects, the prevalence of CTS was significantly higher in those with borderline/definite hypertension compared to that in those with normal blood pressure; however, such a trend was not observed in the male subjects. Although there was no significant difference, the prevalence of CTS was increased as the increase of the value of HbA1c in female subjects. With regard to the subjective outcome, the Quick DASH score was significantly higher in the subjects with CTS compared to the subjects without CTS; however, there was no significant difference in the PCS and MCS scores of SF-12. Occupational status, smoking and alcohol preference, and medical characteristics such as obesity, Mets, and hyperlipidemia were not associated with CTS (**Table 3**).

3.4. Comparison of Characteristics between Subjects with and without CuTS

Occupational status, smoking and alcohol preference, and any medical characteristics such as obesity, Mets, hypertension, hyperlipidemia, and chronic hyperglycemia were not associated with CuTS in either the male or female subjects. The Quick DASH score was significantly higher in the subjects with CuTS compared to the subjects without CuTS in both the male and female subjects. There was no significant difference in the PCS score in both the male and female subjects; however, in female subjects, the MCS score was significantly lower in the subjects with CuTS (**Table 4**).

3.5. Exploration of Associated Factors for CTS

Female gender and hypertension were independently associated with CTS. Although no significant difference was observed, the odds ratio was higher in the subjects who smoked and had chronic hyperglycemia (**Table 5**).

Table 3. Clinicodemographic factors in subjects with and without CTS.

	Male (N = 822)		P-value	Female (N = 1053)		P-value
	Subjects with CTS (N = 5)	Subjects without CTS (N = 817)		Subjects with CTS (N = 32)	Subjects without CTS (N = 1021)	
Occupational categories						
No occupation	4 (1.1%)	365 (98.9%)		21 (3.0%)	680 (97.0%)	
Non-manual	0 (0%)	74 (100%)		0 (0%)	33 (100%)	
Service	0 (0%)	71 (100%)	0.4279	6 (4.7%)	123 (95.3%)	0.5353
Manual	1 (0.4%)	244 (99.6%)		3 (2.7%)	110 (97.3%)	
Others	0 (0%)	63 (100%)		2 (2.6%)	75 (97.4%)	
Smoking status						
Never	1 (0.5%)	194 (97.5%)		28 (2.9%)	945 (97.1%)	
Past	1 (0.2%)	439 (99.8%)	0.1709	2 (5.6%)	34 (94.4%)	0.6043
Current	3 (1.6%)	184 (98.4%)		2 (4.6%)	42 (95.4%)	
Alcohol consumption						
Every day	2 (0.5%)	408 (99.5%)		2 (3.5%)	52 (96.5%)	
Sometimes	0 (0%)	157 (100%)	0.3305	7 (3.6%)	188 (96.4%)	0.8738
Rarely	1 (0.8%)	126 (99.2%)		11 (3.3%)	320 (96.7%)	
Never	2 (1.6%)	126 (98.4)		12 (2.6%)	457 (97.5%)	
Obesity						
Normal (BMI < 25)	3 (0.6%)	535 (99.4%)	0.7993	19 (2.9%)	631 (97.1%)	0.7816
Overweight (BMI ≥ 25)	2 (0.7%)	282 (99.3%)		13 (3.2%)	390 (96.8%)	
Mets						
No	3 (0.5%)	626 (99.5%)	0.4108	25 (2.7%)	890 (97.3%)	0.1657
Yes	2 (1.0%)	191 (99.0%)		7 (5.1%)	131 (94.9%)	
Hypertension						
Normal	0 (0%)	203 (100%)		3 (1.0%)	300 (99.0%)	
Borderline	1 (0.4%)	240 (99.6%)	0.0704	15 (4.8%)	301 (95.2%)	0.0139
Definite	4 (1.1%)	374 (98.9%)		14 (3.2%)	420 (96.8%)	
Hyperlipidemia						
Normal	2 (0.4%)	549 (99.6%)	0.215	23 (3.3%)	684 (96.7%)	0.558
Definite	3 (1.1%)	268 (98.9%)		9 (2.6%)	337 (97.3%)	
Chronic hyperglycemia						
Favorable control (HbA1C < 5.5)	3 (0.6%)	536 (99.4%)	0.6029	15 (2.2%)	673 (97.8%)	0.0852
Suspected (5.5 ≤ HbA1C < 6.4)	1 (0.4%)	227 (99.6%)		14 (4.4%)	301 (95.6%)	

Continued

Definite (HbA1C \geq 6.5)	1 (1.8%)	54 (98.2%)		3 (6.0%)	47 (94.0%)	
Subjective outcome						
Quick DASH score	16.0 \pm 12.3	6.9 \pm 10.4	0.0533	21.0 \pm 15.8	10.3 \pm 12.1	<0.001
SF-12 PCS score	32.9 \pm 10.6	34.3 \pm 11.6	0.8009	26.2 \pm 12.4	30.7 \pm 12.6	0.0589
SF-12 MCS score	45.7 \pm 10.5	45.9 \pm 9.3	0.9573	44.1 \pm 8.4	45.5 \pm 9.0	0.4095

BMI, body mass index; Mets, metabolic syndrome; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; TG, triglyceride; HbA1c, hemoglobin A1c; DASH, disabilities of arm, shoulder and hand; SF-12, short form 12; PCS, physical component summary; MCS, mental component summary; SD, standard deviation.

3.6. Exploration of Associated Factors for CuTS

Age, gender, occupational status, smoking and alcohol preference, and any medical characteristics such as obesity, Mets, hypertension, hyperlipidemia, and chronic hyperglycemia were not associated with CuTS (**Table 6**).

4. Discussion

4.1. Etiology of CTS

The results of previous studies suggest that CTS occurs more commonly in women, and the incidence among women has been reported to peak at around 45 - 54 years of age. These age and gender differences may be explained at least partly by hormonal factors [3]. It has also been reported that pregnant and breast-feeding women have an increased risk of carpal tunnel syndrome [11], as well as those in their first menopausal year, taking the oral contraceptive pill, or taking hormone replacement therapy [29]. As noted in previous studies, our results showed that the prevalence of CTS was significantly higher in the female subjects when compared with the male subjects in all age groups, and female subjects aged 60 years and younger have a higher prevalence compared with older subjects.

It has been reported that several metabolic factors are associated with CTS. Nordstorm *et al.* reported that body mass index and obesity are strongly associated with CTS, with every 1 unit increase in body mass increasing risk of the condition by 8% [11]. The present study showed that subjects with hypertension was significantly high odds ratio of CTS regardless of age, gender, and other metabolic and factors by multivariable analysis. It has been reported that alterations in endoneural blood vessels caused by hypertension induced morphological and morphometric changes in the peripheral nerves [30]. Laboratory study showed that sustained high blood pressure in adult spontaneously hypertensive rats (SHR) affected the sural nerve myelinated fibers, both morphologically and morphometrically [31]. The present study may be the first to report which directly demonstrates the association between CTS and hypertension.

Table 4. Clinicodemographic variables according to presence of CuTS.

	Male (N = 822)			Female (N = 1053)		
	Subjects with CuTS (N = 22)	Subjects without CuTS (N = 800)	P-value	Subjects with CuTS (N = 19)	Subjects without CuTS (N = 1034)	P-value
Occupational categories						
No occupation	11 (3.0%)	358 (97.0%)		14 (2.0%)	687 (98.0%)	
Non-manual	0 (0%)	74 (100%)		1 (3.0%)	32 (97.0%)	
Service	3 (4.2%)	68 (95.8%)	0.0772	2 (1.6%)	127 (98.4%)	0.8764
Manual	8 (3.3%)	237 (96.7%)		1 (0.9%)	112 (99.1%)	
Others	0 (0%)	63 (100%)		1 (1.3%)	76 (98.7%)	
Smoking status						
Never	9 (4.6%)	186 (95.4%)		15 (1.5%)	958 (98.5%)	
Past	10 (2.3%)	430 (97.7%)	0.1675	2 (5.6%)	34 (94.4%)	0.1681
Current	3 (1.6%)	184 (98.4%)		2 (4.6%)	42 (95.4%)	
Alcohol consumption						
Every day	12 (2.9%)	398 (97.1%)		1 (1.7%)	57 (98.3%)	
Sometimes	4 (2.6%)	153 (97.5%)	0.8273	7 (3.6%)	188 (96.4%)	0.2093
Rarely	2 (1.6%)	125 (98.4%)		6 (1.8%)	325 (98.2%)	
Never	4 (3.1%)	124 (96.9%)		5 (1.1%)	464 (98.9%)	
Obesity						
Normal (BMI < 25)	13 (2.4%)	525 (97.6%)	0.53	10 (1.5%)	640 (98.5%)	0.4158
Overweight (BMI ≥ 25)	9 (3.2%)	275 (96.8%)		9 (2.2%)	394 (97.8%)	
Mets						
No	19 (3.0%)	610 (97.0%)	0.4108	16 (1.8%)	899 (98.2%)	0.7333
Yes	3 (1.6%)	190 (98.4%)		3 (2.2%)	135 (97.8%)	
Hypertension						
Normal	5 (2.5%)	198 (97.5%)		5 (1.7%)	298 (98.3%)	
Borderline	6 (2.5%)	235 (97.5%)	0.9294	7 (2.2%)	309 (97.8%)	0.8123
Definite	11 (2.9%)	367 (97.1%)		7 (1.6%)	427 (99.4%)	
Hyperlipidemia						
Normal	16 (2.9%)	535 (97.1%)	0.558	23 (3.3%)	684 (96.7%)	0.558
Definite	6 (2.2%)	265 (97.8%)		9 (2.6%)	337 (97.4%)	
Chronic hyperglycemia						
Favorable control (HbA1C < 5.5)	13 (2.4%)	526 (97.6%)	0.6447	14 (2.0%)	674 (98.0%)	0.6788
Suspected (5.5 ≤ HbA1C < 6.4)	8 (3.5%)	220 (96.5%)		4 (1.3%)	311 (98.7%)	

Continued

Definite (HbA1C \geq 6.5)	1 (1.8%)	54 (98.2%)		1 (2.0%)	49 (98.0%)	
Subjective outcome						
Quick DASH score	12.2 \pm 12.4	6.8 \pm 10.4	0.0184	19.2 \pm 12.1	10.4 \pm 12.3	0.0021
SF-12 PCS score	33.8 \pm 11.4	34.3 \pm 11.6	0.8634	25.4 \pm 12.4	30.6 \pm 12.6	0.085
SF-12 MCS score	43.7 \pm 9.1	45.9 \pm 9.3	0.2681	40.9 \pm 7.0	45.6 \pm 9.0	0.0287

BMI, body mass index; Mets, metabolic syndrome; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; TG, triglyceride; HbA1c, hemoglobin A1c; DASH, disabilities of arm, shoulder and hand; SF-12, short form 12; PCS, physical component summary; MCS, mental component summary; SD, standard deviation.

Table 5. Multivariable odds ratios mutually adjusted for determinants of CTS.

	Odds ratio	95% confidence interval	P-value
Age			
40 - 59	1		
60 - 69	0.52	0.20 - 1.47	0.2096
\geq 70	0.51	0.20 - 1.45	0.1956
Gender			
Male	1		
Female	7.33	2.13 - 27.52	0.0011
Occupation			
No	1		
Yes	0.81	0.37-1.69	0.5865
Smoking status			
Never	1		
Past	1.08	0.21 - 4.10	0.9222
Current	2.77	0.77 - 8.40	0.1116
Alcohol consumption			
Never	1		
Current	1.04	0.49 - 2.40	0.9167
Obesity			
Normal (BMI < 25)	1		
Overweight (BMI \geq 25)	0.89	0.40 - 1.88	0.7590
Mets			
No	1		
Yes	1.58	0.61 - 3.88	0.3378
Hypertension			
Normal	1		
Borderline	5.56	1.80 - 24.38	0.0019
Definite	4.55	1.47 - 19.97	0.0068
Hyperlipidemia			
Normal	1		
Definite	0.77	0.36 - 1.59	0.4917
Chronic hyperglycemia			
Favorable control (HbA1C < 5.5)	1		
Suspected (5.5 \leq HbA1C < 6.4)	1.89	0.91 - 3.87	0.0860
Definite (HbA1C \geq 6.5)	2.48	0.67 - 7.34	0.1586

Table 6. Multivariable odds ratios mutually adjusted for determinants of CuTS.

	Odds ratio	95% confidence interval	P-value
Age			
40 - 59	1		
60 - 69	0.91	0.35 - 2.65	0.8494
≥70	0.76	0.28 - 2.27	0.5582
Gender			
Male	1		
Female	0.61	0.25-1.53	0.1150
Occupation			
No	1		
Yes	0.7	0.35 - 1.37	0.3232
Smoking status			
Never	1		
Past	0.79	0.31 - 2.00	0.7258
Current	0.68	0.20 - 2.02	0.6308
Alcohol consumption			
Never	1		
Current	0.57	0.27-1.15	0.5829
Obesity			
Normal (BMI < 25)	1		
Overweight (BMI ≥ 25)	1.62	0.82 - 3.16	0.1688
Mets			
No	1		
Yes	0.56	0.19 - 1.43	0.2388
Hypertension			
Normal	1		
Borderline	1.26	0.54-3.03	0.5581
Definite	1.1	0.50 - 2.55	0.7456
Hyperlipidemia			
Normal	1		
Definite	1.04	0.50 - 2.04	0.9754
Chronic hyperglycemia			
Favorable control (HbA1C < 5.5)	1		
Suspected (5.5 ≤ HbA1C < 6.4)	1.1	0.52 - 2.15	0.9013
Definite (HbA1C ≥ 6.5)	0.97	0.15 - 3.45	0.9128

It has been reported that diabetic neuropathy is one of the most common forms of neuropathy [7]. According to several clinical studies, the prevalence of CTS is several-fold higher in DM patients than in the general population [8] [9], and the hazard ratio for CTS is 1.31 (95%CI: 1.28 - 1.34) in DM patients [10]. Although there was no significant difference in the present study, our results

showed that patients with chronic hyperglycemia are at a higher risk of CTS (suspected: 1.89, definite: 2.48).

4.2. Etiology of CuTS

CuTS has been reported to be the second most common nerve entrapment in the upper limb after CTS, and several risk factors have been identified.

The prevalence of CuTS among workers varies from 2.8% to 6.8% [5] [16]. In a review by Piligian *et al.* [32], some work-related risk factors, such as holding a tool in the same position [16] [33], repetitive and sudden elbow flexion, and repeated trauma or pressure to the elbow at the ulnar groove, were mentioned and appeared to be common to CuTS [2]. However, the current study's results showed that occupation was not associated with CuTS. One of the possible reasons for this is that the categories used in our study might not reflect the actual physical demands of manual tasks that involve the upper extremities. In addition, the majority of the residents, including unemployed subjects, would be engaged in agriculture as a family business in addition to their own occupation. To make a precise assessment of the association between occupation and CuTS, detailed evaluations of the actual physical demands of manual tasks at each occupation are needed.

According to previous studies, smoking preference was reported to predispose the development of ulnar nerve compression at the elbow. Richardson *et al.* described in their small case-control study that smoking preference was associated with CuTS [15]. Furthermore, Bartels *et al.* also reported that only smoking was a risk factor of CuTS [12]. In contrast to previous studies, our results revealed no significant association between CuTS and smoking preference.

Few studies have investigated metabolic factors as a risk factor of CuTS. Bartels *et al.* reported in their hospital-based case-control study that there was no significant correlation between CuTS and diabetes mellitus, hypothyroidism, or hypertension [12]. Consistent with this report, our large epidemiologic study showed that metabolic factors, such as metabolic syndrome, obesity, hypertension, hyperlipidemia, and chronic hyperglycemia, were not associated with CuTS. Taken together, smoking preference and metabolic factors might not be associated with the onset of CuTS.

4.3. Limitations

The current study has several limitations. First, the area surveyed is located in a very rural area of Japan with a particularly aged population. In addition, our study population was not sufficiently large to accurately estimate the prevalence and risk factors of CTS and CuTS in the Japanese general population. A similar epidemiologic study should be performed in urban areas to eliminate regional differences and enhance the reliability of the statistical analyses. Second, there was no information on trauma, such as fracture and dislocation, in the current study. To assess the involvement in trauma to these entrapment neuropathies would be an issue in the future. Third, there might be some selection bias in this

study. Since subjects voluntarily attended the health checkup, relatively healthy and health-conscious individuals may have participated in this study, and some individuals who make regular hospital visits may not come for an annual health checkup. Fourth, the diagnostic criteria were insufficient because nerve conduction velocity was not assessed in the diagnosis of CTS and CuTS. Last, since our research was a cross-sectional study, it was not possible to assess a causal relationship. A prospective cohort study should be done to clarify this problem.

5. Conclusion

In conclusion, the prevalence of CTS in the Japanese general population was 0.6% in males and 3.0% in females, and the prevalence of CuTS was 2.7% in males and 1.8% in females. Female gender and hypertension might be risk factors of CTS; however, age, gender, smoking and alcohol preference, and any medical characteristics were not associated with the onset of CuTS.

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