Occupational Carpal Tunnel Syndrome in Washington State, 1984–1988

ABSTRACT

Background: There are no published population-based studies of occupational carpal tunnel syndrome (OCTS) using a strict case definition. Most studies are either industry specific or present patient self-report of symptoms.

Methods: We conducted a population-based incidence study of OCTS using the Washington State Workers' Compensation database. Incident OCTS claims were identified with paid bills for physician reported ICD codes 354.0 and 354.1.

Results: There were 7,926 incident OCTS claims identified for the years 1984–1988, which yields an industry-wide incidence rate of 1.74 claims /1,000 FTEs. The mean age (37.4 years) and female/male ratio (1.2:1) in this population differ from those reported in nonoccupational carpal tunnel studies (mean age, 51 years; female/male ratio, 3:1). The female-specific OCTS incidence rate increased significantly during the study period. The highest industry specific OCTS rates were found in the food processing, carpentry, egg production, wood products, and logging industries.

Conclusion: Demographic differences and industry-specific rates consistent with workplace exposures suggest that OCTS is distinct from CTS occurring in nonoccupational settings. Workers' compensation data proved useful in identifying high risk industries. (*Am J Public Health.* 1991;81:741–746)

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Introduction

Occupational carpal tunnel syndrome (OCTS) is a major cause of lost work days and workers' compensation costs in the United States. A recent Centers for Disease Control report, based on physician reporting, estimated that 47 percent of carpal tunnel cases are work-related.[1] Industry-specific prevalence rates of OCTS have been reported to be as high as 15 percent.[2] Most such reports reflect prevalence rates in individual plants or small populations of workers.

Population-based data on the incidence of OCTS has been difficult to generate. The principal problem appears to be that OCTS does not have a unique code in the US Department of Labor Z–16.2 coding system. All wrist disorders are aggregated, and specifically diagnosed cases of OCTS cannot be identified routinely. A recent report using Wisconsin workers' compensation data could identify only "potential" OCTS cases.[3]

Washington State Department of Labor and Industries' claims and medical bill payment information systems were utilized to generate age-, sex- and industry-specific OCTS rates for the years 1984–88. In the context of this study, the validity of using such an administrative data base in performing epidemiologic research was investigated.

Methods

Workers' Compensation System

The Washington State Department of Labor and Industries (L&I) is the sole regulator of workers' compensation coverage in Washington State covering approximately 1.3 million full-time workers in 1988. Coverage for roughly one-third of these workers is through self-insurance administered company programs, and the other two-thirds of workers are covered by the Washington State Fund.

Claims Management Data Base

The L&I claims management data base consists of two major data processing systems. The Medical Information and Payment System receives all billing information generated by provider medical bills. This system records such relevant items as dates of service, all associated procedure (CPT) codes, and physician diagnosis by International Classification of Disease (ICD)[4] code for each provider visit.

The Labor and Industries Industrial Insurance System contains all data necessary for administration of claims. Recorded data include age, sex, claim ID, claimant ID, social security number, nature of injury (Z16.2) codes, time loss, and medical aid paid-to-date. In addition, industry type is coded using the Washington Industrial Classification (WIC) system.

TABLE I—NIOSH Case Definition for Occupational Carpal Tunnel Syndrome (CTS)
A. One or more of the following *symptoms* affecting at least part of the median nerve distribution: paresthesias, hypoesthesia, pain or numbness; and
B. *Objective findings* consistent with CTS: Either 1) *Positive physical examination* findings −(+) Tinel's or Phalen's or decreased or absent sensation to pin prick in median nerve distribution of the hand; or 2) *Nerve conduction findings* indicative of median nerve dysfunction across the carpal tunnel; and
C. Evidence of work-relatedness—a history of a job involving one or more of the following activities *prior to* development of CTS symptoms: 1) *Frequent, repetitive* use of the hand or wrist, 2) Regular tasks requiring the generation of *high force* by the hand, 3) Regular or sustained tasks requiring *awkward hand positions,* 4) Regular use of *vibrating hand tools,* 5) Frequent or prolonged *pressure over the wrist or base of the palm.*
Source = Adapted from Cummings et al.[1]

Incident OCTS Claim Definition

A data extract was generated of all medical bill line items with an ICD code of 354.0 (carpal tunnel syndrome) or 354.1 (median nerve neuritis) from both the claims and medical bill payment systems. The data set included both compensable (time loss) and non-compensable claims for which medical bills were paid between January 1, 1984 and December 31, 1988. Self-insured claims were excluded from both the numerator and denominator in subsequent analyses due to incomplete data.

An incident claim was defined as the first appearance of a paid bill for a claimant with a physician ICD diagnosis of 354.0 or 354.1 between 1984–88. An algorithm was developed to identify unique claimants by claimant ID and social security numbers. This process ensured the removal of multiple claims for the same condition or conditions recurring at a later date, and eliminated problems of missing claimant identifiers for archived claims.

Denominators

OCTS incidence rates by year and industry were estimated directly using worker hours reported to L&I. Worker hours were converted to full time equivalent workers (FTEs) by FTEs = total hours reported/2000.

Age- and sex-specific denominators were not available from worker hours reported to L&I and were estimated by using other available data. Census data for Washington State (1980) were used to estimate an age/sex distribution for the employed population. The Office of Financial Management state and county projected population figures for 1980–91 were used to determine percent changes in the age/sex-specific strata between 1980 and the years of interest.

Industry-Specific OCTS Rates

Worker hours reported to L&I represent hours of exposure by Washington Industrial Classification (WIC). An industrial classification is a grouping of industries that share similar workplace exposures. Currently there are 975 industrial classifications. OCTS rates are presented using WIC classifications as a surrogate for industry type. In order to eliminate unstable rates, only those classifications with a minimum of 25 OCTS cases over the five-year study period were included in the study.

Misclassification Studies

Two separate sub-studies were performed in an attempt to define potential misclassification: 1) a validation study using the medical records for a random sample of 245 incident claims during the period 1984–88 to estimate (a) the proportion of claims with a documented physician diagnosis, and (b) the proportion of claims that fit the clinical criteria for case definition according to National Institute for Occupational Safety and Health (NIOSH) standards (Table 1)[1], and 2) a review of ICD coding errors associated with a separate sample of L&I claimants who received carpal tunnel surgery between 1984–87.
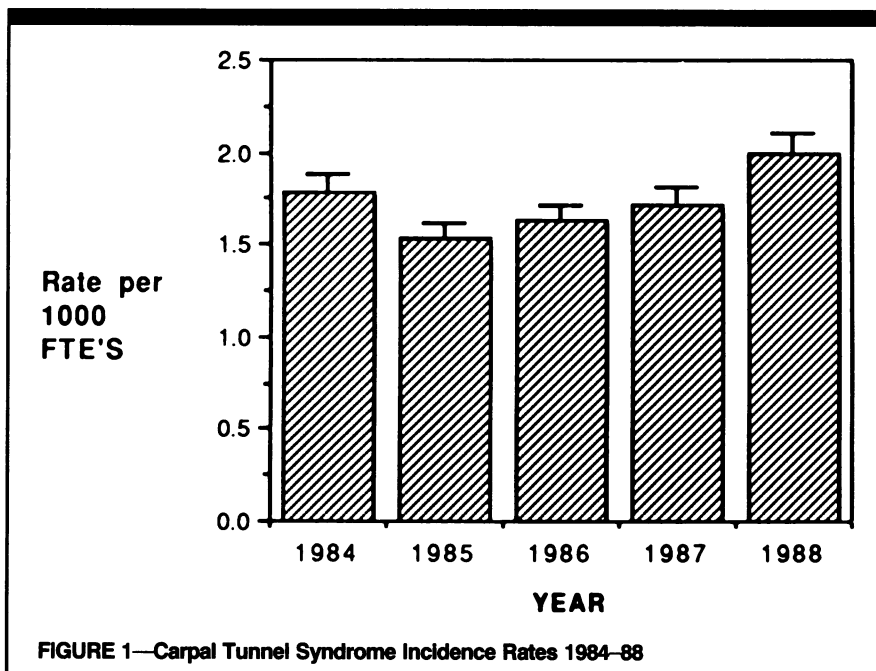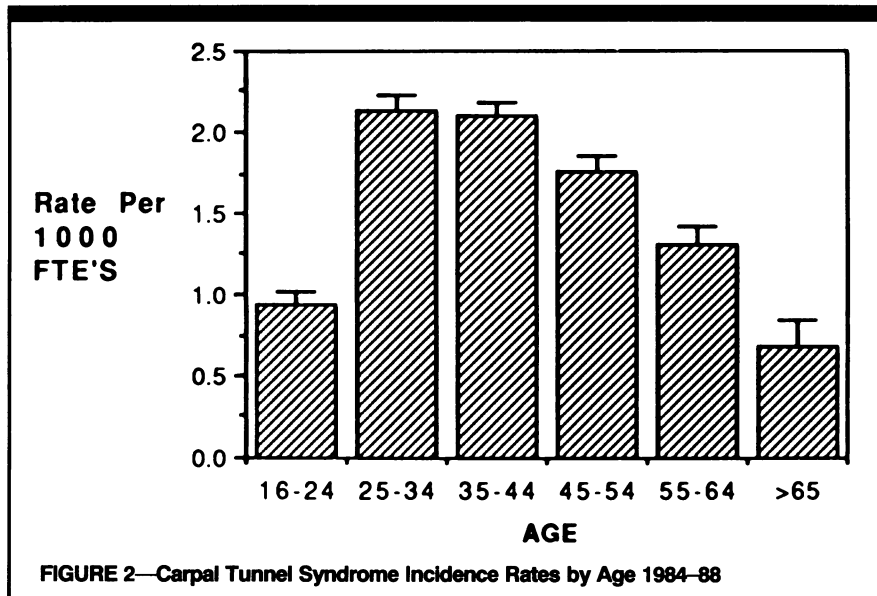
Statistical Methods

Incidence rates by age, sex, year, and industry are expressed as numbers of OCTS claims/1,000 FTEs. A statistical comparison of rates for male/female differences and test for trend over time were done using formulas reflecting a Poisson distribution.[5,6] Each industry-specific rate was compared to the industry-wide rate, and a crude incident rate ratio with a 95 percent confidence interval was developed.[6]

Results

OCTS Incidence by Age, Sex, and Year

Figure 1 shows that the incidence rate for OCTS claims increased from 1.78/1,000 FTEs in 1984 to 2.00/1,000 FTEs in

Rate per 1000 FTE'S

FIGURE 1—Carpal Tunnel Syndrome Incidence Rates 1984–88

FIGURE 2—Carpal Tunnel Syndrome Incidence Rates by Age 1984–88

1988 (1,533 claims in 1984; 1,320 claims in 1985; 1,475 claims in 1986; 1,642 claims in 1987; and 1,956 claims in 1988). The trend of increase is statistically significant (p < .01).

The OCTS incidence rate peaked in the 25–44 age group (mean age 37.4 years) (Figure 2). The overall incidence rate for females (1.96/1,000 FTEs) was significantly greater than that for males (1.58/1,000 FTEs, p < 0.001), and this difference has increased over time (Figure 3). The female OCTS incidence rate increased significantly between 1984–88 (p < 0.005), while the male incidence rate remained stable with no statistically significant trend.

Industry-Specific OCTS Incidence Rates

For the period 1984–88, the industry-wide OCTS incidence rate was 1.74 claims/1,000 FTEs. The top 20 industries are presented sorted by rate (Table 2) and by total number of incident claims (Table 3). The highest OCTS rate of 25.7 claims/1,000 FTEs for oyster, crab, and clam packing was approximately 15-fold higher than the industry-wide rate (1.74 claims/1,000 FTEs).

Misclassification

OCTS Case-Definition Study—In order to validate the methodology used to identify OCTS claims, medical

records for a random sample of 245 incident OCTS claims were reviewed. Two hundred and one (201) out of 245 claims (82 percent) did have a physician diagnosis of OCTS documented in the medical records. The proportion of incident claims without a clear diagnosis of OCTS was consistent across age, sex, and year; no significant differences in proportions were seen within these categories. A high correlation was found between physician diagnosis of OCTS and the criteria set out by NIOSH for case definition. Of the 201 cases with a physician diagnosis in the medical records, 186 (93 percent) met NIOSH standards for OCTS.

An attempt was made to reduce the potential misclassification due to "false" OCTS claims (missing a clear physician diagnosis) by testing more restrictive incident claim definitions (Table 4). The baseline inclusion criteria of at least one visit with ICD codes 354.0 or 354.1 resulted in a "false" claims rate of 18 percent (44/245) in the validation study. Minimally increasing the inclusion criteria to: a) more than one visit with ICD codes 354.0 or 354.1, or b) subsequent carpal tunnel surgery, would exclude 77 percent (34/44) of the "false" OCTS claims. However, 32 percent (64/201) of the true claims (with physician diagnosis) would also be excluded.

Diagnostic Coding Error Study—In order to determine how much misclassification by diagnosis exists in the data base, an extract was made of all medical bills with a CPT procedure code of 64721 (carpal tunnel decompression surgery) for the time period 1984–87. There were 2,507 unique carpal tunnel surgery claims with 212 associated ICD codes. A classification system (Table 5) was developed to assign the various diagnoses as: 1) CTS with ICD codes 354.0 or 354.1; 2) CTS of traumatic origin; or 3) all other ICD codes. This misclassification study is based on the assumption that all surgeries were indeed cases of CTS. If data were extracted from the system based entirely upon ICD codes 354.0 or 354.1, only 71.6 percent (1,793/2,507) of CTS claims would be captured. Only 3.4 percent (86/2,507) of claims that had received carpal tunnel surgery had diagnosis codes suggesting CTS of traumatic origin. Other diagnosis and data entry errors comprised 25 percent (628/2,421) of CTS surgery claims.
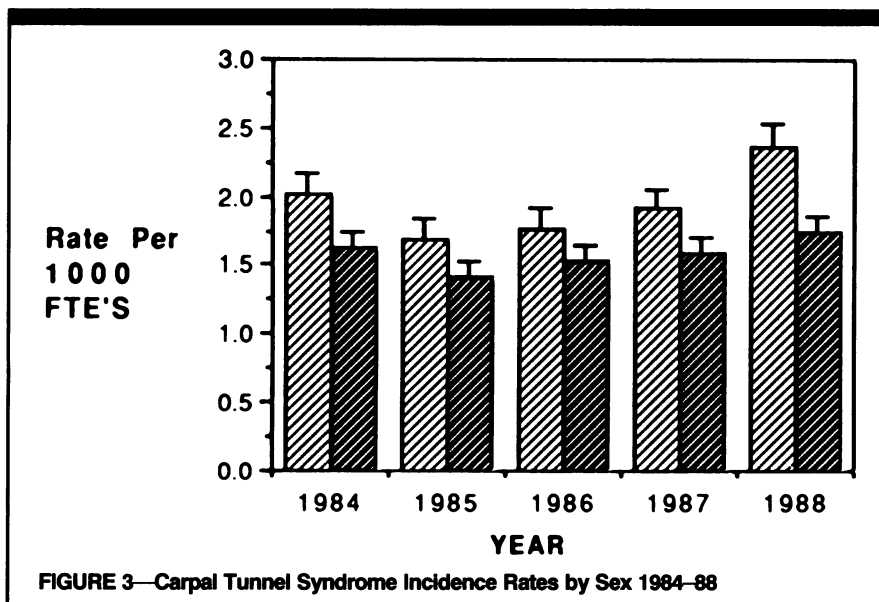

FIGURE 3—Carpal Tunnel Syndrome Incidence Rates by Sex 1984–88

TABLE 2—Rates and Cases of Carpal Tunnel Syndrome by Washington Industrial Classification (WIC), 1984–88 (sorted by rate)

Industrial Class Description	Cases N	Rate/FTE 1000	Rate Ratio	95% Confidence Interval
Oyster, crab, clam packing	50	25.7	14.8	(11.2, 19.5)
Meat, poultry dealers	132	23.9	13.8	(11.6, 16.4)
Packing house	55	18.5	10.6	(8.1, 13.8)
Fish canneries processing	124	18.2	10.5	(8.8, 12.5)
Carpentry	37	11.3	6.5	(4.7, 9.0)
Fruit & vegetable canning	55	10.2	5.8	(4.5, 7.6)
Egg production	30	9.8	5.6	(3.9, 8.1)
Box, shook, pallet bin manufacturing	25	9.3	5.4	(3.6, 8.0)
Sawmills, operation & maintenance	139	9.3	5.3	(4.5, 6.3)
Foundries, steel casting	37	9.0	5.2	(3.8, 7.2)
Logging operations	143	8.9	5.1	(4.4, 6.1)
Wallboard installation	43	8.4	4.8	(3.6, 6.5)
Roofwork, all types	48	8.0	4.6	(3.4, 6.1)
Boat building repair	36	7.7	4.4	(3.2, 6.1)
Plywood manufacturing	54	6.8	3.9	(3.0, 5.1)
Plastic goods manufacturing	121	6.5	3.7	(3.1, 4.5)
Food sundries manufacturing/processing	30	6.4	3.7	(2.6, 5.3)
Wood products manufacturing & assembly	53	6.4	3.7	(2.8, 4.8)
Lumber remanufacturing	26	6.4	3.7	(2.5, 5.4)
Building construction iron/steel/concrete	102	6.3	3.5	(2.9, 4.2)

TABLE 3—Rates and Cases of Carpal Tunnel Syndrome by Washington Industrial Classification (WIC), 1984–88 (sorted by number of cases)

Industrial Class Description	Cases N	Rate/FTE 1000	Rate Ratio	95% Confidence Interval
Convalescent & nursing homes	241	3.1	1.8	(1.6, 2.0)
Grocery/meat stores combination retail	215	3.7	2.1	(1.9, 2.4)
Class H restaurants	207	1.5	0.8	(0.7, 1.0)
Restaurants	170	2.0	1.2	(1.0, 1.4)
Fruit packing	158	5.5	3.1	(2.7, 3.7)
Logging operations	143	8.9	5.1	(4.4, 6.1)
Sawmills, operation & maintenance	139	9.3	5.3	(4.5, 6.3)
Meat, poultry dealers	132	23.9	13.8	(11.6, 16.4)
Fish canneries processing	124	18.2	10.5	(8.8, 12.5)
Plastic goods manufacturing	121	6.5	3.7	(3.1, 4.5)
Building construction iron/steel/concrete	102	6.0	3.5	(2.9, 4.2)
Clerical NOC	92	0.2	0.1	(0.1, 0.1)
Printing, lithography	80	2.9	1.7	(1.3, 2.1)
Fast food, drive-ins	74	1.0	0.6	(0.4, 0.7)
Orchards, fruit	72	1.1	0.6	(0.5, 0.8)
State employees	71	1.8	1.0	(0.8, 1.3)
Clothing manufacturing	71	5.0	2.9	(2.3, 3.7)
Higher education institutions	66	0.4	0.2	(0.2, 0.3)
Electric wiring in buildings	65	1.5	0.8	(0.7, 1.1)
Auto, truck, sales agencies	65	1.4	0.8	(0.6, 1.0)

TABLE 4—Validation Study Using Physician Diagnosis of OCTS

| Inclusion Criteria | Physician Diagnosis | | |
	(Yes)	(No)	
One visit and no surgery	64	34	98
>One visit or subsequent surgery	137	10	147
Total	201	44	245

Discussion

Although findings from a number of recent case-control studies demonstrate a strong association between workplace exposures (high repetition, high force, vibration) and carpal tunnel syndrome,[7–11] this is the first population-based study to report age-, sex- and industry-specific incidence rates of OCTS. The mean age and female/male gender ratio (37.4 years; F:M = 1.2:1) of the OCTS population reported here differ dramatically from that reported for non-occupational carpal tunnel populations (51 years; F:M = 3:1).[12,13] These clear demographic differences between the occupational and non-occupational CTS populations, as well as the magnitude of numbers reported here, would appear to support the concept that workplace exposures may be responsible for a substantial proportion (up to 47 percent)[1] of physician-reported carpal tunnel cases.

The highest incidence rate reported here for shellfish packing (25.7 claims/1,000 FTEs) is similar to the highest reported incidence rates of "potential" carpal tunnel cases using Wisconsin WC data.[3] Industry-specific rates would be expected to vary according to the distributions of industries in each state or region. Some of the highest rates reported here are very characteristic of Washington State (seafood processing and canning, logging and wood products manufacturing, boat building), whereas others are represented in many regions and could be used for comparison (meat and poultry processing, carpentry, fruit and vegetable canning, egg production, foundries, wallboard installation, roofing, plastics manufacturing, and construction).

Industries reported in Table 3, sorted by total numbers of cases, represent more modest incidence rates and rate ratios. Rates for some of these industries (retail groceries, clothing manufacturing, printing and lithography, and electric wiring) may involve relatively weak CTS hazards, or may represent dilution of high exposure jobs by increased job diversification in some industries. Others with very high numbers of claims but non-significant rate ratios (e.g. restaurants) or difficult to explain exposures (e.g. convalescent and nursing homes) require further investigation.

Although video display terminal (VDT) operation has been associated with cumulative trauma disorders,[14] its relationship to OCTS has not been documented clearly in the literature. The industrial classes reported here whose claims may be related to VDT exposure (e.g. clerical, state employees, higher education employees) have non-elevated rate ratios. As these industrial classes represent a wide range of occupations, an association between VDT use and CTS may be diluted. Underreporting of cases in pre-

TABLE 5—Diagnostic Coding Errors for OCTS	
71.6%	CTS diagnosis codes 354.0 and 354.1
3.4%	Probable CTS secondary to trauma (fracture, burn)
25.0%	ICD codes not specific for OCTS
	Miscellaneous data entry errors for OCTS

dominantly female job titles might be an alternative explanation for these lower than expected rates.

Rates among females increased significantly during the study period, while rates among males remained stable. The trends could be due to prior underreporting of claims among females or to a shift of women into higher exposure jobs. Because the gender-specific rates reported here depend on extrapolated rather than direct denominators, these conclusions should be validated in other studies.

Potential pitfalls in the use of workers' compensation[15] and other administrative data bases[16] to generate epidemiologic research have been well documented. Serious underreporting of OCTS cases to workers' compensation bureaus,[1,15] a lack of specificity in the current US Department of Labor coding system,[3] and difficulty generating direct denominators[17] present formidable obstacles that will require public policy changes before improvement is realized. We were able to mitigate the effects of the latter two problems by use of physician-generated ICD billing codes and worker hours reported by WIC, respectively.

Misclassification and coding errors are other serious problems in using workers' compensation data. Incidence rates for OCTS presented were subject to error by both overcounting and undercounting. We were able to validate that only 82 percent of incident claims are true cases of carpal tunnel syndrome by documented physician diagnosis in the medical records. This potential source of overcounting, however, was non-differential by age, sex, or year, and using more or less restrictive inclusion criteria for incident claim definition did not reduce the degree of misclassification.

An equally serious source of potential undercounting of incident claims was also encountered, particularly in regard to ICD coding errors. Only 72 percent of unique claims that were associated with carpal tunnel surgery had an ICD code

(354.0 or 354.1) compatible with carpal tunnel syndrome. Another 3.4 percent of claims had diagnosis codes that were related to CTS of traumatic origin, but 25 percent of claims had either non-specific diagnoses or erroneous diagnostic codes. The latter cases would not have been captured in this study. No gains in precision could be derived from applying these estimates of misclassification to the OCTS incidence rates.

The WIC system is specific to Washington State and is not directly comparable to the national Standard Industrial Classification (SIC) coding system. We were unable to generate reliable SIC code-specific OCTS rates because employee hours are not reported to L&I by SIC code. The WIC system differs from the SIC system in that the former sets aside a separate classification for some occupations such as clerical workers regardless of the employers principal industry type. However, the WIC and SIC systems of classification are sufficiently similar to allow other investigators indirect comparability.

On balance, and with more complete understanding of the limitations of workers' compensation[15] and administrative data bases,[16] workers' compensation data can be useful in generating population-based data for the purposes of surveillance, forecasting trends, and resource targeting for loss control and prevention. The use of other surveillance systems, dependent on direct physician or laboratory reporting,[18,19] could provide complementary information. Workers' compensation data might be particularly useful in the investigation of occupational conditions for which no other good surveillance systems exist, such as OCTS, morbid head injuries, labor injuries among minors, sexual assaults,[20] or for conditions related to mandatory reporting, such as lead poisoning.[21] □

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Developmental, Learning, and Emotional Problems Affect 10.7 Million American Children

One in five American children has had a developmental delay, learning disability, or emotional problem according to a survey by the National Center for Health Statistics. The 1988 National Health Interview Survey of Child Health found such disorders among the most prevalent chronic conditions of childhood and adolescence, with a total of 10.7 million children affected. By the teen years, one in four children had experienced one of these disorders and, among male teenagers, almost three in 10 have been affected.

A report on the survey *Developmental, Learning and Emotional Problems: Health of Our Nation's Children, United States, 1988,* states that 4 percent of all children 17 years of age and under (2.5 million) had delays in growth or development; 6.5 percent among children aged 3–17, 3.4 million (6.5 percent) had learning disabilities and 7 million (13.4 percent) have had an emotional or behavioral problem that lasted three months or more or required psychological treatment.

About half of the children with a developmental delay had received treatment or counseling. More than three fourths of those with learning disabilities or emotional problems had received treatment or counseling, according to the parents reporting in the survey. Parents who reported that their child had a learning, developmental or emotional disorder were asked whether the condition made it necessary for the child to attend special classes, or a special school, or get special help at school. About a quarter of children with delays in growth or development and those reported to have emotional or behavior problems received special educational help. About 70 percent of those with learning disabilities received educational assistance for their disabilities.

In relation to family structure, young people from single-parent families or stepfamilies were two to three times more likely to have had emotional or behavior problems than those from two-parent homes. The prevalence of childhood emotional and behavioral problems showed significant variation across family income groups and minority populations with children from less advantaged backgrounds standing a somewhat greater chance of exhibiting such problems. Black and Hispanic parents were less likely than White non-Hispanic parents to report their children's developmental delays or emotional problems, suggesting that emotional and behavioral problems may be underreported by minority parents, when the data from this nationwide household interview survey are compared to data from other sources. Teacher reports and school records, for example, suggest that minority children are over-represented among special education and remedial instruction classes.

The 1988 National Health Interview Survey of Child Health was a survey of 17,100 children 17 years of age and under, residing in the home, and was based on interviews with an informed adult member of the family, usually the mother.

To obtain a copy of the child health report, *Developmental, Learning and Emotional Problems,* contact NCHS, CDC/ PHS/DHHS, 6525 Belcrest Road, Hyattsville, MD 20782; (301) 436-8500.