

An epidemiologic study of tennis elbow: Incidence, recurrence, and effectiveness of prevention strategies

By: [H. William Gruchow, Ph.D.](#), and Douglas Pelletier, B.S.

Gruchow HW and Pelletier DW: An epidemiologic study of tennis elbow. *American Journal of Sports Medicine*, 7(4):234-238, 1979.

Made available courtesy of Sage Publications: <http://www.sagepub.com/>

***** Note: Figures may be missing from this format of the document**

Abstract:

An epidemiologic study of the incidence and recurrence of tennis elbow among over 500 tennis players (278 men, 254 women; age range, 20 to 50 years) indicated that age and amount of playing time per day were contributing factors to the injury. Both incidence and recurrence rates increased with age. An interactive effect of playing time and age was observed with increased playing time associated with higher incidence at younger ages. Larger grip size was also associated with higher incidence in the older group. These findings were interpreted as being consistent with the hypothesis that tennis elbow is a degenerative disease, the onset of which is hastened by overuse of the arm and elbow. Changes in stroke technique and types of racket were successful in preventing recurrence. Least successful was the forearm brace.

Article:

It has been estimated that one-half of all tennis players suffer at one time or another from the affliction known as "tennis elbow."¹ The nature of the pathology of this condition has been debated over the years, and the symptoms have been attributed to various deformities and inflammations of the tissues and bones comprising the elbow and its associated structures.² A current view describes tennis elbow as inflammation (with or without rupture) of the extensor aponeurosis in the region of the lateral epicondyle.^{3,4} Symptoms of the condition generally include a tenderness over the anterior aspect of the epicondyles of the humerus, pain in the extensor muscles of the forearm induced by gripping or resistive movements in the wrist, and localized pain in the olecranon region induced by carrying weight. The pain ranges from an occasional throbbing to severe agony, although passive movements are generally pain free.⁵

Previous epidemiologic studies have identified age as an important factor associated with the occurrence of tennis elbow, with onset more common after age 30.^{6,7} Other than age, however, there is little consensus on what the risk factors are for tennis elbow. Evidence for differing rates of tennis elbow between men and women is not conclusive. Garden⁸ found that women were afflicted more than men. However, subsequent studies *have* shown equal occurrence rates in both sexes.^{1,6,8}

Based on clinical studies, other factors suggested as contributing to the occurrence of tennis elbow are playing experience, ability, and racket type. Inexperienced players more often use improper stroke techniques and are more prone to "mishit" the ball which results in greater mechanical stress on the elbow joint.^{2,9} Heavier, stiffer, or more tightly strung rackets increase the muscle required during the swing and at impact, and also increase the stress at the elbow.^{9,10} Colt¹¹ reported that metal rackets are a cause of tennis elbow because they allow shock waves to pass unimpeded.

A change of racket, altering stroke technique, and exercising to build-up muscle strength have been reported successful in alleviating the symptoms of tennis elbow and preventing recurrence. However, no epidemiologic data exist which measure the effect of these methods on a population basis.^{2,6,12}

Our study is an epidemiologic study of tennis elbow among a group of tennis players. We looked at the possible etiologic significance of age, sex, playing ability, years of play, daily playing time, warm-up activity, and racket

characteristics, incidence (new cases) and recurrence are separated in the analyses to determine whether or not factors associated with the onset of tennis elbow differ from those associated with exacerbation.

One possibility to be considered in searching for etiologic factors of tennis elbow is that, since it is widely agreed that degenerative changes play a role in the etiology, there may be no aspects of tennis playing which singularly relate to the occurrence, except for the excessive use of the arm and elbow inherent in playing tennis and a wide range of other activities. From this perspective, failure to identify specific aspects of tennis as related to the occurrence of tennis elbow would support the degenerative hypothesis; whereas, if any specific risk factors are found which pertain only to playing tennis, then additional causal hypotheses will need to be considered.

SOURCE OF DATA

The data for this study were obtained by means of a self-report questionnaire which was distributed to members of a private tennis club in the northeastern United States. The reporting instrument was designed to provide a general description of each player including age, sex, level of ability, amount of playing time, warm-up activity, and preferences for racket materials, weight, and grip size. Also included were questions about whether or not the player experienced symptoms of tennis elbow, and if so, their severity and the methods of treatment and prevention.

Questionnaires were distributed to 750 members of the tennis club, representing approximately 60% of the total membership. The members selected were from among those using the tennis facilities of the club during the study period. A cover letter accompanied the questionnaire, describing the nature of the study and requesting the member's cooperation in completing and returning the questionnaire. Also included was a single page of instructions on how to fill in the appropriate responses.

Of the 750 questionnaires distributed, 568 replies were received (a return rate of 76%). Thirty-six respondents who were under age 20 were not included in the study population, because of possible physiologic differences from the adult population, and because this smaller group of respondents was not adequate for a separate analysis. The age and sex distributions of the study population are described in Table 1, along with the distributions of playing ability by sex.

TABLE 1
Age and playing ability distributions of study population by sex

Age:	20-29	30-39	40-49	50+	Totals
Men	39	110	76	53	278
Women	32	109	70	43	254
Totals	71	219	146	96	532

Ability:	A	B	C	Novice	Totals
Men	43	144	86	5	278
Women	37	97	108	12	254
Totals	80	241	194	17	532

PREVALENCE, INCIDENCE, AND RECURRENCE

Two questions pertaining to the occurrence of tennis elbow symptoms were asked of the respondents. One question asked if they had experienced tennis elbow during the 2-month period September 1, 1977 through October 31, 1977. The other asked if they had ever experienced tennis elbow at other times prior to the 2-month period. From these two items the incidence of new cases, the rate of recurrent cases, and the prevalence of tennis elbow during the study period were determined.

A total of 75 respondents reported experiencing episodes of tennis elbow symptoms during the 2-month study period. This yields a prevalence rate of 14.1% (Table 2). Of these 75 cases, 32 were first-time occurrences to individuals who had not previously experienced such symptoms, for an incidence rate of 9.1%. Forty-three cases were recurrent in individuals who had a previous history of tennis elbow symptoms.

An additional 136 subjects reported a history of tennis elbow symptoms, but no episodes during the study period. Combining all categories, a total of 211 (39.7%) respondents reported current or previous problems with tennis elbow symptoms.

TABLE 2
Reported occurrence of tennis elbow in study population

Category	No. reporting/ population at risk	Rates (%)
New cases (incidence)	32/353	9.1
Recurrent cases	43/179	24.0
Total cases during study period (prevalence)	75/532	14.1
History of tennis elbow without episode during study period	136/532	25.6
Total number of respondents afflicted with tennis elbow	211/532	39.7

Less than one-fourth (24%) of the respondents under age 50 who reported tennis elbow symptoms indicated that they were "severe" or "disabling." In contrast, 42% of those over 50 identified severe or disabling symptoms. More women (36%) than men (24%) considered their symptoms to be severe or disabling.

More than one-half of the cases of tennis elbow were diagnosed by the individual or a fellow player (54%). A diagnosis by a medical person (M.D. or nurse) or by a trainer was made for the remainder of cases (46%). The proportion of medically diagnosed cases, as expected, increased with the severity of symptoms.

TABLE 3
Occurrence of tennis elbow symptoms by age and sex^a

	Men	Women	Both sexes
Total cases during study period			
Age: 20-29	2/39 (5.1)	3/32 (9.4)	5/71 (7.0)
30-39	9/110 (8.2)	10/109 (9.2)	19/219 (8.7)
40-49	20/76 (26.3)	12/70 (17.1)	32/146 (21.9)
50+	13/53 (24.5)	6/43 (14.0)	19/96 (19.8)
All ages	44/278 (15.8)	31/254 (12.2)	75/532 (14.1)
χ^2 (age) 3 d.f. = 18.39, $P < 0.001$; χ^2 (sex) 1 d.f. = 1.55, $P = NS$			
New cases			
Age: <40	8/121 (6.6)	8/113 (7.1)	16/234 (6.8)
40+	12/62 (19.4)	4/57 (7.0)	16/119 (13.4)
All ages	20/183 (10.9)	12/170 (7.1)	32/353 (9.1)
χ^2 (age) 1 d.f. = 4.15, $P < 0.05$; χ^2 (sex) 1 d.f. = 1.59, $P = NS$			
Recurrent cases			
Age: <40	3/28 (10.7)	5/28 (17.9)	8/56 (14.3)
40+	21/67 (31.3)	14/56 (25.0)	35/123 (28.5)
All ages	24/95 (25.3)	19/84 (22.6)	43/179 (24.0)
χ^2 (age) 1 d.f. = 4.30, $P < 0.05$; χ^2 (sex) 1 d.f. = 0.17, $P = NS$			
Total cases of tennis elbow, including new and recurrent cases and respondents with a history of previous tennis elbow			
Age: <40	36/149 (24.2)	36/141 (25.5)	72/290 (24.8)
40+	79/129 (61.2)	60/113 (53.1)	139/242 (57.4)
All ages	115/278 (41.4)	96/254 (37.8)	211/532 (39.7)
χ^2 (age) 1 d.f. = 58.57, $P < 0.0001$; χ^2 (sex) 1 d.f. = 0.70, $P = NS$			

^a Rates (%) in parentheses.

FACTORS ASSOCIATED WITH TENNIS ELBOW

Age and sex

Reported cases of tennis elbow during the study period increased with age for both men and women (Table 3). This increase was most evident in the over 40 age groups, where there was a 4-fold increase in prevalence

among men and a nearly 2-fold increase among women. Men had a marginally higher over-all prevalence rate than women, but this was not consistent within each age group, and was not a statistically significant difference. The incidence rate of new cases during the study period also was significantly higher in the over 40 age group of men, but no difference was observed between the rates for older and younger women (Table 3). As for prevalence, men experienced a marginally higher over-all incidence rate, but the difference between men and women was not statistically significant.

The rates of recurrent cases during the study period were significantly higher in the over 40 age groups for both males and females (Table 3), as were the total rates of all persons in the study afflicted with tennis elbow symptoms during or prior to the study period (Table 3).

TABLE 4
Occurrence of tennis elbow by amount of playing time^a

	Hours per day playing time		Total
	Less than 2	2 or more	
New cases	21/286 (7.3)	9/50 (18.0)	30/336 (8.9)
Recurrent cases	35/143 (24.5)	8/36 (22.2)	43/179 (24.0)

^a In this and subsequent tables, totals in some categories may be inconsistent with those in Table 3 due to less than 100% response to some items.

TABLE 5
Incidence of tennis elbow by amount of playing time and age

	Hours per day playing time			Total
	Less than 2	RR ^a	2 or more	
Age <40	9/187 (4.8)	0.5	6/36 (16.7)	15/223 (6.7)
40+	12/100 (12.0)	1.3	3/4 (21.4)	15/114 (13.2)

^a RR: relative risk, which is the ratio of incidence rates using the over-all population rate (32 of 353 = 9.1%) as the basis for comparison.

Playing time

Increased playing time was associated with an increase in the incidence of new cases during the study period, but not with the recurrence of previously existing cases (Table 4). However, further investigation revealed that the increased incidence with increased playing time is statistically significant only for respondents under age 40, although a parallel trend is evident for the older age group as well (Table 5). Using the ratios of incidence rates to assess the relative risk of a new case of tennis elbow, players over 40 years old and playing more than 2 hr per day had nearly twice the risk of developing tennis elbow than those who played less than 2 hr, but in the younger age group, those who played 2 or more hr had over 3.5 times the risk of those who played less.

Experience and ability

When the incidence rate of new cases is tabulated according to the number of years the individual has been playing tennis, there is no evidence that experience and ability are related to the onset of symptoms (Table 6). The recurrence of symptoms shows a lower rate for the longest playing group, although this might be due to fewer individuals who are bothered by tennis elbow continuing to play for a longer number of years. As might be expected, the proportion of players who reported a history of tennis elbow increases with a greater number of playing years.

Playing ability appears to be a significant factor for the incidence of new cases, with higher rates among class A and B players compared to class C and novice players (Table 7). However, an opposite, but not statistically significant, trend is observed for the recurrence of previous cases, with an increasingly higher rate as ability level decreases. Further investigation showed that, when these incidence rates are examined according to hours per day of playing time, the relationship is no longer significant (Table 8), which indicates that the increased incidence of tennis elbow among players with greater ability is probably due to their greater amount of playing time rather than to their ability level.

TABLE 6
Occurrence of tennis elbow by number of playing years

	Years of play			Total
	1 or less	2-5	6+	
New cases	2/17 (11.8)	17/196 (8.7)	13/140 (9.3)	32/353 (9.1)
Recurrent cases	0/0	18/59 (30.5)	25/120 (20.8)	43/179 (24.0)
History, without re- currence during study period	0/0	41/255 (16.1)	95/260 (36.5)	136/532 (25.6)

χ^2 , 1 d.f. = 27.05, $P < 0.01$

TABLE 7
Occurrence of tennis elbow by playing ability

	Playing class				Total
	A	B	C	Novice	
New cases	5/45 (11.1)	20/148 (13.5)	6/143 (4.2)	1/17	32/353 (9.1)
Recurrent cases	7/35 (20.0)	22/93 (23.7)	14/51 (27.5)	0/0	43/179 (24.0)

χ^2 (classes A, B, and C only), 2 d.f. = 7.69, $P < 0.05$

TABLE 8
Incidence of tennis elbow by ability and playing time

Hours per day	Playing Class			Total
	A	B	C	
Less than 2	2/32 (6.3)	13/122 (10.7)	5/117 (4.3)	20/271 (7.4)
2 or more	3/12 (25.0)	5/23 (21.7)	1/14 (7.1)	9/49 (18.4)

χ^2 , 2 d.f. = 3.63, $P = NS$
 χ^2 , d.f. = 1.74, $P = NS$

TABLE 9
Occurrence of tennis elbow by warm-up frequency and warm-up time

Warm-up frequency	Never	Seldom	Sometimes	Often	Always
New cases	16/171 (9.4)	7/62 (11.3)	3/47 (6.4)	3/31 (9.7)	3/42 (7.1)
Recurrent cases	21/88 (23.9)	5/32 (15.6)	8/28 (28.6)	3/10 (30.0)	6/21 (28.6)

Warm-up time	Minutes			
	1-2	3	4	5+
New cases	3/58 (5.2)	11/128 (8.6)	13/128 (10.2)	3/24 (12.5)
Recurrent cases	8/20 (40.0)	18/78 (23.1)	13/61 (21.3)	2/12 (16.7)

Warm-up frequency and time

Whether a player "warms up" before playing, or for how long, does not seem to be a factor associated with the occurrence of tennis elbow (Table 9). Neither the slight increase in incidence or the decrease in recurrence with longer warm-up times is statistically significant.

TABLE 10
Occurrence of tennis elbow by racket material, weight, and grip size

Racket material	Wood	Metal	Composition
New cases	15/170 (8.8)	13/123 (10.6)	3/39 (7.7)
Recurrent cases	18/62 (29.0)	14/65 (21.5)	9/35 (25.7)

Racket weight	Heavy or medium	Light or very light
New cases	11/130 (8.5)	14/144 (9.7)
Recurrent cases	17/64 (26.6)	17/72 (23.6)

Racket grip size	Small (<4% inches)	Large (4% inches +)
New cases	8/132 (6.1)	24/190 (12.6)
Recurrent cases	19/75 (25.3)	22/99 (22.2)

χ^2 , 1 d.f. = 3.73, $P < 0.06$

TABLE 11
Incidence of tennis elbow by grip size and age

	Grip size	
	Small (<4% inches)	Large (4% inches +)
Age < 40	6/107 (5.6)	10/127 (7.9)
40+	2/56 (3.6)	14/63 (22.2)

χ^2 , 1 d.f. = 0.46, $P = NS$
 χ^2 , 1 d.f. = 8.77, $P < 0.01$

Racket material, weight, and grip size

No significant variation in either incidence or recurrence of tennis elbow symptoms was evident based on racket material or racket weight (Table 10). A higher incidence of symptoms was observed for a larger grip size which approached statistical significance (Table 10). Further examination revealed that this effect was limited to the over 40 age group where the larger grip size was associated with a significantly higher incidence of tennis elbow (Table 11).

Effectiveness of preventive measures

The various methods used by the afflicted players in the study population to alleviate their tennis elbow disabilities and prevent recurrences are listed in Table 12. Over-all, about one-fourth of the respondents with a previous history of tennis elbow suffered a recurrence during the 2-month study period. Effectiveness of the different methods varied from only 21% recurrence among players with mild cases who changed stroke technique to over 41% recurrence among players with mild or severe cases who used a forearm brace. Too few players (3) in the study population had surgery for tennis elbow to allow for a reliable analysis. One of the three surgical cases reported a recurrence during the study period. Although changes in stroke technique and/or racket were the most effective at preventing recurrences, information on the nature of these changes was not available from the survey.

DISCUSSION

The symptoms of tennis elbow are not peculiar to tennis players, or limited to the elbow. "Painful shoulder" (subacromial bursa), miner's elbow, and housemaid's knee are other names for similar conditions. As these names suggest, the conditions are frequently associated with specialized and repetitious use of the joint involved. The question we are asking concerning tennis elbow is whether the risk is greater for tennis players because there are some unique characteristics of the game which predispose to the condition, or because playing tennis simply results in overuse of the elbow joint. The findings of this study support the latter conclusion.

As in other studies,^{1, 2, 6-8} no difference in the incidence or recurrence of tennis elbow was observed between men and women, and age was the most important factor relating to tennis elbow in the study population. The slight decline in total cases after age 50 (Table 3) may be due to diminished intensity of play at these older ages as Nirschl⁶ suggested or to the fact that those afflicted with tennis elbow at earlier ages ceased to play and were not included in this study population.

TABLE 12
Effectiveness of preventive measures^a

Measure	Symptom severity	Total no.	% recurrence	
			Mild vs. severe	Over-all
Change of stroke technique	Mild	67	20.9	25.0
	Severe	21	38.1	
Change of racket	Mild	55	25.5	25.3
	Severe	24	25.0	
Exercise to increase forearm strength	Mild	43	30.2	31.7
	Severe	19	31.6	
Forearm brace	Mild	36	41.7	41.7
	Severe	24	41.7	
Medication	Mild	27	29.6	35.0
	Severe	33	39.4	
Surgery	Mild	1	—	33.0
	Severe	2	50.0	
Rest, with no treatment	Mild	9	33.3	38.5
	Severe	4	50.0	
All cases	Mild	149	23.5	25.8
	Severe	60	31.7	

^a Some respondents reported more than one measure and have been included in the totals for each one reported.

Since there is no parallel increase in either incidence or recurrence with the number of years played, the association with age appears to be directly related to aging and not to cumulative exposure to the game. Incidence, but not recurrence, is also related to the amount of playing time per day, although the importance of playing time is greater for those under 40 years of age. An interaction between playing time and age is evident here, which suggests that more playing time may lead to the onset of tennis elbow at an earlier age. With regard

to the pathology of the condition this may mean overuse hastens the onset of degenerative changes responsible for the symptoms. That the amount of playing time does not affect recurrence also points to the existence of progressive degenerative changes which are unlikely to regress entirely, even with less strenuous use of the joint.

Among other factors examined in this study, playing ability was related to the incidence of tennis elbow but only because the better players spent more hours per day playing. When playing time was controlled (Table 8), the association between higher incidence and better ability is no longer significant. This is contrary to the findings of at least two investigators^{2,3} who have reported that inexperienced players are more likely to use inappropriate stroke techniques which result in greater mechanical stress on the elbow. Although differences in stroke technique between inexperienced and experienced players are well-documented by these authors,^{2,3} the present data, if substantiated in further studies, raise questions about the significance of these differences for the etiology of tennis elbow.

There were no discernible differences in incidence or recurrence rates based on racket materials or weights. Previous studies have been inconclusive on this point, although several investigators^{2,6} have emphasized the importance of using rackets of proper weight.

Players over 40 years old using larger grip sizes (4 1/4 inches or larger) experienced an incidence rate over six times that for smaller grip sizes (Table 11). It is not immediately evident how larger grip size might relate to the pathology of tennis elbow. This finding is especially surprising since Bernhang et al.² have concluded that use of the largest grip comfortable is effective prophylaxis against developing tennis elbow. Perhaps continued use of heavier rackets with larger grip sizes by the older players results in an increased "load" on the arm structures as muscle strength declines. Further verification and study of this point is required.

A change in stroke technique and/or a change of racket were among the successful methods for preventing recurrence (Table 12). Notably, changing stroke technique was relatively unsuccessful in preventing the recurrence of severe cases, whereas a change of racket was equally successful in mild and severe cases. However, the precise nature of the racket change(s) associated with lower recurrence was not identified, and therefore no conclusion can be made. As previously mentioned, no over-all association was observed between racket characteristics and recurrence rates, although respondents were asked only about their current equipment and changes which may have been made to alleviate tennis elbow symptoms would not be evident from this. This point warrants more complete investigation.

Medication and particularly use of a forearm brace were not among the successful methods. It may be that these techniques, which tend to reduce the symptomatic pain of tennis elbow, encourage players to continue excessive use of the elbow in playing tennis and other activities.

Our findings are consistent with the hypothesis that tennis elbow is a degenerative type of disease, the onset of which is hastened by overuse of the arm and elbow as occurs in tennis. The etiologic importance of factors such as ability, experience, warm-up, and racket characteristics (other than grip size) was not demonstrated in this study.

REFERENCES

1. Allman FL: Tennis elbow, Etiology, prevention and *treatment*. *Clin Orthop* 3: 308-316, 1975
2. Bernhang AM, Definer W, Fogarty C: Tennis elbow. A biomedical approach. *Am J Sports Med* 2: 235-258, 1974
3. Nirschl RP: Tennis elbow. *Primary Care* 4: 367-382, 1977
4. Goldie L: Epicondylitis lateralis humeri (epicondalgia or tennis elbow). A pathogenic study. *Acta Chir Scand Suppl* 339: 104-109, 1964
5. Roche Pi, Brubaker ML: The problems of tennis elbow. A review. *J Am Osteopath Assoc* 57: 268-271, 1957
6. Nirschl RP: The injuries of tennis etiology and treatment of tennis elbow. *World Tennis* 20: 22-28, 1972

- 7, Garden RS: Tennis elbow. *J Bone Joint Surg* 42B: 788-792, 1960
8. Coonrad RW, Hooper WR: Tennis elbow. Its course, natural history, conservative and surgical management. *Bone Joint Surg* 55: 1177-1182, 1973
9. Nirschl RP: Tennis elbow. *Orthop Clin North Am* 4: 787-800, 1973
10. Plagenhoef S: *Fundamentals of Tennis*. Englewood Cliffs, NJ, Prentice-Hall, 1970
- II. Colt E: Tennis elbow. *Br Med J* 4: 679, 1970
12. Stillman FH: Preventing tennis elbow. *N Engl J Med* 294: 172, 1976