

Prevalence of Carpal Tunnel Syndrome in a General Population

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CARPAL TUNNEL SYNDROME (CTS), or compression neuropathy of the median nerve at the wrist, is a cause of pain, numbness, and tingling in the upper extremities^{1,2} and an increasingly recognized cause of work disability.^{3,4} Carpal tunnel syndrome constitutes a major part of the occupational upper-extremity disorders and is associated with considerable health care and indemnity costs.⁴

Although CTS has been described as the most common peripheral mononeuropathy,² little is known about its prevalence in the general population. We have found only 1 prospective population-based study, performed in the Netherlands in 1985, that attempted to determine the prevalence of CTS.⁵ In a survey of 715 subjects (33% men) aged 25 to 74 years, the prevalence of electrophysiologically confirmed CTS was 5.8% in women and 0.6% in men.⁵ However, the study's sample size and response rate were probably inadequate, reducing its precision.

Higher prevalence rates for CTS have been found in certain occupational groups.⁶⁻⁸ However, in the absence of an accurate estimate of the prevalence in the general population, it is difficult to interpret prevalence rates related to specific occupations. There-

Context Carpal tunnel syndrome (CTS) is a cause of pain, numbness, and tingling in the hands and is an important cause of work disability. Although high prevalence rates of CTS in certain occupations have been reported, little is known about its prevalence in the general population.

Objective To estimate the prevalence of CTS in a general population.

Design General health mail survey sent in February 1997, inquiring about symptoms of pain, numbness, and tingling in any part of the body, followed 2 months later by clinical examination and nerve conduction testing of responders reporting symptoms in the median nerve distribution in the hands, as well as of a sample of those not reporting these symptoms (controls).

Setting A region in southern Sweden with a population of 170 000.

Participants A sex- and age-stratified sample of 3000 subjects (age range, 25-74 years) was randomly selected from the general population register and sent the survey, with a response rate of 83% (n = 2466; 46% men). Of the symptomatic responders, 81% underwent clinical examination.

Main Outcome Measures Population prevalence rates, calculated as the number of symptomatic responders diagnosed on examination as having clinically certain CTS and/or electrophysiological median neuropathy divided by the total number of responders.

Results Of the 2466 responders, 354 reported pain, numbness, and/or tingling in the median nerve distribution in the hands (prevalence, 14.4%; 95% confidence interval [CI], 13.0%-15.8%). On clinical examination, 94 symptomatic subjects were diagnosed as having clinically certain CTS (prevalence, 3.8%; 95% CI, 3.1%-4.6%). Nerve conduction testing showed median neuropathy at the carpal tunnel in 120 symptomatic subjects (prevalence, 4.9%; 95% CI, 4.1%-5.8%). Sixty-six symptomatic subjects had clinically and electrophysiologically confirmed CTS (prevalence, 2.7%; 95% CI, 2.1%-3.4%). Of 125 control subjects clinically examined, electrophysiological median neuropathy was found in 23 (18.4%; 95% CI, 12.0%-26.3%).

Conclusion Symptoms of pain, numbness, and tingling in the hands are common in the general population. Based on our data, 1 in 5 symptomatic subjects would be expected to have CTS based on clinical examination and electrophysiologic testing.

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fore, we conducted an epidemiologic study to estimate the prevalence of CTS in a general population.

METHODS

Study Population and Survey

A sex- and age-stratified sample of 3000 subjects, aged 25 to 74 years, was randomly selected from the population register of northeastern Scania in southern Sweden. This region has a population of 170 000 inhabitants, whose demographic characteristics are similar to those of the

Swedish general population.⁹ The study was approved by the Ethics Committee at Lund University's Medical Faculty.

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See also p 186 and Patient Page.

A questionnaire was devised that incorporated questions from a validated general health survey,¹⁰ with questions about medical history and the presence of pain, numbness, or tingling in any part of the body during the preceding 4 weeks as well as their localization, duration, frequency, and severity. Whole body diagrams were provided for marking pain, numbness, and tingling. Demographic data included sex, age, handedness, height, weight, social status, education, amount of exercise, smoking habits, employment, and work activities. The study was presented in the local media 1 week before the mailing of the questionnaires. To reduce selection bias, the study was described as a general health survey. The questionnaires were mailed to the 3000 subjects in February 1997. Two consecutive reminders were mailed to those who did not respond within 3 weeks. All returned questionnaires were reviewed twice by 2 investigators to identify subjects reporting symptoms in the median nerve distribution in the hands. Responders who reported pain, numbness, and/or tingling in 2 or more of the first 4 fingers at least twice weekly during the preceding 4 weeks were identified. They were then contacted by telephone or, if necessary, by mail, and asked to come to the hospital for a clinical examination and nerve conduction testing.

Controls were randomly selected from the responders who reported no hand symptoms, diabetes, rheumatic disease, thyroid disorder, previous wrist fracture, or carpal tunnel surgery. The controls were also asked to come to the hospital for examination.

Subjects in a random sample of 10% of the nonresponders were contacted by telephone and questioned about the presence of hand symptoms.

Clinical Examination

The clinical examinations were begun 2 months after the initial mailing of the questionnaires and conducted during a 4-week period. All subjects were examined by the same hand surgeon (I.A.), who is experienced in the assessment of CTS. Examination of both hands in-

cluded median nerve provocative tests (Tinel nerve percussion and Phalen maneuver), and evaluation of sensibility and thenar muscle strength.^{1,2} All hands previously operated on for CTS were excluded. Based on the history and the findings at the clinical examination, the examining physician diagnosed each symptomatic subject as having either clinically certain or clinically uncertain CTS. The diagnosis of clinically certain CTS required the presence of recurring nocturnal and/or activity-related numbness or tingling involving the palmar aspects of at least 2 of the first 4 fingers. It usually included positive nerve percussion and/or wrist flexion test results. The presence of median nerve sensory and/or motor deficit was supportive of the diagnosis, but was not considered necessary. The diagnosis of clinically uncertain CTS was considered for the symptomatic subjects reporting poorly defined median nerve paresthesias, whole hand or arm paresthesias, or chronic pain as the main clinical feature.

Nerve Conduction Testing

After the clinical examination the subjects underwent nerve conduction testing using an electromyography device (Viking IV; Nicolet, Madison, Wis). The nerve conduction testing was performed by 3 experienced electromyography technicians who were blinded to the results of the preceding examination. Skin temperature was measured prior to testing, and hands with a temperature of less than 30°C were warmed. Nerve conduction testing was performed using the technique described by Kimura¹¹ and included measurements of median nerve distal sensory latency (third finger–wrist) and wrist–palm sensory conduction velocity, as well as ulnar nerve distal sensory latency (fifth finger–wrist).^{11,12}

The results of the nerve conduction testing were examined to identify subjects with electrophysiological median neuropathy at the carpal tunnel. The electrophysiological criterion used for the diagnosis of median neuropathy was median-ulnar sensory latency difference,¹³ with 0.8 milliseconds or

longer considered abnormal. This cutoff was used in accordance with the previously reported normal values for median-ulnar wrist-digit latency difference as measured with the technique described by Kimura.¹¹

Data Analysis

We calculated the prevalence of pain, numbness, and/or tingling in the median nerve distribution, clinically certain CTS, electrophysiological median neuropathy, and clinically and electrophysiologically confirmed CTS. The prevalence rates were calculated as the number of subjects in each of the 4 categories divided by the total number of survey responders. Ninety-five percent confidence intervals (CIs) were calculated based on the Poisson distribution.¹⁴ Sex- and age-specific prevalence rates were also calculated. Sex-specific overall prevalence rates were age standardized using the general Swedish population in December 1997⁹ as an external standard. Group comparisons were performed using 2-tailed χ^2 tests for categorical data and *t* tests for continuous variables, with significance set at .05.

RESULTS

Survey

Of the 3000 subjects, 15 had recently moved from the study region, 5 were reported recently deceased, 8 were severely ill or cognitively impaired, and 12 had recently relocated to unknown addresses. Of the remaining 2960 subjects, 2466 (83%) returned completed questionnaires (FIGURE).

Symptomatic Subjects

Symptoms of recurring pain, numbness, and/or tingling in the median nerve distribution were reported by 354 responders (34% men; mean [SD] age, 51 [13] years). There were 2112 non-symptomatic responders (48% men; mean [SD] age, 50 [15] years). A significantly higher proportion of women were symptomatic ($P < .001$).

Of the symptomatic responders, 287 subjects (81%) came to the hospital for the clinical examination. Twenty-five

subjects were excluded for the following reasons: previous CTS surgery in the symptomatic hand ($n = 13$), unwillingness to undergo nerve conduction testing ($n = 2$), and either resolution of the median nerve symptoms or symptoms not consistent with the inclusion criteria ($n = 10$).

Clinical examination and nerve conduction testing were performed on 262 symptomatic subjects (35% men; mean [SD] age, 52 [13] years). The results of the clinical and electrophysiological examinations are shown in the Figure.

There was a fair-to-moderate agreement between the clinical diagnosis (clinically certain CTS vs clinically uncertain or no CTS) and the electrophysiological diagnosis (median neuropathy or no median neuropathy) ($\kappa = 0.36$; $P < .001$), and good agreement between the clinical diagnosis alone and the clinical and electrophysiological diagnosis ($\kappa = 0.75$; $P < .001$).¹⁴

Prevalence

The population prevalence of pain, numbness, and/or tingling in the median nerve distribution was 14.4% (95% CI, 13.0%-15.8%). The sex- and age-specific prevalence rates are shown in TABLE 1. The prevalence of clinically certain CTS was 3.8% (95% CI, 3.1%-4.6%). The prevalence of median nerve symptoms and electrophysiological median neuropathy was 4.9% (95% CI, 4.1%-5.8%). The prevalence of clinically and electrophysiologically confirmed CTS was 2.7% (95% CI, 2.1%-3.4%). The sex- and age-specific prevalence rates are shown in TABLE 2.

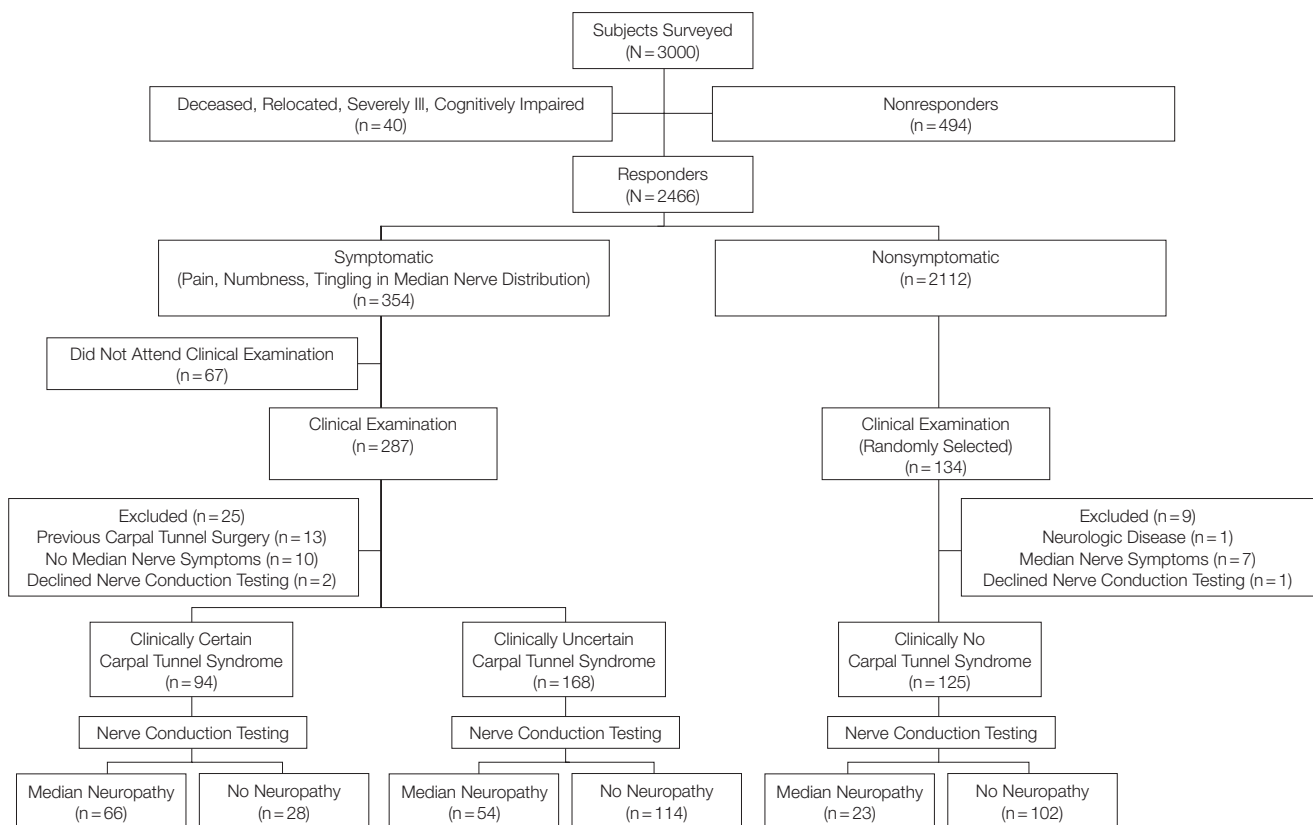
Medical and Occupational Data

Diabetes was reported in 3.0% of the subjects with clinically and electrophysiologically confirmed CTS and 3.2% of the remaining responders. Also reported were thyroid disorder in 3.0% and 3.0%, rheumatoid arthritis in 4.5%

and 1.9%, and overweight or obesity (defined as body mass index of at least 25 kg/m²) in 70% and 47%, respectively. The higher proportion of overweight or obese subjects in the CTS population was significant ($P < .001$).

Clinically and electrophysiologically confirmed CTS was present in 25 of 710 active blue-collar workers (prevalence, 3.5%), and in 12 of 712 active white-collar workers (prevalence, 1.7%) (95% CI for the difference, 0.2%-3.6%; $P = .03$). The higher prevalence among active blue-collar workers was significant even after adjusting for sex, age, and body mass index. The prevalence of confirmed CTS among working subjects who reported more than 1 h/d use of excessive force with the hand during work and those reporting less frequent or no such use was 5.4% and 1.8%, respectively (95% CI for the difference, 1.4%-6.8%; $P < .001$). In a similar analysis of other work-related activities (ie, use >1

Figure. Study Profile



h/d vs use ≤ 1 h/d), CTS prevalence in the 2 groups was, for working with excessively flexed or extended wrist, 3.8% and 1.7% (95% CI for the difference, 0.4%-4.1%; $P = .01$); for repetitive hand or wrist motion, 2.4% and 2.7% (95% CI for the difference, -2.0%-1.5%; $P = .69$); and for use of hand-held vibratory tools, 5.5% and 2.4% (95% CI for the difference, 0.0%-9.1%; $P = .05$).

Controls

Of the nonsymptomatic responders asked to come to the hospital, 134 subjects received a clinical examination. Nine subjects were excluded for the following reasons: neurological disease ($n = 1$), unwillingness to undergo nerve conduction testing ($n = 1$), and presence of median nerve numbness or tingling ($n = 7$).

Clinical examination and nerve conduction testing were performed on 125 control subjects (45% men; mean [SD] age, 51 [14] years). In 3 subjects, nerve

conduction testing was performed on only 1 hand owing to a previous nerve laceration involving the right wrist ($n = 1$) and unwillingness to proceed with examination of the left hand ($n = 2$).

Electrophysiological median neuropathy was found in 23 control subjects (18.4%; 95% CI, 12.0%-26.3%) (TABLE 3). Six of 41 active blue-collar workers and 5 of 45 active white-collar workers had median neuropathy. Analysis of the work-related activities in the controls did not show significant differences regarding the prevalence of median neuropathy.

Nonresponders

A total of 494 eligible subjects (52% men; mean [SD] age, 47 [14] years) did not respond to the questionnaire. The nonresponders differed significantly from the responders with respect to sex ($P = .02$) and age ($P < .001$). Telephone contact was attempted with 49 randomly selected nonresponders.

Twenty-two subjects could not be reached, 1 was reported to have recently died, and 2 declined to answer any questions. Responses could thus be obtained from 24 subjects (11 men). Numbness and/or tingling in the hands were reported in 6 subjects.

Sixty-seven symptomatic subjects (37% men; mean [SD] age, 50 [12] years) did not come to the clinical examination.

COMMENT

The findings of this epidemiologic study of CTS, the largest to date, show this compression neuropathy to be common in the general population. The prevalence of upper-extremity pain and paresthesias in the general population has not been addressed in the literature. The high prevalence of these symptoms in the general population should be borne in mind when assessing the possible relationship of upper-extremity complaints to specific occupations.

Table 1. Prevalence of Pain, Numbness, and/or Tingling in the Median Nerve Distribution in Hands (N = 2466)*

Age, y	Men			Women		
	Responders, No.	Symptomatic, No.	Prevalence, % (95% CI)	Responders, No.	Symptomatic, No.	Prevalence, % (95% CI)
25-34	219	11	5.0 (2.5-8.8)	244	30	12.3 (8.4-17.1)
35-44	213	17	8.0 (4.7-12.5)	280	55	19.6 (15.1-24.8)
45-54	209	32	15.3 (10.7-20.9)	280	50	17.9 (13.5-22.8)
55-64	259	41	15.8 (11.6-20.8)	252	59	23.4 (18.3-29.1)
65-74	234	20	8.5 (5.3-12.9)	276	39	14.1 (10.2-18.8)
All†	1134	121	10.4 (8.6-12.2)	1332	233	17.3 (15.3-19.4)

*CI indicates confidence interval.

†The sex-specific overall prevalence rates are age standardized to the Swedish general population.

Table 2. Sex- and Age-Specific Prevalence Rates of Carpal Tunnel Syndrome*

Age, y	Men						Women					
	Clinically Certain CTS		Electrophysiological Median Neuropathy at the Carpal Tunnel		Clinically and Electrophysiologically Confirmed Diagnosis of CTS		Clinically Certain CTS		Electrophysiological Median Neuropathy at the Carpal Tunnel		Clinically and Electrophysiologically Confirmed Diagnosis of CTS	
	No.	Prevalence, % (95% CI)	No.	Prevalence, % (95% CI)	No.	Prevalence, % (95% CI)	No.	Prevalence, % (95% CI)	No.	Prevalence, % (95% CI)	No.	Prevalence, % (95% CI)
25-34	3	1.4 (0.3-3.9)	4	1.8 (0.5-4.6)	2	0.9 (0.1-3.3)	7	2.9 (1.2-5.8)	5	2.0 (0.7-4.7)	4	1.6 (0.5-4.1)
35-44	3	1.4 (0.3-4.1)	6	2.8 (1.0-6.0)	2	0.9 (0.1-3.3)	16	5.7 (3.3-9.1)	11	3.9 (2.0-6.9)	8	2.9 (1.2-5.5)
45-54	11	5.3 (2.7-9.2)	17	8.1 (4.8-12.7)	9	4.3 (2.0-8.0)	11	3.9 (2.0-6.9)	18	6.4 (3.8-10.0)	8	2.9 (1.2-5.5)
55-64	10	3.9 (1.9-7.0)	14	5.4 (3.0-8.9)	8	3.1 (1.3-6.0)	14	5.6 (3.0-9.1)	20	7.9 (4.9-12.0)	8	3.2 (1.4-6.2)
65-74	4	1.7 (0.5-4.3)	7	3.0 (1.2-6.1)	3	1.3 (0.3-3.7)	15	5.4 (3.1-8.8)	18	6.5 (3.9-10.1)	14	5.1 (2.8-8.4)
All†	31	2.8 (1.8-3.8)	48	4.3 (3.1-5.5)	24	2.1 (1.3-3.0)	63	4.6 (3.5-5.7)	72	5.2 (4.0-6.3)	42	3.0 (2.1-3.9)

*CTS indicates carpal tunnel syndrome; CI, confidence interval.

†The sex-specific overall prevalence rates are age standardized to the Swedish general population.

Table 3. Electrophysiological Median Neuropathy Among a Random Sample of 125 Nonsymptomatic Survey Responders

Age, y	Median Neuropathy	
	No. (Male)	%
25-34	2 (2)	8.7
35-44	2 (1)	7.8
45-54	5 (2)	18.5
55-64	4 (1)	23.5
65-74	10 (5)	31.2
All	23 (11)	18.4

Despite the high incidence of surgery for CTS, no standard criteria for clinical diagnosis have been established.¹ There is also no consensus on whether CTS is a clinical or electrophysiological diagnosis. Normal electrophysiological findings do not rule out CTS.¹⁵ In fact, most studies assessing the sensitivity of nerve conduction testing in diagnosing CTS have used the clinical diagnosis as the criterion standard.¹⁵ On the other hand, physical examination for CTS also has been reported to have limited sensitivity and specificity.¹⁶ Consequently, we calculated 2 separate prevalence rates: 1 in which the diagnosis of CTS was made on the basis of characteristic symptoms and signs and 1 requiring median nerve symptoms combined with electrophysiological median neuropathy. We also calculated a conservative prevalence estimate based on clinically and electrophysiologically confirmed diagnoses. Although this figure may be an underestimate because it excludes electrophysiologically normal subjects with clear clinical features of CTS, this prevalence estimate is important for epidemiologic studies because it probably represents the highest level of classification accuracy.¹⁷ That only 1 clinician performed the clinical examinations may be a source of potential bias.

We found electrophysiological median neuropathy not only in 70% of the subjects diagnosed as having clinically certain CTS and in 46% of those with paresthesias in the median nerve distribution in the hands, but also in 18% of the nonsymptomatic control subjects. Abnormal nerve conduction testing results were more common among older control subjects. The rea-

son for this high rate of asymptomatic median neuropathy is unclear. Although abnormal nerve conduction testing results have been reported in nonsymptomatic subjects, previous electrodiagnostic studies generally have not used controls randomly selected from the general population.¹⁵ Asymptomatic median neuropathy has previously been found in 13% of 724 industrial and/or clerical workers,¹⁸ and in 16% of 1021 industrial job applicants.¹⁹ These 2 studies used median-ulnar sensory latency difference measured at a distance of 14 cm (digit-wrist) and 8 cm (palm-wrist), respectively, using the 0.5-millisecond cutoff commonly used for these measurement techniques. A higher cutoff for the latency difference has been derived from the technique described by Kimura, in which the median and ulnar nerves are stimulated at a fixed point (3 cm proximal to the wrist's distal crease) and the recording made at the interphalangeal joints of the third and fifth digits, respectively.¹¹ A recent study reporting normative median and ulnar nerve conduction values in 324 nonsymptomatic active workers with a mean age of 36 years suggested the use of a 0.8-millisecond cutoff for the 14-cm sensory latency difference to reduce the false-positive rate.²⁰ Our results using the alternative measurement technique also show that the rate of asymptomatic median neuropathy in a general population appears to be higher than previously reported in nonrandom, and often smaller, control groups.

We found a strong association between overweight or obesity and the presence of CTS. The other medical conditions analyzed did not show significant associations, although rheumatoid arthritis was more commonly reported than the other conditions among CTS subjects. Our findings of higher CTS prevalence among blue-collar than white-collar workers, and among workers who reported using excessive force with the hand or working with excessive wrist flexion or extension, might provide additional

support to the role of work-related factors in CTS.

In our study, the prevalence of CTS recorded in men (male-female ratio, 1:1.4) was higher than previously reported.^{5,21} This difference in the reported prevalence rates might be due to differences in the size and/or design of earlier studies, or to a real increase in the prevalence in men. Among older persons, however, the prevalence in women was almost 4 times that in men, with older women showing the highest age-specific prevalence for confirmed CTS.

Since we had a response rate exceeding 80% for both the survey and the clinical examination, we believe selection bias is a minor problem. Furthermore, the nonresponder analysis revealed almost similar proportions of symptomatic subjects among the nonresponders as among the responders. In addition, the rate of false-positive and false-negative questionnaire responses regarding hand symptoms was shown to be low.

When calculating prevalence rates, we assumed that symptomatic subjects who did not come to the examination (19% of all symptomatic subjects) did not have CTS. Consequently, based on clinical and/or electrophysiological criteria, the prevalence rates estimated in our study ought to be close to, or somewhat lower than, the true prevalence.

Estimation of CTS prevalence rates in the general population may contribute to early diagnosis and effective treatment of symptomatic subjects and provide useful data for the interpretation of results of studies that estimate CTS prevalence in specific occupational groups.

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“When you come to a patient’s house, you should ask him what sort of pains he has, what caused them, how many days he has been ill, whether the bowels are working and what sort of food he eats.” So says Hippocrates in his work *Affections*. I may venture to add one more question: what occupation does he follow?
—Bernardino Ramazzini (1633-1714)